



BOOK OF ABSTRACTS

**XVIII International Conference on
Surfaces, Materials and Vacuum 2025**

Sociedad Mexicana de Ciencia y Tecnología de Superficies y Materiales

EDICIÓN NÚMERO: XVIII

BUAP

Benemérita Universidad
Autónoma de Puebla



Ciencia y Tecnología

Secretaría de Ciencia, Humanidades, Tecnología e Innovación



EDINBURGH
INSTRUMENTS



Malvern
Panalytical



AcMax
solución estratégica

IOP

Institute of Physics

Fleming

FARMACIAS UNIVERSITARIAS

LAS MÁS COMPLETAS

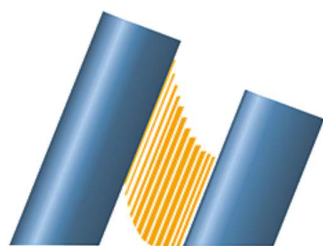


nanociencias
de México

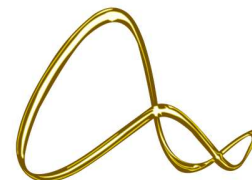
EDWARDS



INTERCOVAMEX



CENTRO DE NANOCIENCIAS
Y NANOTECNOLOGÍA



upiita-ipn



Cinvestav



SOCIEDAD MEXICANA DE CIENCIA Y TECNOLOGÍA DE SUPERFICIES Y MATERIALES A.C.
XVIII INTERNATIONAL CONFERENCE ON SURFACES, MATERIALS AND VACUUM
SEPTEMBER 22 TO 26, 2025, PUEBLA, MEXICO

**ORGANIZING
COMMITTEE**

María Leticia Pérez Arrieta
UAZ

Eduardo Martínez Guerra
CIMAV

Abraham N. Meza Rocha
SECIHTI-BUAP

Noboru Takeuchi Tan
CNYN-UNAM

Ateet Dutt
UNAM

Yenny Lucero Casallas Moreno
SECIHTI-UPiITA-IPN

Cristo Manuel Yee Rendón
UAS

**LOCAL ORGANIZING
COMMITTEE**

Dr. Rosendo L. Lozada Morales
FCFM-BUAP

Dr. Salvador Carmona Tellez
SECIHTI-BUAP

Dr. Abraham N. Meza Rocha
SECIHTI-BUAP

Dr. Gregorio Hernández
Cocoletzi
IFUAP-BUAP

Dr. Wilfrido Calleja Arriaga
INAOE

**PROGRAM
COMMITTEE**

- ☞ **Atomic Layer Deposition**
Dr. Pierre Giovanni Mani González (UACJ)
Dr. Frank Romo García (UNISON)
Dr. Matthew Snelgrove (University of Limerick-Ireland)
- ☞ **Biomaterials and Polymers**
Dr. César Márquez Beltrán (BUAP)
Dr. Amir Maldonado Arce (USON)
- ☞ **Characterization and Metrology**
Dr. Alfonso Pérez García (CIMAV-MTY)
Dra. Lilita Licea Jiménez (CIMAV-MTY)
Dr. Francisco Javier Flores Ruiz (IF-BUAP)
- ☞ **Luminescence Phenomena: Materials and Applications**
Dr. Vicente Vargas: (BUAP)
Dr. Uriel Balderas: (IIM-UNAM)
- Microelectronics and MEMS**
Dr. Norberto Hernández Como (Centro De Nanociencias y Micro y Nanotecnologías, IPN)
Dr. Isai Salvador Hernández Luna (Centro De Nanociencias y Micro y Nanotecnologías, IPN)
- ☞ **Nanostructures**
Dra. Reyna Méndez Camacho (CINVESTAV-IPN)
Dr. Víctor Cabrera Arenas (UPIITA-IPN)
- ☞ **Plasma and Vacuum**
Dr. José G. Quiñones Galván, (CUCEI, U de G)
Dr. Miguel Ángel Santana Aranda, (CUCEI, U de G)
- ☞ **Renewable Energy: Materials and Devices**
Dr. Mario Fidel García Sánchez (UPIITA-IPN)
Dra. Issis Claudette Romero Ibarra (UPIITA-IPN)
- ☞ **Semiconductors**
Dr. Joaquín Alvarado Pulido (BUAP)
Dr. Irving Eduardo Cortes Mestizo (CIACYT-UASLP)
- ☞ **Tribology, Surfaces and Interfaces**
Dr. Edgar Enrique Camps Carvajal (ININ)
Dr. Ernesto David García Bustos (SECIHTI-UPVM)
- ☞ **Theory and Simulation of Materials**
Dra. Ariadna Sánchez Castillo (UAEH)
Dr. Edgar Martínez (UANL)
Dra. Sandra Julieta Gutiérrez (IFUNAM)
- ☞ **Thin Films**
Dr. Alfredo Morales Sánchez (INAOE)
Dr. Servando Aguirre (CIMAV)
- ☞ **Science Outreach**
Dra. Dalia Alejandra Mazón Montijo (SECIHTI, TECNOL-CIIT)
Dr. Wilfrido Calleja Arriaga (INAOE)



Dear Colleagues,

From its inception, the Annual Conference of the Sociedad Mexicana de Ciencia y Tecnología de Superficies y Materiales (SMCTSM, Mexican Society of Science and Technology of Surfaces and Materials) has been an important forum for the Mexican scientific community to discuss topics related to research in the fields of surface and materials science.

On this occasion, we are pleased to welcome you to participate in the XVIII International Conference on Surface, Materials and Vacuum (ICSMV), to be held in Puebla, México, from September 22-26, 2025.

The conference program includes plenary talks, short courses, and the various symposia featuring oral and poster presentations. In addition to the scientific program, there will be a Science Outreach symposium, a traditional forum that brings together students and the general public to engage with the Society's work.

We hope that the efforts of the organizing committee, sponsors and colleagues will lead to an engaging and friendly gathering, providing opportunities for close and new interactions among researchers from diverse institutions.

The XVIII ICSMV
Organizing Committee SMCTSM
Puebla, Mexico
September 2025



Alessandro Chiasera, PhD

IIFN-CNR, CSMFO Lab and FBK Photonics Unit, Trento, Italy

Flexible glass planar structures fabricated by rf-sputtering



A.H. MacDonald, PhD

Physics Department, University of Texas at Austin, USA

Moiré Materials



Cathy Wong, PhD

University of Oregon, USA

In situ transient absorption spectroscopy during materials formation



Huziel Saucedo, PhD

Institute of Physics-UNAM, México

Machine Learning in condensed matter: from molecular systems to materials



Juan Francisco Rivas Silva, PhD

IFUAP, Puebla, México

An overview of computational material modelling



Jean-Claude M'Peko, PhD

São Carlos Institute of Physics, University of São Paulo, Brasil

Flash and Reactive Flash Sintering in Electroceramics Manufacturing



Manuel Quevedo, PhD

University of Texas, Dallas, USA

CHIPs Act and Related Efforts in North Texas in Semiconductor Materials and Devices for Harsh Environments



Sergio Ivan Yanez Sanchez, MSc

C2MI, Quebec, Canada

C2MI's collaborative model for innovation: The Canadian experience on Lab to Fab development for next generation MEMS



PLENARY TALKS

Alessandro Chiasera



Researcher
Institute for Photonics and Nanotechnologies (IFN-CNR), Unit of Trento

Affiliation: IFN-CNR, CSMFO Lab and FBK Photonics Unit, Trento

alessandro.chiasera@cnr.it

Research: Photonic devices, Glasses and films for photonic applications, Optical planar waveguides, Nanostructured and composite materials, Photonic crystals, Artificial opals

Alessandro Chiasera received his Ph.D. degree in Physics in 2003. He is currently a Researcher at the Institute for Photonics and Nanotechnologies (IFN-CNR), Unit of Trento, Italy. Since 2000, his main research has focused on the development and diagnostics of photonic devices based on glass matrices fabricated by various techniques, particularly rf-sputtering. His work covers the properties, structure, and processing of glasses and films for photonic applications, as well as the modeling and interpretation of related physical phenomena. He has contributed extensively to the fabrication and optical, structural, and spectroscopic characterization of optical planar waveguides (via dip-coating, spin-coating, rf-sputtering, and ion-exchange) activated with rare earth ions. His research also extends to nanostructured and composite materials, such as co-activated systems with metal nanoparticles, ultra-transparent glass-ceramics, and 1D photonic crystals and artificial opals fabricated using sol-gel and rf-sputtering techniques. He has participated in numerous national and international projects in glass photonics. He has published over 343 articles in international scientific journals, presented 305 communications at national and international conferences, and has an H-index of 37.

Education: Ph.D. in Physics, 2003.

Flexible glass planar structures fabricated by rf-sputtering.

The benefits in terms of cost efficiency and versatility achieved through the development of flexible and stretchable electronics and optoelectronics, in contrast to rigid systems, have greatly fueled the exploration of flexible photonic technologies. Introducing mechanical flexibility to photonic structures enables novel functionalities, further broadening their already extensive range of applications. Alongside advancements in flexible photonics based on organic platforms, an emerging approach is gaining attention, emphasizing the use of inorganic, all-glass ultra-thin structures. For oxide-based materials, their intrinsic properties, such as transparency, high thermal resistance, and chemical stability, can be harnessed within appropriate systems.

In this study, we present flexible $\text{SiO}_2/\text{HfO}_2$ one-dimensional photonic crystals and Er^{3+} -doped flexible planar waveguide, fabricated via radio frequency sputtering. The photonic crystals exhibit a pronounced dependence of their optical properties on the angle of light incidence, particularly demonstrating a blue-shift of the stopband and a narrowing of the reflectance window. However, the most remarkable finding lies in the experimental evidence showing that even after breakage, with visible cracks forming in the flexible glass, the multilayer structures largely retain their integrity. The waveguiding system, deposited on ultrathin flexible glass substrate, showed an attenuation coefficient lower than 0.2 dB/cm at 1.54 μm and exhibits emission in the NIR region. This positions them as promising candidates for flexible photonic applications due to their robust optical, thermal, and mechanical stability.



A.H MacDonald



Professor
Department of Physics

Affiliation: University of Texas at Austin, Austin, TX, USA

Research: Condensed matter theory, Mathematical modeling of physical systems, Strongly correlated electron systems

Allan H. MacDonald is a Professor of Physics at the University of Texas at Austin, which he joined in 2000. He earned his undergraduate degree in Mathematics and Physics from St. Francis Xavier University in Nova Scotia, Canada, and pursued graduate studies in Physics at the University of Toronto. Prior to UT Austin, he conducted research at the National Research Council of Canada and Indiana University. With more than 30 years of contributions to condensed matter theory, his work focuses on developing mathematical models to understand and predict unexpected behaviors in complex materials. Widely recognized for his insights into correlated electron systems, MacDonald has trained and mentored numerous young scientists, continuing to inspire new directions in theoretical physics.

Affiliations (visiting/prof.): National Research Council of Canada (former), Indiana University (former)

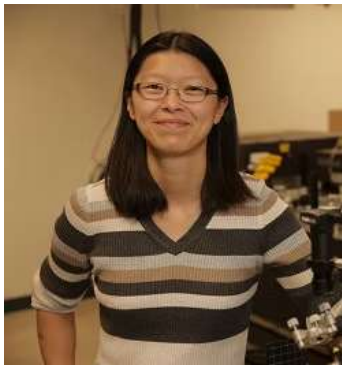
Education: Undergraduate degree in Mathematics and Physics, St. Francis Xavier University; Graduate studies in Physics, University of Toronto

Moiré Materials

When a moiré pattern is formed by overlaying 2D semimetals or semiconductors with a twist or a difference in lattice constant, low-energy electrons and long-wavelength excitonic collective models are accurately described by periodic Hamiltonians with lattice constants on the 10 nm scales. 2D electron systems of this type have become known as moiré materials, which act like artificial crystals in which the number of electrons per effective atom can be electrically varied by around 10 – effectively moving through the moiré material periodic table. In recent years moiré materials have emerged as a powerful platform for fundamental physics studies of strongly correlated matter, especially strongly correlated topological matter. I will discuss different strategies for deriving moiré material effective Hamiltonians, and review some of the rich physics that has been observed in this materials platform.



Cathy Wong



Associate Professor
Department of Chemistry and Biochemistry

Affiliation: University of Oregon, Eugene, OR, USA

Honors: National Science Foundation CAREER Award

Research: Ultrafast spectroscopy, Organic thin films, Semiconducting nanocrystals, In situ characterization of material formation and degradation

Cathy Wong is an Associate Professor in the Department of Chemistry and Biochemistry at the University of Oregon, which she joined in 2015. She received her B.Sc. from McMaster University in 2004 and her Ph.D. in Chemistry from the University of Toronto in 2011. Following her doctoral studies, she was awarded an NSERC Postdoctoral Fellowship at the University of California, Berkeley. Wong is a spectroscopist specializing in probing the formation, processing, and degradation of materials in situ during chemical transformations. Using ultrafast laser techniques, she pioneered single-shot transient absorption to study organic thin films and semiconducting nanocrystals. Her research has been recognized with a National Science Foundation CAREER Award. She also serves as faculty sponsor for the Community for Minorities in STEM at the University of Oregon.

Education: B.Sc., McMaster University, 2004; Ph.D. in Chemistry, University of Toronto, 2011; NSERC Postdoctoral Fellowship, University of California, Berkeley

In situ transient absorption spectroscopy during materials formation

Molecules, polymers, and nanocrystals can form the active layer in electronic devices such as photovoltaics and light-emitting diodes. Their electronic structure and excited state dynamics dictate their function and suitability for these applications. Transient absorption (TA) spectroscopy is used to measure these properties, and has provided remarkable insights into the behavior and function of electronic materials. However, multiple minutes-to-hours are typically required to perform these measurements, making it difficult to accurately measure the excited state dynamics of unstable and evolving materials systems such as electronic materials during their synthesis or deposition into a thin film. In this seminar, I will introduce a novel implementation of TA spectroscopy that can measure transient spectra in 8 ms, with good signal-to-noise achieved in ~ 30 s. This new technique is applied to the study of organic molecules during their aggregation into a thin film, as well as lead-halide perovskite nanocrystals during their synthesis. These examples demonstrate that in addition to providing an understanding of how excited state dynamics change during materials formation, TA signals measured in situ can reveal new insights into the mechanisms of complex materials formation processes.



Juan Francisco Rivas-Silva



Research Professor
Institute of Physics "Luis Rivera Terrazas" (IFUAP)

Affiliation: Benemérita Universidad Autónoma de Puebla (BUAP), Puebla, Mexico

rivas@ifbuap.buap.mx

Honors: Member of the Mexican National System of Researchers (SNI), Level III

Research: Computational condensed matter physics, Density Functional Theory (DFT), Hartree-Fock methods, Quantum chemistry, Optical and electronic properties of nanomaterials, Luminescent materials, Biomolecular modeling in nanotubes, Nanostructured systems

Dr. Juan Francisco Rivas-Silva is a Research Professor at the Institute of Physics "Luis Rivera Terrazas" (IFUAP) of the Benemérita Universidad Autónoma de Puebla (BUAP), Mexico. He is a member of the Mexican National System of Researchers (SNI), Level III. His work centers on computational modeling of condensed matter systems, bridging theoretical, methodological, and applied aspects. Based on quantum principles and atomic theory, his research employs Hartree-Fock, Density Functional Theory, and advanced computational tools such as Gaussian, CASTEP, VASP, Wien2k, and GAMESS to investigate the structural, electronic, and optical properties of atoms, molecules, solids, and nanostructures. His group has developed significant contributions in areas such as luminescence spectroscopy of biomolecules, encapsulation of medical compounds in boron nitride nanotubes, and optical applications of rare-earth doped thin films. Dr. Rivas-Silva has authored numerous research articles in international journals, including ACS Omega, Chemical Physics, Computational Materials Science, and Crystal Growth & Design.

An overview of computational material modelling

This presentation provides an overview of the work carried out by our academic staff at IFUAP, Computational Modelling of Condensed Matter, in its methodological, theoretical, and applied aspects, over the last ten years.

Based on the atomic theory of matter, quantum principles are employed to develop structural models of the systems studied (atoms, molecules, solids in n-D) to predict, as far as possible, their physicochemical properties of interest.

In this way, the general theories of Hartree-Fock and DFT are mentioned, which, when applied together with increasingly updated and compacted numerical and computational tools in computer codes (such as Gaussian, CASTEP, Espresso, VASP, GAMESS, Wien2k, etc.), make it possible to achieve this objective.

However, in the quest to obtain results comparable to experimental data, numerous obstacles arise, ranging from theoretical to technical and computational problems, which can often be disappointing, although in other cases, quite acceptable.

As a first example of the work done, we will mention the modelling of the tryptophan molecule in its optical excitation on a Eu^{3+} ion, as studied in luminescence spectroscopy in biochemistry. Second, we will discuss the structure of medical biomolecules within nanotubes, with a focus on their use as carriers of these active substances in the body system, as seen in the study of the BNNT/Carboplatin system. Finally, some details will be given on the study of Eu luminescence in a thin film of $\text{NaYF}_4:\text{Tb}^{3+}, \text{Eu}^{3+}$ for optical applications.

In these and all other works, new methodologies had to be explored, schemes compared, and experimental data acquired; and above all, the collaboration of excellent colleagues was essential.



Huziel Saucedo



Research Professor
Institute of Physics

Affiliation: Universidad Nacional Autónoma de México (UNAM), Mexico City, Mexico

Research: Machine learning for materials science, Machine-learned force fields (MLFFs), Quantum dynamics, Computational nanoscience, Interatomic potentials, Quantum and classical propagators, Molecular and battery simulations

Dr. Huziel E. Saucedo is a Research Professor at the Institute of Physics of the National Autonomous University of Mexico (IFUNAM), where he leads the Machine Learning for Simulations research group. He earned his Ph.D. in Physics at IFUNAM, specializing in computational nanoscience. He later conducted postdoctoral research at the Fritz Haber Institute of the Max Planck Society in Berlin, where he advanced the development and application of machine learning models in materials science. Saucedo subsequently joined the Machine Learning and Big Data group at the Technical University of Berlin, where he served as a group leader until returning to IFUNAM in late 2021. His current research focuses on developing machine-learned interatomic potentials, advancing classical and quantum propagator learning, performing quantum molecular dynamics simulations, and applying machine learning to many-body quantum systems and battery physics.

Affiliations (visiting/prof.): Fritz Haber Institute of the Max Planck Society (former), Technical University of Berlin (former)

Education: Ph.D., Institute of Physics, Universidad Nacional Autónoma de México (IFUNAM)

Machine Learning in condensed matter: from molecular systems to materials

Machine learning (ML) encompasses a wide range of algorithms and models, which have been prominently applied to condensed matter physics. Some applications range from atomistic simulations, generative quantum and classical distributions, physicochemical properties learning, among many others. In this talk, we will present some examples of how ML models have advanced our understanding of molecular systems and their complex interactions. In particular, we will focus on how combining machine learned force fields (MLFFs) and quantum dynamics, reveals the intricate nature of molecular systems and materials, as well as evince the limitations of many electronic structure methods. Furthermore, we will show how MLFFs enable the study of materials under realistic simulation conditions to generate predictive observables comparable with experimental results.



Jean-Claude M'Peko



Professor
São Carlos Institute of Physics

Affiliation: University of São Paulo (USP), Brazil

peko@ifsc.usp.br

Honors: Edward C. Henry Award (2014), Electronics Division of the American Ceramic Society (ACerS, USA)

Research: Materials processing and characterization, Flash and reactive flash sintering, Dielectric response of electroceramics, Grain boundary phenomena, Correlation of microstructural and dielectric properties

Prof. Jean-Claude M'Peko is a Professor at the São Carlos Institute of Physics of the University of São Paulo (IFSC-USP), Brazil. Originally from Congo-Brazzaville, he earned his Ph.D. in Physics from the University of Havana, Cuba, in 1998. He completed postdoctoral research at the University of Minho (Portugal, 1999–2000), the University of São Paulo (Brazil, 2000–2004), and the University of Colorado at Boulder (USA, 2012–2014). His research focuses on the processing and characterization of functional materials, with emphasis on field-assisted flash and reactive flash sintering, and disentangling bulk versus grain boundary contributions to dielectric responses in electroceramic materials. He has published nearly 90 peer-reviewed articles, with an h-index of 27 (Web of Science), and has supervised multiple graduate students, including 4 M.Sc. and 6 Ph.D. theses. Prof. M'Peko received the prestigious Edward C. Henry Award from the American Ceramic Society in 2014.

Affiliations (visiting/prof.): University of Minho (Portugal), University of Colorado at Boulder (USA)

Education: Ph.D., Physics, University of Havana, Cuba (1998)

Flash and Reactive Flash Sintering in Electroceramics Manufacturing.

Conventional processing of functional materials in the form of electroceramics normally involves several steps that include calcination of the reagent-grade raw materials at a relatively-low temperature for synthesis of the end-product powder, followed by grinding to reduce particle size, compaction to get a reasonable green density, and finally sintering at a high temperature for densification. Introduced in the literature in 2010 is a novel approach known as flash sintering, which is assisted by an electric field, and whose main characteristics is that high-density electroceramics can be produced from green compacts in mere seconds, at furnace temperatures well below those required in conventional sintering. This technique has become largely explored in materials processing, and much of the effort includes advancing, as much as possible, the debate on the underlying mechanism(s). This talk aims to present results observed not only in single-phase powders, with a review of the effects of electric field strength and current density, but also in multi-phase powders where flash synthesis plus sintering, called reactive flash sintering, can develop in a single running experiment. Particularities and generalities applying in both scenarios will be discussed, including the case of ionic conductor/insulator composites where percolation effects may become the determining key.



Manuel Quevedo



Department Head, Materials Science and Engineering
Texas Instruments Chair in Nanoelectronics
Director, Center for Harsh Environment Semiconductors and Systems

Affiliation: University of Texas at Dallas, USA

Research: Nanoelectronics, Flexible electronics, High-k dielectrics, Metal gate technology, Thin film materials, Large-area electronics, Harsh-environment semiconductors, Semiconductor devices and sensors

Prof. Manuel Quevedo is Department Head of the Materials Science and Engineering Department and Texas Instruments Chair in Nanoelectronics at the University of Texas at Dallas (UTD). He is also Director of the Center for Harsh Environment Semiconductors and Systems. Before joining UTD in 2007, he worked at Texas Instruments' Silicon Technology Development Group, where he contributed to the development of advanced high-k gate dielectrics, metal gate alternatives, and shallow trench isolation technologies for CMOS. He also served as Texas Instruments' assignee at International SEMATECH, collaborating with leading semiconductor companies such as Intel, IBM, Motorola, Samsung, and AMD. Prof. Quevedo has published over 400 peer-reviewed papers, authored three book chapters, and holds 15 U.S. patents (with 6 more pending). His research spans flexible and large-area electronics, harsh-environment semiconductors, and novel materials for Si-based technologies.

Prof. Quevedo is a member of the scientific board of Nanoholdings LLC and RDUSA LLC, serves on the executive board of Context, and collaborates with the Center for Advanced Materials (Mexico) and the Center for Applied Chemistry (Mexico). He also contributes to the Texas Task Force to host the National Semiconductor Technology Center (NSTC). His research has been supported by the National Science Foundation (NSF), Air Force Office of Scientific Research (AFOSR), DARPA, Department of Homeland Security (DHS), Conacyt, Texas Instruments, and NanoHoldings LLC.

CHIPs Act and Related Efforts in North Texas in Semiconductor Materials and Devices for Harsh Environments

This talk will introduce some of the coordinated efforts ongoing in North Texas to utilize the state infrastructure and capabilities to engage in upcoming opportunities created by the CHIPs act. In addition, we will also cover research in the Center for Harsh Environment Semiconductors and Systems and show practical examples to demonstrate the impact of radiation-induced damage dose in several semiconductor materials systems.



Sergio Ivan Yanez Sanchez



MEMS Process Development Engineer

Affiliation: C2MI, Canada

Research: MEMS fabrication, Inkjet printing, Photolithography processes, Binder jetting 3D printing

Sergio Ivan Yanez Sanchez is a MEMS process development engineer at C2MI, where he has been working since 2021. He received his M.A.Sc. from Polytechnique Montreal in 2021, with research focused on binder selection for binder jetting 3D-printing technologies. His current work includes inkjet printing and photolithography processes for MEMS manufacturing.

Education: M.A.Sc., Polytechnique Montreal, 2021

C2MI's collaborative model for innovation: The Canadian experience on Lab to Fab development for next generation MEMS

In many cases the obstacle to innovation and economic growth is an ecosystem where products can't pass smoothly through research, industrial process development, and mass production. Big companies can do it all by themselves, but what about startups and small to medium size companies? In Quebec, Canada, C2MI developed a collaborative model where fundamental research and proof of concept coming from universities as well as companies can be further developed in an industrial environment. Using controlled, repeatable processes and trained operators, C2MI offers prototyping and low-volume production with easy scalability, enabling companies to transition seamlessly from lab to fab.

C2MI is a non-for-profit Innovation center with an open IP philosophy. It is equipped with automated industrial tools in class 10 clean rooms for microfabrication and class 10k-100k clean rooms for packaging. Though the years, multiple next generation MEMS processes have been developed including but not limited to IMUs, pressure sensors, microphones, microspeakers, Piezo-MEMS, biochips, and micromirrors. With MEMS performance being pushed further and further, C2MI, Canada's largest electronics and microfabrication hub is embracing new trends such as advanced packaging at wafer level for 200 and 300 mm wafers including hybrid bonding, wafer bumping, Cu TSV technology, and photonic wirebonding. Enhancements to SiN-waveguides, sub-100 nm lithography, and new materials processing like LiNbO₃ are also of interest. Additionally, being aware of the environmental impact of foundries, C2MI's development is also focusing on exploring ecofriendly processes and materials as well as optimizing its current operations. Technologies like inkjet printing that could allow a reduction of photoresist consumption, the use of alternative etching gases and biomaterials, and the reduction of water consumption are some examples of the environmental improvements a fab can undertake. In this talk, besides presenting C2MI's collaborative model, a series of case studies will be presented to illustrate some of the above-mentioned key topics.



ATOMIC LAYER DEPOSITION

CHAIRMEN

Dr. Pierre Giovanni Mani González: (UACJ), pierre.mani@uacj.mx

Dr. Frank Romo García (UNISON), frank.romo@unison.mx

Dr. Matthew Snelgrove (University of Limerick-Ireland), matthew.snelgrove@ul.ie

Atomic layer deposition (ALD), is well renowned for the growth of thin films with a high degree of thickness and stoichiometric control. Its advantageous properties have enabled its incorporation into areas such as the semiconductor industry and renewable energy sector.

The purpose of this symposium is to provide a forum for the discussion about current research and development in the field of atomic layer deposition (ALD), encouraging discussion from fundamentals to applications. The topics will include:

- Simulation, Modelling and Theory of ALD
- Precursors and chemistry
- Surface Functionalization
- Structural, chemical and electrical characterization
- Growth and Nucleation in the Ultra-Thin Regime
- Plasma-Enhanced ALD
- Molecular Layer Deposition
- Sequential infiltration synthesis
- Area selective Deposition
- Vapor Phase Infiltration



ATOMIC LAYER DEPOSITION / 14

COMPOSITION-TUNED PHOTOLUMINESCENCE IN HIGH-QUALITY $\text{CdS}_x\text{Se}_{1-x}$ THIN FILMS GROWN BY PULSED LASER DEPOSITION

Autores: Luis Arturo Martínez Ara¹; Patricia Maldonado Altamirano²

Coautores: Jaime Santoyo Salazar ³; Jorge Sastré Hernandez ⁴; Luis Ángel Bibiano Salas ⁴; Ma. de los Ángeles Hernández Pérez ⁵

¹ Centro de Análisis y Pronósticos Meteorológicos Aeronáuticos, Servicios a la Navegación en el Espacio Aéreo Mexicano

² Escuela Superior de Física y Matemáticas

³ Departamento de Física, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional

⁴ Departamento de Física, Escuela Superior de Física y Matemáticas

⁵ Departamento de Metalurgia, Escuela Superior de Ingeniería Química e Industrias Extractivas

Autor responsable de la comunicación: pma8410@gmail.com

$\text{CdS}_x\text{Se}_{1-x}$ ($0 \leq x \leq 1$) ternary semiconductor thin films were synthesized by pulsed laser deposition (PLD) on quartz substrates using a Nd:YAG laser (1064 nm). The films were grown under high vacuum (4×10^{-6} Torr) at a substrate temperature of 500 °C, varying the composition by adjusting the sulfur-to-selenium ratio in the targets. Structural, morphological and optical properties of the films were thoroughly characterized to evaluate their suitability for optoelectronic applications. X-ray diffraction revealed a hexagonal structure with a preferential orientation along the (002) plane for all compositions, and a clear shift in diffraction peaks as a function of sulfur content, consistent with Vegard's law. Atomic force microscopy (AFM) showed that all films exhibit dense, homogeneous surfaces with nanometric grain size and low roughness. Optical transmittance measurements revealed a high degree of transparency in the visible region, with optical bandgaps ranging from 1.68 eV (CdSe) to 2.39 eV (CdS), and intermediate values of 1.78, 1.90, and 2.06 eV for the ternary films. Photoluminescence (PL) spectra at room temperature showed intense, narrow emission bands that follow a tunable trend according to composition, demonstrating that precise control over the emission wavelength is achievable via anion substitution. Raman spectroscopy confirmed the co-existence of longitudinal optical (LO) phonon modes of CdS and CdSe in the ternary films, with shifts in intensity and position correlated to the sulfur content. These results demonstrate that high-crystalline-quality $\text{CdS}_x\text{Se}_{1-x}$ films with composition-dependent emission can be obtained by PLD without post-deposition treatment. The tunable optical properties, sharp emission, and high transparency make these films promising candidates for light-emitting devices, photodetectors, and other optoelectronic applications.

Keywords:

$\text{CdS}_x\text{Se}_{1-x}$, PL emission, band gap engineering, pulsed laser deposition, Raman

Reference:

Hernandez-Perez M A, Sanchez-Ramirez E A, Castillo-Plata F J, Manzo-Robledo A, Aguilar-Hernandez J R, Ezeta-Mejia A and Flores-Caballero A A 2020 Photoelectrochemical properties of chemically deposited cadmium sulphoselenide ($\text{CdS}_{1-x}\text{Se}_x/\text{ITO}$) thin films Vacuum 1751 09277

Ris work was supported by:

IPN-SIP projects 20210117, 20221713, 20231749, 20240679, 20250084, 20250026 and LABS, thanks CONA-CyT for graduate scholarship, LAMA and PMA thanks the CONACyT for post-doctoral scholarship



ATOMIC LAYER DEPOSITION / 101

PLASMA-TUNED ZnO-DOPED Ni RIN FILMS VIA PE-ALD: STRUCTURAL, OPTICAL, AND ELECTRONIC MODULATION FOR OPTOELECTRONIC APPLICATIONS

Autores: EDUARDO MARTINEZ¹; YAZMIN PALAFOX²

Coautores: ATEET DUTT³; TONATIUH SAUCEDO²

¹ CIMAV

² UNIDAD ACADEMICA DE CIENCIA Y TECNOLOGIA DE LA LUZ Y LA MATERIA, UNIVERSIDAD AUTONOMA DE ZACATECAS

³ Instituto de Investigaciones en Materiales - UNAM

Autor responsable de la comunicación: yaz.palafox@uaz.edu.mx

This work explores the structural, morphological, optical, and electrical properties of nickel-doped ZnO (ZnO:Ni) thin films synthesized via plasma-enhanced atomic layer deposition (PE-ALD). Films with Ni concentrations ranging from 1 to 5 at.% were deposited using diethylzinc (DEZ), nickel acetylacetonate ($\text{Ni}(\text{acac})_2$), and O_2 plasma (200 W) at 220 °C. The study systematically examines the effects of plasma energy and Ni incorporation on the functional characteristics of the films for optoelectronic applications. X-ray diffraction (XRD) analysis revealed that higher plasma power induces lattice strain and enhances defect formation, particularly oxygen interstitials, leading to a preferred orientation shift from the (002) to the (100) plane. Increasing Ni content resulted in progressive suppression of diffraction peak intensity, attributed to lattice distortion caused by the ionic radius mismatch between Zn^{2+} (0.074 nm) and Ni^{2+} (0.069 nm). At 5 at.% Ni, the emergence of a ZnNi_2O_4 spinel phase was confirmed by the characteristic (311) reflection at $2\theta \approx 60.37^\circ$. Atomic force microscopy (AFM) revealed a significant reduction in root mean square (RMS) surface roughness, from 2.73 nm for undoped ZnO to 0.77 nm for 5 at.% Ni, indicating enhanced surface uniformity. Scanning electron microscopy (SEM) showed a morphological evolution from faceted, rice-like grains to denser nanostructures with increasing dopant concentration. Photoluminescence spectroscopy exhibited a doping-dependent emission behavior: films with 1–3 at.% Ni displayed a blue-shifted UV emission (~ 370 nm), likely due to sp-d exchange interactions, while higher doping levels (4–5 at.%) enhanced visible emission (500–650 nm), associated with oxygen vacancies and structural defects. All films maintained high optical transparency in the visible range ($>80\%$), with a slight bandgap widening from 3.28 to 3.32 eV. Electrical measurements demonstrated that optimal Ni incorporation (1–3 at.%) reduced film resistivity by up to five orders of magnitude compared to undoped ZnO. These results confirm that PE-ALD enables precise modulation of ZnO film properties through controlled Ni doping, making them suitable for applications in UV optoelectronics ($\leq 3\%$ Ni) and spintronic devices ($> 3\%$ Ni), while preserving excellent structural integrity and optical performance.

Author will attend:

I confirm

Keywords:

ZnO:Ni thin films, plasma-enhanced atomic layer deposition (PE-ALD), photoluminescence.

Reference:

Structural and optical properties of ZnO and Ni:ZnO thin films: the trace of post-annealing



DESIGN AND EVALUATION OF A LABORATORY-SCALE ALD REACTOR: CASE STUDY WITH ALUMINUM OXIDE AND ZINC OXIDE.

Autor: Jackeline Navarro Rodríguez¹

Coautores: Francisco David Mateos Anzaldo ¹; Jesus Roman Martinez Castelo ²; Rogelio Arturo Ramos Irigoyen ¹; Oscar Manuel Perez Landeros ¹; Mario Alberto Curiel Alvarez ¹; Benjamin Valdez Salas ¹; Eduardo Martínez Guerra³; Hugo Jesús Tiznado Vázquez ⁴; Nicola Nedev ¹

¹ Instituto de Ingeniería, Universidad Autónoma de Baja California

² Universidad Autónoma de Baja California

³ Centro de Investigación en Materiales Avanzados (CIMAV-Monterrey)

⁴ Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México

Autor responsable de la comunicación: jackeline.navarro@uabc.edu.mx

Atomic layer deposition (ALD) is crucial in microelectronics because of its precise control at the atomic scale, although its sustainability remains a challenge. This work presents the results of a customized, cost-effective and efficient ALD system designed to deposit aluminum oxide (Al_2O_3) and zinc oxide (ZnO) films, using trimethylaluminum (TMA) and diethylzinc (DEZ) precursors respectively as well as hydrogen peroxide. On silicon and corning glass substrates, thin films were achieved at a temperature of 200 °C with growth rates comparable to commercial systems. Ellipsometry tests were performed to compare the thickness and obtain the optical constants of the aluminum oxide and zinc oxide deposits.

The results obtained indicate the presence of a thin film deposited on silicon with 1160 cycles, with a growth rate of 1 Å/cycle which is equivalent to a thickness of 116.38nm, as well as a refractive index of 1.76, an extinction coefficient of 0. Additionally, in the zinc oxide film deposited on a corning glass the percentage of the visible region is approximately 80%. The system stands out for its optimized design, easy handling and low cost, which makes it a viable option for academic research and applications in electronics and nanotechnology.

Keywords:

ALD, Lab-Made, Characterization, Deposition System

Ris work was supported by:

Jackeline Navarro gratefully acknowledges the financial support of CONAHCyT for the master's student grant (No. 290842). Also, Dr. Mateos thanks to Universidad Autónoma de Baja California for the financial support of the project (111/6/C/17/24) approved in the "24va. Convocatoria Interna".



SURFACE TUNNING OF GOLD NANOPARTICLES VIA ATOMIC LAYER DEPOSITION: A POWERFUL TOOL TO MAKE CONVENTIONAL CATALYSTS GREAT AGAIN

Autor: Liliana Magdalena Vargas Arreguín¹

Coautores: Andrey Simakov ²; Brenda Jeanneth Acosta Ruelas ³; Elena Smolentseva ²; Hugo Tiznado ²

¹ *Centro de Investigación Científica y de Educación Superior de Ensenada*

² *Centro de Nanociencias y Nanotecnología*

³ *CIACYT-Universidad Autónoma de San Luis Potosí*

Autor responsable de la comunicación: lmvargas@cicese.edu.mx

Heterogeneous catalysis plays a fundamental role for the chemical industry, most of the process relies on heterogeneous catalysts which global market size was USD 25.9 billion in 2024. Metal catalysts are highly valued, especially those based on gold nanoparticles (AuNPs), which have shown outstanding catalytic performance due to their physicochemical properties. However, AuNPs are very energetic and tend to agglomerate which might result in catalytic performance loss. Traditionally, agglomeration is passivated by supporting AuNPs in metal oxide supports. Nonetheless the surface is still exposed to chemical environments that could compromise the active sites of the AuNPs. Recently the synthesis of a new generation of supported catalysts, better known as inverse catalysts, represents a new strategy for AuNPs stabilization. The term “inverse catalyst” has only recently begun to reveal its full potential by simultaneously stabilizing AuNPs against agglomeration and boosting their catalytic properties due to the formation of new reaction sites. Atomic Layer Deposition technique (ALD) is widely recognized for the deposition of tunable thin films, in catalysis terms, ALD is useful to obtain core as well as yolk shell types structures. The purpose of this research is to apply ALD, to obtain inverse catalysts based on gold, with both core and yolk shell structure. AuNPs were synthesized via DP-Urea and covered with a thin layer of Al₂O₃ using TMA as precursor. The samples were characterized by TEM, FTIR, ICP, UV Vis Techniques and tested in Nitrophenol reduction to track effect of the layer over the AuNPs surface. Our results show that it is possible to optimize Al₂O₃ over AuNPs/Al₂O₃ under mild conditions to effectively obtain yolk and core shell type inverse catalysts, protecting the integrity of the AuNPs surfaces after their exposure to chemical environment.

Keywords:

AuNPs, ALD, Inverse catalysts, heterogeneous catalysis

Reference:

J. Zhang, J. Will Medlin. Catalyst design using an inverse strategy. *Surface Science Reports*, Vol. 73, 2018
<https://doi.org/10.1016/j.surfrep.2018.06.002>

Ris work was supported by:

The study was partly supported by DGAPPA (México) via project #203117, CONACyT #272894, IN112117, IN113219 y IA101018



XPS ANALYSIS OF Al_2O_3 FILMS DEPOSITED BY ALD ON SILICON SUBSTRATES

Autor: Agustín Calixto Ramos Solano¹

Coautores: Alberto Herrera Gómez²; Dulce María Guzmán Bucio³; Joaquín Gerardo Raboño Borbolla⁴; Orlando Cortazar Martínez⁵

¹ Universidad Autónoma de Querétaro

² Centro de Investigación y de Estudios Avanzados del IPN - Unidad Querétaro

³ Centro de Investigación y Estudios Avanzados (CINVESTAV) unidad Querétaro

⁴ Cinvestav, Unidad Querétaro

⁵ CINVESTAV, Unidad Querétaro

Autor responsable de la comunicación: aramos37@alumnos.uaq.mx

Aluminum oxide (Al_2O_3), or alumina, is a high-performance ceramic material widely used across various industries due to its excellent physical properties such as hardness, thermal stability, and corrosion resistance. In the aerospace industry, alumina is particularly relevant for its thermal resistance and is used as a thermal shield for critical components. In this work, Al_2O_3 films were deposited on (100) silicon wafers using atomic layer deposition (ALD), and their chemical composition and film thickness were analyzed using X-ray photoelectron spectroscopy (XPS).

Prior to deposition, the silicon substrates underwent standard RCA cleaning to remove any type of surface contaminants. ALD was carried out at 250 °C using trimethylaluminum (TMA) and deionized water (type 1) as precursors, with dose times of 21 ms for TMA and 15.5 ms for H_2O , purge times of 15 s for both, and a total of 20 cycles. The ALD system used in this work was a Savannah Cambridge 100.

XPS analysis was performed using a non-monochromatic Al K α source (1487.6 eV, XR4, ThermoFisher) and a 7-channeltron hemispherical analyzer (Alpha110, ThermoFisher), assembled by Intercovamex. Spectra were processed using AAnalyzer®, applying advanced background models including Shirley-Sherwood, SVSC (Shirley-Vegh-Salvi-Castle), and Tougaard (two-parameter). Peak fitting and multilayer modeling enabled quantitative analysis of the chemical composition of the samples and estimation of film thickness. The results confirmed the presence of Al_2O_3 on the silicon surface, demonstrating the effectiveness of the ALD process and the sensitivity of XPS for thin-film characterization.

Keywords:

ALD, XPS, Surface analysis, Chemical composition, Thin films.

Reference:

D. Shah, D. I. Patel, T. Roychowdhury, D. Jacobsen, J. Erickson, y M. R. Linford, *Optical function of atomic layer deposited alumina (0.5–41.0 nm) from 191 to 1688 nm by spectroscopic ellipsometry with brief literature review (2019). <https://doi.org/10.1116/1.5114827>

Ris work was supported by:

This work was partially financed by CONAHcyT Project Fronteras 58518, Mexico



ATOMIC LAYER DEPOSITION / 400

CHEMICAL COMPOSITION AND INTERFACIAL ANALYSIS OF ATOMIC LAYER DEPOSITED ZrO_2 TIN FILMS ON Si(100)

Autor: Emmanuel Martinez^{None}

Coautores: Alberto Herrera Gómez ¹; Dulce María Guzmán Bucio ²; Orlando Cortazar Martinez ³

¹ Centro de Investigación y de Estudios Avanzados del IPN - Unidad Querétaro

² Centro de Investigación y Estudios Avanzados (CINVESTAV) unidad Querétaro

³ CINVESTAV, Unidad Querétaro

Autor responsable de la comunicación: emmanuel.martinez5349@alumnos.udg.mx

The electronics industry has reached the limits of transistor miniaturization using silicon dioxide. As a result, alternative high-dielectric-constant materials, such as zirconium dioxide (ZrO_2 or zirconia), are being explored. Zirconia is a promising high-k dielectric for advanced semiconductor devices due to its thermal stability and compatibility with silicon substrates. Characterizing the chemical composition and thickness of both the zirconia layer and the interface is essential for ensuring control over the fabrication process. X-ray Photoelectron Spectroscopy (XPS) is a powerful technique that enables this characterization and facilitates future correlation between these physicochemical properties and the performance of electronic devices based on such multilayered structures.

In this work, ZrO_2 thin films were deposited on Si(100) wafers using a Savannah Cambridge 100 atomic layer deposition (ALD) system. The films (thicknesses <10 nm) were grown using tetrakis(ethylmethylamide)zirconium and Type 1 deionized water as precursors. Prior to deposition, the Si(100) substrates were cleaned

using the standard RCA method and etched with HF to remove the native oxide.

The samples were analyzed by XPS using a monochromatic Al K α source (1487.6 eV, XR5, ThermoFisher) and a 7-channeltron hemispherical analyzer (Alpha110, ThermoFisher), assembled by Intercovamex. The spectra were peak-fitted using AAnalyzer® software, employing advanced methods such as the Active Background Approach, which allows simultaneous fitting of peaks and background, and the Simultaneous Fitting method, which allowed for simultaneously analyzing spectra from samples corresponding to different numbers of ALD cycles. Chemical composition and thickness were evaluated using the MultiLayer Method.

The analysis of peak intensities confirmed the formation of a stoichiometric ZrO_2 layer and a zirconium silicate interfacial layer. Further experiments are needed to grow zirconia without an interfacial layer, at least not detectable within XPS limits, and to determine the growth rate of zirconia.

Keywords: zirconia, ALD, XPS

Acknowledgments

Keywords:

ALD, XPS, Silicio, zirconia

Reference:

Ceballos Sánchez, O. (2015). Stabilité thermique de structures de type TiN/ ZrO_2 /InGaAs [Tesis doctoral, Université Grenoble Alpes]. Cinvestav-Querétaro y CEA-LETI.

Ris work was supported by:

This work was partially financed by CONAHcyT Project Fronteras 58518, Mexico



EXPLORING NEXT-GEN PHOTOELECTRODES WITH PALD ON 3D-PRINTED POLYMER STRUCTURES

Autor: Edgar Homero Ramirez Soria¹

Coautores: Eduardo Martínez Guerra ¹; Maria Isabel Mendivil Palma ¹; Mario Alberto Hidrogo Rico ¹; Tania Ernestina Lara Cenicerros ¹; Alfredo Aguilar Elguezabal ²; Jose Bonilla Cruz ¹

¹ *Subsede Monterrey - Centro de Investigación en Materiales Avanzados, Av. Alianza Norte 202, Apodaca, Nuevo León-México*

² *Laboratorio de Materiales Nanoestructurados -Centro de Investigación en Materiales Avanzados, Chihuahua, Chihuahua- México*

Autor responsable de la comunicación: edgar.ramirez@cimav.edu.mx

Photoelectric energy technologies are at the forefront of contemporary scientific research, driven by the urgent need to identify alternative energy sources to replace fossil fuel-based methods. Furthermore, three-dimensional (3D) printing technologies have initiated a revolution in numerous manufacturing processes; however, significant limitations remain, particularly in applications requiring functional surface properties. In the context of photoelectric applications, such as water splitting and photoelectrochemical oxidation, as-printed electrodes often exhibit limited photoelectric activity due to their relative inertness. To overcome this, research groups have explored various coating techniques to deposit photoactive layers onto 3D-printed electrodes. Among the methods used, such as electrodeposition and anodization, only Atomic Layer Deposition (ALD) stands out for its ability to deposit materials with angstrom-level precision and strong substrate adhesion, without compromising the complex geometries of 3D-printed structures. Unlike methods such as sputtering or electron beam deposition, ALD ensures uniform coverage even on high-aspect-ratio surfaces, making it uniquely suited for enhancing the photoactivity of 3D-printed electrodes.

In this context, plasma-assisted atomic layer deposition (PALD) is applied for the first time in conjunction with polymer-based 3D-printed substrates to fabricate high-aspect-ratio photoactive electrodes. To demonstrate this concept, zinc oxide (ZnO) was deposited via plasma-assisted atomic layer deposition (PALD) onto stereolithographic vat-polymerized 3D-printed electrodes with gyroid infill, using commercial resin. Moreover, by modulating the deposition chamber temperature during the process, the electrical performance of the ZnO can be optimized. This approach demonstrates that the combination of PALD and polymer 3D printing enables the direct fabrication of photoelectrodes using photoactive materials. This facilitates rapid prototyping and opens new possibilities for advancements not only in energy systems but also in biomedical and electronic applications.

Keywords:

PALD, 3D-Printing, Photoelectrodes

Reference:

Browne, M. P., Plutnar, J., Pourrahimi, A. M., Sofer, Z., & Pumera, M. (2019). Atomic layer deposition as a general method turns any 3D-printed electrode into a desired catalyst: Case study in photoelectrochemistry. *Advanced Energy Materials*, 9(26), 1900994.

Ris work was supported by:

E.H.R.S. expresses appreciation to SECIHTI-Mexico for awarding the "Estancia Posdoctoral Académica Inicial 2022." J.B.C. and E.M.G. extend their gratitude for the Proyecto Interno - CIMAV 25001 and 26005. This endeavor received partial support from the bilateral project CONAHCYT-AFOSR CC0015-2016-05-279915.



ATOMIC LAYER DEPOSITION / 31

ATOMIC LAYER DEPOSITION AT THE ENGINEERING INSTITUTE OF UABC, MEXICALI: PAST DEVELOPMENTS, CURRENT ADVANCES, AND FUTURE DIRECTIONS

Autor: Jesus Roman Martinez Castelo¹

Coautores: Francisco David Mateos Anzaldo ²; Jackeline Navarro Rodríguez ²; Juan Antonio Ruiz Ochoa ³; Armando Pérez Sánchez ³; Claudia Salinas Boldo ⁴; Mario Alberto Curiel Alvarez ²; Hugo Jesús Tiznado Vázquez ⁵; Nicola Nedev ²

¹ *Universidad Autónoma de Baja California*

² *Instituto de Ingeniería, Universidad Autónoma de Baja California*

³ *Facultad de Ciencias de la Ingeniería y Tecnología, Universidad Autónoma de Baja California*

⁴ *Facultad de Ciencias Humanas, Universidad Autónoma de Baja California*

⁵ *Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México*

Autor responsable de la comunicación: jesus.roman.martinez.castelo@uabc.edu.mx

This work presents the historical development, current progress, and future perspectives of implementing atomic layer deposition (ALD) technology at the Engineering Institute of the Autonomous University of Baja California (UABC), Mexicali campus. The initial phase of the project focused on the electrical and optical characterization of thin films deposited by ALD, aiming to evaluate their properties for potential applications in electronic and photonic devices.

Currently, a custom ALD system has been designed and fabricated to address the specific research and educational needs of the institute. The system has been validated through the deposition and characterization of aluminum oxide (Al_2O_3) and zinc oxide (ZnO) thin films. This development phase includes the integration of precursor delivery components, temperature regulation, vacuum control, and basic automation. The objective is to provide a functional and flexible deposition platform supporting both materials science research and hands-on student training.

Future work will focus on optimizing system performance through enhanced automation, process refinement, and systematic experimental validation. Additionally, a second-generation ALD system is planned, incorporating improvements based on lessons learned from the current prototype and recent advances in ALD technology. Planned upgrades include the integration of heated precursor lines with dedicated temperature control systems to accommodate low-volatility or solid precursors, as well as the addition of plasma-assisted deposition capabilities. These enhancements aim to broaden the range of depositable materials and improve film quality through increased surface reactivity and process versatility. The upgraded system will aim to enhance scalability, precision, and reliability, further strengthening the institute's capabilities in thin-film deposition and nanofabrication.

Keywords:

ALD, System Design and Fabrication, Automation in Deposition Systems

Work was supported by:

The authors gratefully acknowledge the financial support provided by the Universidad Autónoma de Baja California for this project (111/6/C/17/24), approved under the "24va. Convocatoria Interna."



ATOMIC LAYER DEPOSITION / 428

TiO_x ANALYSIS ON THE ALD OBTENTION PROCESS BY USING TITANIUM (IV) n-BUTOXIDE: THEORETICAL AND EXPERIMENTAL STUDY.

Autores: Pierre Giovanni Mani González¹; Tanabat Promjun²

Coautores: Jesus Alfredo Hernandez Marquez ³; Moises Hernandez Robledo ³

¹ *Universidad Autónoma de Ciudad Juárez*

² *Faculty of Science at Si Racha, Kasetsart University, Sriracha Campus Chonburi, Thailand.*

³ *Institute of Engineering and Technology, Department of Physics and Mathematics, Autonomous University of Ciudad Juárez, Av. Del Charro 450 Nte, Cd. Juárez 32310, México*

Autor responsable de la comunicación: pierre.mani@uacj.mx

TiO_x layers were deposited based on metallic liquid and OH- radical liquid precursors materials which is compared step by step with simulation process of the each molecules. The methods involved the vacuum vaporization for to reaction on silicon substrate due to vapor pressure of the precursor. This can be sequential surface reactions between precursors and oxidizing agents as H₂O or H₂O₂. Theoretical investigation of the oxidation step was focusing using Density Functional Theory (DFT). TiO_x films have been deposited by thermal atomic layer deposition (ALD) onto silicon substrates. Films were analyzed with X-ray Photoelectron Spectroscopy (XPS). This photoemission-based technique gives information about Ti 2p, O 1s, and C 1s core levels. Those core levels reveal the theory and experimental chemical interaction. Activation barriers could suggest the active sites for the TiO_x formation. Despite its higher energy requirement, the O-O pathways of H₂O₂ are effectively halving the oxidant consumption energy contributed to industries obtention. XPS measurements enabled details of the chemical composition of the thin film to be characterized and offered a robust analysis of both interfaces and discrete layers present in the films according to theory results. This study displayed evidence of bonding interactions between the metals in the silicon substrate, assuming an interface that could change chemically according OH or O-O bonds which assists in developing an understanding of the preferential vaporization process which needs to be optimized for device fabrication applications

Keywords:

ALD; Titanium n butoxide; Oxidizing agents; DFT; B3LYP.

Reference:

Mani-Gonzalez, Pierre Giovanni, et al. Journal of Vacuum Science & Technology A 39.4 (2021). Promjun, Tanabat, et al. Materials Today Communications 38 (2024)



BIOMATERIALS AND POLYMERS

CHAIRMEN

Dr. César Márquez Beltrán (BUAP), cmarquez@ifuap.buap.mx

Dr. Amir Maldonado Arce (USON), amir.maldonado@unison.mx

The XVIII International Conference on Surface Materials and Vacuum takes immense pleasure & feel honored in inviting the contributors across the globe to attend in the symposium on Biomaterials and Polymers during September 22-September 26th, 2025 at Puebla, Mexico.

Conference will be organized on themes related with: 'Emerging Technologies and Scientific Advancements in polymers and Biomaterials Engineering.

The scientific event offers a best platform with its well organized scientific program to the audience which includes interactive panel discussions, plenary talks, short presentations, short courses, invited sessions and poster sessions on the topics that cover areas of:

- Polymer science
- Engineering and technologies from the latest innovations in synthesis
- Processing and modeling to the advanced applications of polymers in health
- Advanced Biomaterials
- Biomaterials and Nanotechnology Applications in Biomedicine
- Use in Therapeutic and Investigative Delivery
- Biomaterials in Biological Engineering
- Biodegradable Biomaterials,
- Utility Based Biomaterials
- Energy and sustainability
- Future materials and devices



ELECTROSPUN PVA NANOFIBERS ENCAPSULATING CIPROFLOXACIN: FABRICATION AND ANTIMICROBIAL EVALUATION

Autor: Estefania Álvarez Martínez¹

Coautores: Aime Margarita Gutiérrez Peralta ¹; Alma Delia Bertadillo Jilote ; Christian Iván Enríquez Flores ²; Claudia Elena Pérez García ¹; David Gustavo García Gutiérrez ¹; Karla Isabel Lira de León ¹; Luis Alberto Madrigal Pérez ³

¹ Universidad Autonoma de Querétaro

² Cinvestav Unidad Querétaro

³ Instituto Tecnológico Superior de Ciudad Hidalgo

Autor responsable de la comunicación: zaraestefaa@gmail.com

Polymeric nanofibers represent a promising alternative for localized drug delivery due to their high surface area, porosity, and capacity to encapsulate active compounds. In this study, nanofibers were prepared using polyvinyl alcohol (PVA), a water-soluble, non-toxic, biocompatible, and biodegradable synthetic polymer. PVA was selected for its suitability in forming thin films and stable fibrous structures via electrospinning, making it ideal for biomedical applications. The objective was to encapsulate ciprofloxacin, a broad-spectrum antibiotic, aiming at the development of an antimicrobial wound patch.

Three formulations were prepared: (a) PVA, (b) PVA/ciprofloxacin, and (c) PVA/acetic acid/ciprofloxacin. Acetic acid was included as a pH modifier and to enhance ciprofloxacin solubility. All formulations contained 5.0 µg/mL of ciprofloxacin. Electrospinning was conducted under controlled conditions (20 kV, flow rate of 1500 µL/h, and relative humidity of 35–40%), yielding continuous and uniform fibers. Fiber morphology was analyzed by scanning electron microscopy (SEM).

Drug release kinetics were monitored over 24 hours in a medium with pH 7.3 ± 1 , simulating a wound environment. Antimicrobial activity was assessed using nanofiber discs (6 mm diameter, 13.0 ± 1 mg), tested against *Escherichia coli* ATCC. Preliminary results indicate that both formulation composition and the presence of additives influence ciprofloxacin release and antimicrobial efficacy, highlighting the potential of these nanofibers as drug delivery systems for medical applications.

Keywords:

Electrospinning, PVA/ciprofloxacin nanofibers, antimicrobial activity, acetic acid.

Reference:

Ju, T., Gaisford, S., & Williams, G. R. (2024). Ciprofloxacin-loaded electrospun nanofibres for antibacterial wound dressings. *Journal of Drug Delivery Science and Technology*, 91, 105264. <https://doi.org/10.1016/j.jddst.2023.105264>

Ris work was supported by:

Universidad Autonoma de Querétaro y Cinvestav Unidad Querétaro



SYNTHESIS OF GOLD CONCAVE NANOCUBES AND THEIR EXCHANGE OF SURFACTANT WITH SODIUM CITRATE, FOR THEIR POTENTIAL USE AS SENSORS OF BIOMARKERS

Autor: Williams de Jesús Jiménez Martínez¹

Coautores: Iouri Koudriavtsev²; Patricia Talamás Rohana³; Salvador Gallardo Hernández⁴

¹ Programa de Doctorado en Nanociencias y Nanotecnología. Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional. Unidad Zacatenco

² Departamento de Ingeniería Eléctrica. Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional. Unidad Zacatenco.

³ Departamento de Infectómica y Patogénesis Molecular. Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional. Unidad Zacatenco

⁴ Departamento de Física. Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional. Unidad Zacatenco

Autor responsable de la comunicación: williams.jimenez@cinvestav.mx

The synthesis of gold nanoparticles with concave cube morphology (AuNCCs) is carried out using cetyltrimethylammonium chloride (CTAC) as a stabilizing agent. Due to their concave structure and sharp edges, these nanoparticles exhibit high electron density enhancing Localized Surface Plasmon Resonance (LSPR) and consequently the Surface-Enhanced Raman Scattering (SERS) effect. However, to employ these nanoparticles as biomarker sensors, their cytotoxicity must be reduced. A first approach is replacing CTAC with a more biocompatible surfactant as a sodium citrate. This work presents a comparison of AuNCCs obtained by both surfactants. The conventional synthesis of AuNCCs yields nanoparticles with a 34 nm size (TEM), a plasmon peak at 580 nm (UV-Vis), a hydrodynamic diameter of 58.20 nm, and a zeta potential of +52.31 mV. The surfactant exchange was performed using direct and indirect methods, as described by Zhou for anisotropic nanoparticles [1]. The indirect method resulted in a significant increase in hydrodynamic diameter to 371.66 nm and a near-neutral zeta potential (+0.0062 mV), with no visible plasmon peak in the UV-Vis spectrum, indicating loss of stability. In contrast, the direct method, using a 2:1 ratio of sodium citrate to CTAC-AuNCCs, produced particles with a plasmon peak at 588 nm, a hydrodynamic diameter of 79.24 nm, and a zeta potential of -15.8 mV. Finally, cytotoxicity tests using SKOV-3 ovarian cancer cells and the MTT assay revealed that citrate-coated AuNCCs significantly reduced toxicity after 24 hours of exposure compared to those stabilized with CTAC, highlighting their potential as safer and more effective biomarker sensors.

Keywords:

gold nanoparticles, biomarker sensors, surfactant exchange, bionanomaterials, biocompatible nanomaterials

Reference:

S. Zhou, et al. Enabling complete ligand exchange on the surface of gold nanocrystals through the deposition and then etching of silver. *Journal of the American Chemical Society*, 140(38) (2018), 11898-11901.

Ris work was supported by:

Elisa Acuña maintenance scholarship and National scholarship for postgraduate studies SECIHTI 4044363



MECHANICAL CHARACTERIZATION OF PPF-GO AND APPLICATION TO 3D PRINTED PROTOTYPES

Autores: Douglas Fuentes de la O¹; José Pardiñaz Mercado¹; Skyler Rodríguez Schenk²

Coautores: Aaron Rivas Menchi³; Alejandro May Pat³; Gerardo Alonzo¹; Jorge Alonso Uribe Calderón³

¹ *Universidad Anahuac Mayab*

² *Universidad Anahuac Mayab, Texas A&M University*

³ *Centro de Investigación Científica de Yucatán*

Autor responsable de la comunicación: douglas_fuentes@anahuac.mx

This work aims to characterize polypropylene filaments (PPF) reinforced with graphene oxide (GO) at different concentrations and geometries. Tensile and flexural specimens will be 3D printed following ASTM D638 Type I, ASTM D790, and auxetic custom designs using a Creality Ender 3 with variations on printing parameters (Nozzle and Bed temperature, print speed, infill density, pattern and orientation). Mechanical characterization on a universal testing machine will determine Young's modulus, yield and ultimate strengths, elongation at break, flexural modulus, and flexural strength. The incorporated auxetic designs, in addition to the ASTM standard, are expected to amplify mechanical characteristics in resultant stress-strain curves for analysis, where auxetic patterns undergo a "realignment" phase that produces a post-elastic region that is more readily analyzed. Scanning Electron Microscopy (SEM) will be used to assess interlayer fusion, void areas, and GO dispersion. Prior to this, the PPF-GO strands will be adapted into 1.75mm filament using a custom extrusion system run by an ESP-32 microcontroller. The ESP-32 system controls a heating element and extrusion speed to feed filament through a custom nozzle and normalize the filament. The overall outcome of the printed PPF-GO is expected to be an improvement on tensile and flexural properties compared to normal PPF while being non-toxic, biocompatible, and lightweight, making it a great option for engineering and biomedical application.

Keywords:

PPF-GO, Tensile, Flexural, Auxetic, 3D-Printing

Reference:

ASTM International, Standard Test Method for Tensile Properties of Plastics, ASTM D638-14, ASTM International, West Conshohocken, PA (2014). <https://doi.org/10.1520/D0638-14>

Ris work was supported by:

Universidad Anáhuac Mayab.



POROUS POLYMERS FROM BIOSTRUCTURES FOR WATER CONTAMINATION MITIGATION IN AGRICULTURE

Autores: Alma Berenice Jasso Salcedo¹; Gesuri Yareth Salgado Hernández²

Coautores: Alejandro López Ortiz ³; Ana Victoria Sepúlveda Salas ⁴; Blanca Cristina Hernandez ³; Javier Arcibar Orozco ⁵; Javier Eliel Morales Mendoza ³; Jorge Luis Domínguez ³; Luis Carlos Rodríguez Pacheco ⁶; Manuel Román Aguirre ³; Rocío Yaneli Aguirre Loredo ⁷; Virginia Collins Martínez ³

¹ *Corresponding Author Departamento de Ingeniería y Química de Materiales, Centro de Investigación en Materiales Avanzados. Investigadoras e Investigadores por México*

² *Presenting Author, Departamento de Ingeniería Química, Benemérita Universidad Autónoma de Puebla*

³ *Departamento de Ingeniería y Química de Materiales, Centro de Investigación en Materiales Avanzados*

⁴ *Ingeniería Matemática, Universidad Autónoma de Chihuahua*

⁵ *Departamento de Medio Ambiente y Energía, Centro de Investigación en Materiales Avanzados*

⁶ *Centro de Investigación en Materiales Avanzados*

⁷ *Departamento Procesos de Polimerización, Centro de Investigación en Química Aplicada*

Autor responsable de la comunicación: gesuri.salgadoh@alumno.buap.mx

Porous polymers represent innovative advanced materials with significant applications in adsorption. Given that the agricultural sector consumes over 70% of global freshwater and is a major source of water pollution from agrochemicals, particularly systemic neonicotinoids like imidacloprid and thiacloprid, there is an urgent need for sustainable water treatment technologies. This project aims to develop porous polymers of the MOF type, utilizing organic ligands derived from biomass, specifically ellagic acid, to achieve rapid and sustainable adsorption of agrochemicals from agricultural water. The methodology involves synthesizing MOFs through a non-solvothermal route using ellagic acid and strontium extracted from celestite by mechanosynthesis. Materials are comprehensively characterized for chemical, textural, and superficial properties (XRD, SEM-EDS, FTIR, BET, pH stability). Their efficacy in removing neonicotinoid pesticides were evaluated using UV-vis spectrophotometry. Additionally, potential environmental impacts, such as lixiviation and seed germination are assessed. This research contributes to the understanding of bio-based porous structures and their application in mitigating water pollution as well as technological development of sustainable environmental solutions in Mexico.

Keywords:

Porous Polymers, Water Treatment, Neonicotinoids, Ellagic Acid.

Reference:

E.S. Grape, et al. A robust and biocompatible bismuth ellagate MOF synthesized under green ambient conditions, *J. Am. Chem. Soc.* 142 (2020) 16795–16804. <https://doi.org/10.1021/JACS.0C07525>

Ris work was supported by:

Internal projects CIMAV 2025 No. 27027 for subject Water Crisis Management.



ZnO NANOPARTICLES EMBEDDED IN POLYMERIC MEMBRANES AND THEIR EFFECT ON PHYTOPATHOGENIC FUNGI

Autor: Mario Cervantes Contreras¹

Coautores: Armando Yavazul Sánchez González¹; Axel Uriel Colorado Delgado¹; Francisco Hernández Rosas²; José Abraham Balderas López¹; Leonel Sanchez García³; Marlene Clara Godinez Alvarez¹; Miguel Ángel Meléndez Lira⁴

¹ *Departamento de Ciencias Básicas, Unidad Profesional Interdisciplinaria de Biotecnología del Instituto Politécnico Nacional, Avenida Acueducto S/N, Col. Barrio la Laguna Ticomán, Gustavo A. Madero, 07340, Ciudad de México, México*

² *Km. 348 Carretera Federal Córdoba-Veracruz, Manuel León, Municipio de Amatlán de los Reyes, Veracruz, México C. P. 94953*

³ *Avenida Instituto Politécnico Nacional No. 2580, Col. Barrio la Laguna Ticomán, Gustavo A. Madero, Ciudad de México, 07340, México*

⁴ *Departamento de Física, CINVESTAV-IPN, Apdo. Postal 14-740, Ciudad de México, 07360, México*

Autor responsable de la comunicación: calculo1fm1@gmail.com

Polycaprolactone membranes with ZnO nanoparticles were obtained through electrospinning. The nanoparticles were obtained using green synthesis. X-ray diffraction, Raman spectroscopy and Transmission Electron Microscopy (TEM) were used to characterize the nanoparticles. The fibers with the nanoparticles were studied by Scanning Electron Microscopy (SEM) and Energy-dispersive X-ray spectroscopy (EDS). The system composed of membranes with nanoparticles was used to study its effect on phytopathogenic fungi.

Keywords:

Polycaprolactone, Nanoparticles, Electrospinning, Polymeric, Fungi

Reference:

T. Sarkar, S. Kundu, G. Ghorai, P. K. Sahoo and A. Bhattacharjee. Adv. Nat. Sci.: Nanosci. Nanotechnol. 14 (2023) 035001 (11pp).

Ris work was supported by:

Instituto Politécnico Nacional and CONAHCYT



INJECTION MOLDING PROCESS FOR POLYPROPYLENE DEVICE USED IN CHROME PLATING

Autor: Samuel de la Luz Merino¹

Coautor: José Victor Sandoval Ramos ¹

¹ *Universidad Tecnológica de Puebla*

Autor responsable de la comunicación: samuel.delaluz@utpuebla.edu.mx

Injection molding method is one of the most used to shape thermoplastic and thermoset materials, the polymer (usually, in form of pellets) is fed to a machine called injector, which plasticizes it and then injects it by positive displacement of the screw, in a closed cavity called mold. The mold presents the shape of the article what we want to get. The elements and the order that constitute a production line for a plastic product are: Material –mold –machine. In this work experimental tests were made by using a Krauss - Maffei (KM) injection molding machine model CX 80-380 (according to datasheet: Clamping force 800 KN, mold opening force 55.3 KN, Plasticizing unit SP 380, effective surface 103.869 cm², 80 Ton, Screw diameter 35 mm, maximum injection pressure 2429 bar), polypropylene (PP) devices denominated “cut current”, used as tongs to hold parts in the chromium electrolytic solution process, were obtained using a 2 plates cold runner system mold. The injection parameters were adjusted according to the manufacture of calculations, with a mass average of 8.84 grams/part, as well as the total injection cycle time that it was approximately 21 seconds. The injection molding process operated with a good analysis calculation in closing force, temperature and other important parameters were able to compensate negative effects on part quality.

Keywords:

Injection molding, polypropylene

Reference:

J. Volke, M. Reit, H.P. Heim, Parameter recommendation for injection molding based on similarity analysis of injection molded parts, Journal of Manufacturing Processes, (95), 2023, 171-182, <https://doi.org/10.1016/j.jmapro.2023.03.072>.

Ris work was supported by:

Universidad Tecnológica de Puebla



RE USE OF ISOTOPE LABELS TO STUDY INTRACELLULAR METABOLISM

Autor: Yuriy Kudriavtsev¹

Coautores: Juan Pedro Luna-Arias ²; Maria Luisa Labra-Barrios ²; Rene Asomoza ¹; Yuliana Elvira Saucillo ³

¹ Departamento Ingeniería Eléctrica - SEES, CINVESTAV, Zacatenco

² Departamento Biología Celular, Cinvestav

³ Departamento Ingeniería Eléctrica - SEES, CINVESTAV

Autores responsables de la comunicación: yuliana.elvira.s@cinvestav.mx, yuriyk@cinvestav.mx

The use of radioisotope labels in medicine and biology dates back several decades but remains very limited due to radiation hazards. A new generation of time-of-flight mass-spectrometers has found widespread application in medicine and biology thanks to their high lateral resolution and ability to analyze any stable isotopes of any element [1]. This report shows results obtained with the MDAMB231 y MCF7 breast cancer cell lines compared to the MCF-12F healthy breast cell line. One hundred thousand cells were grown on silicon substrates cultured in DMEM/F12 culture medium containing 5% horse serum for MC12F and in DMEM medium containing 10% fetal bovine serum for the breast cancer cell lines. Then, we added 1 mM thymidine labeled with ¹³C and ¹⁵N non-radioactive isotopes, and cells were incubated for 43 h at 37°C in an atmosphere containing 5% CO₂. Cells were then fixed with 4% paraformaldehyde in PBS pH 7.0 for 20 min, followed by serial dehydration. Then, the cells were analyzed using a TOF-SIMS-5 time-of-flight mass spectrometer from IonToF (Germany) by monitoring of secondary negative ions. The lateral resolution during analysis was approximately 150 nm, allowing for the visualization of intracellular structures. The images obtained show the distribution of typical elements that make up the cell structure: ¹H, ¹²C, ¹⁶O, ¹²C, etc., and the analyzed isotopes recorded using secondary cluster ions: ¹³C¹H, ¹³C¹⁴N, ¹²C¹⁵N, ¹³C¹⁵N, etc., showed the accumulation of the isotope ¹⁵N in the nuclei of dividing cancer cells. In the case of analysis of the healthy MCF-12F cell line, there was no accumulation of ¹³C and ¹⁵N isotopes in them, since the treatment time with labeled thymidine was less than its cell division time. Our results demonstrate the possibility of effectively studying intracellular metabolism using stable isotope labels.

Keywords:

Stable isotope labels, TOF-SIMS, breast cancer, intracellular metabolism

Reference:

E.A. Bonnin, S.O. Rizzoli, Novel Secondary Ion Mass Spectrometry Methods for the Examination of Metabolic Effects at the Cellular and Subcellular Levels, *Frontier in Behavioral Neuroscience* 14 (2020) 124. <https://doi.org/10.3389/fnbeh.2020.00124>

Ris work was supported by:

SECIHTI, grant CF-2023-I-1621



BIOMATERIALS AND POLYMERS / 383

DESIGN AND DEVELOPMENT OF A BIOACTIVE OCCLUSAL GUARD USING 3D PRINTING AND PHOTOGRAMMETRY

Autores: Alexis Baigts Morales¹; Heriberto Hernández Cocoltzi²

Coautores: Efrain Rubio Rosas¹; Eva Aguila Almanza¹

¹ BENEMERITA UNIVERSIDAD AUTONOMA DE PUEBLA

² Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: alexis.baigtsm@alumno.buap.mx

The limited access to dental services increases the risk of oral diseases, highlighting the need for effective protective devices like occlusal splints. Conventional splints, typically made from synthetic polymers such as ethylene-vinyl acetate (EVA) and polyvinyl chloride (PVC), present issues including high energy consumption, lack of biodegradability, biofilm formation, microplastic release, and potential long-term toxicity. This study proposes the development of a biocompatible and biodegradable occlusal splint from biopolymers and natural compounds like gellan gum, collagen, chitosan, and hydroxyapatite. This approach utilizes valuable by-products from the fishing industry in Mexico, addressing both oral health needs and environmental concerns. The splint will be designed to remineralize dental enamel and prevent oral diseases, offering advantages over traditional methods through prolonged contact with the tooth surface and personalized 3D-printed fabrication. The methodology involves the obtention of hydroxyapatite from fish waste, designing a customized dental mold using photogrammetry and 3D modeling, fabricating the biopolymers based matrix, and evaluating the mechanical material properties according to ASTM D2240-05, D570-98 (2005), D624-00, and ASTM D6110-06f guidelines. This project aims to provide an innovative, sustainable alternative for improving oral health.

Keywords:

Chitosan, Hydroxiapaite, 3D printing, Occlusal guard, Biomaterials,

Reference:

Lalebeigi, F., Alimohamadi, A., Afarin, S., Aliabadi, H. A. M., Mahdavi, M., Farahbakhshpour, F., Hashemi-aval, N., Khandani, K. K., Eivazzadeh-Keihan, R., & Maleki, A. (2024). Recent advances on biomedical applications of gellan gum: A review. *Carbohydrate Polymers*, 334, 122008. <https://doi.org/10.1016/j.carbpol.2024.122008>

Ris work was supported by:

This work was supported by Vicerrectoría de Investigación y Estudios de Posgrado, BUAP



BIOMATERIALS AND POLYMERS / 329

Thermal Diffusivity Enhancement in Polycaprolactone Fibers Through Nanomaterial Incorporation

Autor: Rubén Gutiérrez Fuentes¹

Coautores: Alfredo Cruz Orea ; Jose Luis Jiménez Pérez ; Lilia Ivonne Olvera Cano ²

¹ Tecnológico de Estudios Superiores de Villa Guerrero

² Cinvestav

Autores responsables de la comunicación: jimenezp1957@gmail.com, ruben_tol@yahoo.com.mx

The thermal properties of polycaprolactone (PCL) fibers and their nanocomposites were studied to evaluate the effect of graphene oxide (GO) and carbon nanotubes (CNT) on thermal diffusivity. Employing the Open photoacoustic cell technique, the thermal diffusivity (α) was determined in fibers that had thicknesses between 100 and 266 μm . Pure PCL fibers displayed the lowest thermal diffusivity, decreasing from $2.017 \times 10^{-3} \text{ cm}^2/\text{s}$ at 254 μm to $0.906 \times 10^{-3} \text{ cm}^2/\text{s}$ at 100 μm . The incorporation of GO enhanced thermal performance moderately, with thermal diffusivity reaching $2.6152 \times 10^{-3} \text{ cm}^2/\text{s}$ at 259 μm . In contrast, PCL/CNT fibers showed a significant improvement in thermal diffusivity, with values as high as $7.871 \times 10^{-3} \text{ cm}^2/\text{s}$ at 266 μm . These results highlight the potential of CNT as highly effective thermal diffusivity enhancers in biodegradable fiber composites, suggesting promising applications in biomedical scaffolding and thermal management systems.

Keywords:

Polycaprolactone fibers, Thermal Diffusivity, Nanocomposites, Photoacoustic Technique

Reference:

Sánchez-González, A. Y., Cervantes-Contreras, M., Balderas-López, J. A., & Meléndez-Lira, M. (2024). Thermal diffusivity measurements of polycaprolactone membranes by means of photoacoustic techniques. *MRS Advances*. <https://doi.org/10.1557/s43580-024-00768-6>

Ris work was supported by:

The author gratefully acknowledges the financial support provided by SECIHTI, Mexico, for his post-doctoral studies.



STRUCTURAL CHARACTERIZATION OF SYNTHETIC HYDROXYAPATITE BY RIETVELD REFINEMENT: EVALUATION OF PHASE PURITY AND CRYSTALLOGRAPHIC STABILITY

Autor: María Magdalena Méndez-González¹

Coautores: Dionisio Manuel Tun Molina ¹; José Armando Ezquivel Centeno ²

¹ *Depto. Física, Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional*

² *Departamento de Formación Básica, Escuela Superior de Computo, Instituto Politécnico Nacional*

Synthetic hydroxyapatite (HA) is a key bioceramic used in bone regeneration, where biological performance is closely tied to its crystal structure and phase composition. Due to its sensitivity to synthesis conditions, precise structural analysis is essential. This study employs X-ray diffraction (XRD) combined with Rietveld refinement to extract crystallographic parameters, identify secondary phases, and detect ionic substitution effects. The results confirm the utility of Rietveld analysis in revealing subtle structural features relevant to the optimization of HA-based biomaterials for clinical applications.

Keywords:

Hydroxyapatite, Rietveld refinement, X-ray Diffraction, Structural characterization

Reference:

Koutsopoulos, S. (2002). Synthesis and characterization of hydroxyapatite crystals: A review study on the analytical methods. *Journal of Biomedical Materials Research*, 62(4), 600–612. <https://doi.org/10.1002/jbm.10280>

Ris work was supported by:

Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional



BIOMATERIALS AND POLYMERS / 191

PHYSICAL AND THERMAL CHARACTERIZATION OF FERMENTED ARABICA COFFEE CHERRY (COFFEA ARABICA L.) SOLUTIONS

Autor: Jose Luis Jiménez Pérez

Coautores: Alfredo Cruz Orea ; Guillermo Cruz Nicolás ; Lilia Ivonne Olvera Cano ; Rocio Ramírez Mozón ; Rubén Gutiérrez Fuentes ; Zormy Nacary Correa Pacheco

Autor responsable de la comunicación: rociomozon83@gmail.com

In the spontaneous fermentation of coffee cherries, lactic acid bacteria (LAB) are used to impart new flavors and aromas to the coffee bean (Oktaviani & et al., 2020). In this study, controlled liquid fermentations of coffee cherries inoculated with LAB were carried out for 7 days at 30°C and solid fermentations for 3 months. An organoleptic analysis was performed, which determined a characteristic apple odor for the liquid fermentation, and for the solid fermentations, an apple cider vinegar odor with citrus and fruity notes, and ethanol at months 1, 2, and 3, respectively. The pH was measured to monitor lactic fermentation. In the unfermented cherries, the pH was 6.42. In liquid fermentations, the pH ranged from 4.47 to 3.61, and in solid fermentations, the pH was 4.21, 3.71, and 3.52 at 1, 2, and 3 months, respectively. Degrees Brix (°Bx) were also measured to determine the concentration of soluble solids in the coffee cherry juice. The unfermented cherry had 11.9 °Bx, while the liquid fermentation showed 10.8 °Bx. In solid fermentations, the values were 9.6, 9.2, and 8.4 °Bx for months 1, 2, and 3, respectively. This decrease may be due to the consumption of glucose and fructose by the LAB. Thermal properties were measured with thermal lens (TL) and photoacoustic (PA) techniques for different sample concentrations, obtaining small variations in heat transport for thermal diffusivity, being more noticeable between unfermented grain ($15.5 \text{ cm}^2/\text{s} \times 10^{-4}$) and fermented grains ($14.23\text{-}15.27 \text{ cm}^2/\text{s} \times 10^{-4}$) for TL. For PA, there are small variations in the wavelength in liquid samples, increasing the fermentation concentration contrary to solid samples, possibly both TL and PA results are related to the flavor and color of coffee.

Keywords:

Fermentation, lactic acid, coffee, Photoacoustic, Thermal Lens

Reference:

L. Oktaviani, D. I. Astuti, M. Rosmiati, and M.Y. Abduh, Fermentation of coffee pulp using indigenous lactic acid bacteria with simultaneous aeration to produce cascara with a high antioxidant activity, *Helvion* 6(7) (2020) e04462. <https://doi.org/10.1016/j.helion.2020.e04462>

Ris work was supported by:

SIP project 20250257.



ACOUSTIC PERFORMANCE EVALUATION OF A STARCH-BASED BIOPOLYMER REINFORCED WITH COCONUT FIBERS

Autores: Miriam Jaqueline Cruz Espinoza¹; Sandra Loera Serna¹; Uriel Victoria Martínez¹

¹ UNIVERSIDAD AUTONOMA METROPOLITANA

Autor responsable de la comunicación: al2233804372@azc.uam.mx

The development of sustainable materials with functional acoustic properties continues to gain relevance in the field of green construction. This study analyzes composites made from a corn starch-based biopolymer reinforced with coconut fiber, with the aim of evaluating their performance as sound insulators. Samples were prepared with different fiber proportions (10%, 20%, and 30% by weight), and their morphology and density were characterized. Acoustic measurements were performed using an impedance tube over a frequency range of 50 to 10,000 Hz. The results revealed that increasing the amount of coconut fiber does not produce significant variations in the sound absorption coefficient, which remained relatively stable across all compositions. However, it was found that the incorporation of this natural fiber contributes to reducing the material's density and improves cohesion within the polymeric matrix, in addition to increasing the biopolymer's degradation time. The stability of the acoustic properties despite changes in fiber content makes coconut fiber an appealing alternative for the design of eco-friendly and durable materials, with predictable acoustic behavior, suitable for architectural applications where sound control is needed without compromising sustainability.

Keywords:

Biopolymer, Coconut fiber, Sound absorption, Sustainable material, Acoustic impedance

Reference:

Martínez, U. V., Sandra, E. R. V. C. D., & Serna, L. (2022). ESTUDIO DE COMPÓSITOS DE FIBRAS NATURALES Y ARCILLA PARA APLICACIONES ACÚSTICAS.

Ris work was supported by:

SECIHTI and UAM -AZC



BIOMATERIALS AND POLYMERS / 214

ELECTROCHEMICAL ANALYSIS OF ELECTRODES FOR SUPERCAPACITORS BASED ON ACTIVATED CARBON DERIVED FROM SARGASSUM BIOMASS

Autor: Claudia Antonio Hernández¹

Coautores: Mauricio Pacio-Castillo ¹; Abraham Pacio-Castillo ²; Mirna Valdez-Hernández ³; Laura Elvira Serrano- De la Rosa ⁴; Edith Osorio-de-la-Rosa ⁵

¹ *Centro de Investigación en Dispositivos Semiconductores, Instituto de Ciencias, Benemérita Universidad Autónoma de Puebla*

² *Área de Ciencia de Materiales, Departamento de Materiales, División de Ciencias Básicas e Ingeniería, Universidad Autónoma Metropolitana –Azcapotzalco*

³ *Herbario, Departamento Conservación de la Biodiversidad, El Colegio de la Frontera Sur Unidad Chetumal*

⁴ *Instituto de Física, Benemérita Universidad Autónoma de Puebla*

⁵ *SECIHTI-Secretaría de ciencia, humanidades, tecnología e innovación. Universidad Autónoma del Estado de Quintana Roo*

Autor responsable de la comunicación: claudianhz@gmail.com

Due to the depletion of non-renewable energy sources, the search for sustainable alternatives has intensified, driving the development of new energy storage devices. Among these, electrochemical devices known as supercapacitors have gained attention. These devices are primarily composed of two electrodes, a separator, and an electrolyte. This study presents the electrochemical characterization of electrodes fabricated from activated carbon derived from *Sargassum natans* and *Sargassum fluitans* biomass, collected from the coast of Quintana Roo, Mexico. The carbon was produced via a low-cost method involving HCl treatment followed by pyrolysis at temperatures ranging from 200 °C to 600 °C for activation. Cyclic voltammetry (CV) curves, recorded at 10 mV/s, exhibited an increasingly rectangular shape with rising temperatures, indicating electric double-layer capacitive behavior. Nyquist plots (EIS) demonstrated improved performance at higher temperatures, with nearly vertical lines at low frequencies and series resistance of only a few ohms at high frequencies. Galvanostatic charge-discharge (GCD) analysis showed triangular profiles, maintaining a stable response for up to 300 seconds. Scanning electron microscopy (SEM) images revealed porous surface structures on the electrodes. These structural and electrochemical characteristics suggest that the obtained material is a viable candidate for application in energy storage devices such as supercapacitors.

Keywords:

Activated carbon, *Sargassum*, supercapacitor, biomass, energy storage

Reference:

Jia, X., Guo, F., Zhan, Y., Zhou, H., Jiang, X., & Lin, Q. (2020). Synthesis of porous carbon materials with mesoporous channels from *Sargassum* as electrode materials for supercapacitors. *Journal Of Electroanalytical Chemistry*, 873, 114353.

Ris work was supported by:

To SECIHTI for the financial support provided through the postdoctoral fellowship awarded



BIOMATERIALS AND POLYMERS / 254

MANUFACTURING AND CHARACTERIZATION OF ELECTROSPUN PLA/PBAT NANOFIBERS INCORPORATED WITH CURCUMIN.

Autor: Verónica Hernández Rosas^{None}

Coautores: Genaro López Gamboa ; Jose Luis Jiménez Pérez ; José Luis Luna Sánchez ; Rubén Gutiérrez Fuentes

Autor responsable de la comunicación: veronicahdr@gmail.com

Innovation in drug delivery systems is increasing recently as it offers several advantages over traditional methods. This is the case of polymeric nanofibers, which have physicochemical properties that allow their use in the development of these systems (Abdulhussain et al., 2023). This work proposes the development of nanofibers produced by the electrospinning technique from a polymer blend of polylactic acid (PLA) and polybutylene adipate co terephthalate adipate (PBAT) in a ratio (45/55 w/w). Curcumin was incorporated directly into the polymer solution prior to electrospinning at a concentration of 10% w/w relative to the polymers. Curcumin as a drug has anti-inflammatory properties and can be used in the treatment of various conditions, including arthritis and skin diseases. Scanning electron microscopy (SEM) has shown that the morphology of the curcumin-infused fibers (PLA/PBAT/curcumin) is homogeneous and has smaller diameters compared to the polymer blend (PLA/PBAT). The curcumin-incorporated fibers show diameters of 149 ± 45 nm. UV-vis spectroscopy confirms the presence of curcumin in the fibers, which will be reinforced by Fourier transform infrared spectroscopy (FTIR). Moreover, the drug concentration contained in the nanofibers will be determined to study its release in a physiological solution such as phosphate-buffered saline (PBS), as well as the toxicity studies to ensure its viability. The PLA/PBAT/curcumin nanofibers are expected to be effective in drug delivery.

Keywords:

electrospinning, fibers, curcumin, drug delivery, polymers

Reference:

R. Abdulhussain, A. Adebisi, B. R. Conway, K. and Asare-Addo, Electrospun nanofibers: Exploring process parameters, polymer selection, and recent applications in pharmaceuticals and drug delivery. J. Drug Deliver. Sci. Technol. 90 (2023) 105156. <https://doi.org/10.1016/j.jddst.2023.105156>.

Ris work was supported by:

SIP project 20250885.



STUDY OF MICELLIZATION IN MIXTURES OF IONIC SURFACTANTS

Autores: Xairo Leon Valiente¹; Ernesto Hernández Zapata²; Cesar Marquez Beltran³ ¹

IFUAP, Benemérita Universidad Autónoma de Puebla

² *Departamento de Recursos de la Tierra, Universidad Autónoma Metropolitana*

³ *Instituto de Física, Benemerita Universidad Autonoma de Puebla*

This report aims to provide pertinent information regarding micelle formation resulting from the interaction between anionic and cationic surfactants. We employed a binary mixture of oppositely charged ionic surfactants, where the interaction between them can produce a synergistic effect, affecting properties such as critical micelle concentration (CMC) and surface tension. Sodium dodecyl sulfate (SDS) and N-trimethylammonium bromide (CnTAB) were utilized as the anionic and cationic surfactant respectively. The overall charge of the mixture can be adjusted by changing the surfactant ratio, which can significantly impact the behavior of charged colloids. We utilized Dynamic Light Scattering (DLS) and Zeta potential measurements to analyze the size and charge of the micelles formed when the ionic surfactants are combined. These studies enhance our understanding of their properties and potential synergistic effects, which are of practical significance to the chemical industry. Moreover, depending on the concentration, there may be an isoelectric point, and several phenomena observed in non-ionic surfactants can occur, including the cloud point, which indicates the temperature at which a solution becomes cloudy due to the phase separation of the surfactant solution.

Keywords:

ionic surfactant, mixed micelles, Zeta Potential, DLS, Cloud Point

Reference:

- [1] Journal of Molecular Liquids, 2021, Volume 337, 116355,
- [2] Journal of Physical Chemistry B 2010 114 (23), 7808-7816
- [3] J Am Oil Chem Soc (1990), 67: 717-721.

Ris work was supported by:

Departamento de Recursos de la Tierra, UAM Lerma. IFUAP, BUAP



COMPARATIVE EVALUATION OF HYDROXYAPATITE COATINGS ON Ti6Al4V AND 316L STAINLESS STEEL USING LASER ABLATION, PLASMA SPRAYING, AND SOL-GEL TECHNIQUES

Autores: María Magdalena Méndez-González¹; Roberto Conconi García²

Coautor: Carlos Enrique Foyo Castro ³

¹ *Depto. Física, Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional*

² *Nanociencias y Nanotecnología, Cinvestav, zacatenco*

³ *Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional*

In this work, we investigate the structural and functional characteristics of HA coatings applied to Ti6Al4V and 316L stainless steel substrates via three deposition methods: laser ablation, thermal plasma spraying, and sol-gel processing. The coatings were systematically characterized in terms of surface morphology (SEM), phase composition (XRD), adhesion strength, microhardness (Vickers), and corrosion behavior in simulated body fluid (SBF). All deposition techniques yielded bioactive HA coatings; however, distinct differences were observed in coating thickness, porosity, nanocrystallinity, and mechanical-electrochemical performance. Plasma spraying resulted in thicker coatings with higher roughness, while laser ablation produced more uniform layers with improved crystallinity. Sol-gel coatings exhibited the finest nanostructures but lower adhesion strength. The findings demonstrate that the choice of deposition method significantly influences the final coating performance and must be carefully aligned with the specific clinical and mechanical requirements of the intended biomedical application. This study provides insights into optimizing HA-coated metallic implants for enhanced biological response and long-term durability.

Keywords:

Hydroxyapatite, Ti6Al4V, 316L Stainless Steel, Laser Ablation, Thermal Plasma, Sol-Gel

Reference:

Wang, L., & Zreiqat, H. (2010). Functional coatings or films for hard-tissue applications. *Materials*, 3(1), 26–47. <https://doi.org/10.3390/ma3010026>

Ris work was supported by:

Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional



MECHANICAL AND WATER VAPOR PERMEABILITY PROPERTIES OF BIOFILMS MADE FROM CROSS-LINKED STARCH AND PLASTICIZERS

Autor: Lucila Concepción Núñez-Bretón¹

Coautores: Francisco Erik González-Jiménez²; Maricela Zapata-Arroyo¹; Lilia Ivonne Olvera Cano³; Alfredo Cruz-Orea⁴; O Manero¹

¹ Instituto de Investigaciones en Materiales, Departamento de Reología y Mecánica de Materiales, Universidad Nacional Autónoma de México

² Facultad de Ciencias Químicas, Universidad Veracruzana

³ Departamento de Física, CINVESTAV-IPN

⁴ Departamento de Física, CINVESTAV-IPN, Apdo. Postal 14-740, 07000 México D.F., México

Autor responsable de la comunicación: lilia.olvera@cinvestav.mx

The need for new functional, biocompatible, and biodegradable biomaterials that provide a platform for chemical and biological interactions in various food-related applications has stimulated new research focused on obtaining chemically modified starches, primarily through cross-linking. This type of modification increases interchain bonds between amylose and amylopectin through covalent linkages, providing greater stability and serving as a basis for the design of a wide range of biomaterials such as bioplastics or biofilms.

This study aims to demonstrate how starches from non-conventional sources (*Oxalis tuberosa*) can form biofilms when combined with glycerol and polyvinyl alcohol (PVA), comparing three types of cross-linking. The extraction of starch from *Oxalis tuberosa* M. and the chemical crosslinking modifications using phosphorus oxychloride (POCl_3), epichlorohydrin (EPI, $\text{C}_3\text{H}_5\text{ClO}$), and sodium trimetaphosphate (STMP, $\text{Na}_3\text{O}_9\text{P}_3$) were carried out as reported by Núñez-Bretón et al. (2024).

The biofilms were formed using the casting method with appropriate concentrations of glycerol and PVA, and their mechanical properties and water vapour permeability were determined using photoacoustic techniques. The results indicated that the biofilms obtained with EPI crosslinking showed the best mechanical properties (tensile strength of 11.2 MPa and elongation of 207%) compared to the others tested. The biofilms with STMP exhibited the lowest water vapour diffusion coefficient ($1.45 \times 10^{-7} \text{ cm}^2/\text{s}$). In conclusion, starches from non-conventional sources, modified by three types of chemical crosslinking, offer a promising approach for designing semipermeable barrier biomaterials suitable for food packaging and preservation applications.

Keywords:

Biofilms, modified starches, *Oxalis tuberosa* M., Crosslinking, Water vapour permeability.

Reference:

LC Núñez-Bretón, CE Torres-González, JA Del Ángel-Zumaya, A Peredo-Lovillo, JM Rivera-Villanueva, MDJ Perea-Flores, RI Guzmán-Gerónimo, O. Manero & FE González-Jiménez. "Functionalization of starches from Mexican *Oxalis tuberosa* using dual chemical modification". *Food Hydrocolloids*, 149, 109500. (2024). <https://doi.org/10.1016/j.foodhyd.2023.109500>



RERMIC PROTECTION OF CUTICLE OF GARAMBULLO (MYRTILLOCACTUS GEOMETRIZANS), AGAVE (AGAVE SALMIANA), NOPAL (OPUNTIA SPINULIFERA) AND SÁBILA (ALOE VERA)

Autor: Lorena Vargas Rodríguez¹

Coautores: María Marilú Moreno Ramos²; Michelle Farfán Gutiérrez³; Ricardo Navarro Mendoza⁴

¹ Universidad de Guanajuato. Priv. De Arteaga s/n Centro, CP 38900 Salvatierra, Gto. México. Depto. Ingeniería Agroindustrial. División De Ciencias de la Salud e Ingenierías. Campus Celaya-Salvatierra. Tel/fax +52 466 6632132

² Universidad de Guanajuato. Priv. De Arteaga s/n Centro, CP 38900 Salvatierra, Gto. México. Lic. en Ingeniería Agroindustrial. División De Ciencias de la Salud e Ingenierías. Campus Celaya-Salvatierra

³ Universidad de Guanajuato. Av. Juárez Núm. 77 col. Centro CP 36000, Guanajuato, Gto. México. Depto. De Ing. Geomática e Hidráulica. Div. De Ingenierías. Campus Guanajuato. Tel. +52 473 10200100

⁴ Universidad de Guanajuato. Cerro de la venada s/n, Pueblito de Rocha, CP 36040 Guanajuato, Gto. México. Depto. De Química. Div. De C. Naturales y Exactas. Campus Guanajuato

Autores responsables de la comunicación: lvargas@ugto.mx, mm.morenoramos@ugto.mx

The cuticle is the external cover that delimits that organs plant and therefore protects it from the adverse environmental factors. For example, caused by high environmental temperatures that occur in forest fires. The objective of the work was to characterize and analyze the cuticles of garam- bullo(G), agave(A), nopal(N) y sábila(S) at heat resistant capacity(heatR-capacity). The methodol- ogy used to obtain the cuticles consisted of manually removing them from old leaves of all species. Chlorenchyma tissue was removed by rubbing it on a rough surface. The cuticles were stabilized in humidity(40 °C/24 h) and their thickness(th) and mass density(ρm) metrics were recorded; addi- tionally, the samples were observed under an optical microscope to the stomatal density(pst), which was confirmed by SEM. Circular cuts (Φ=1.452 mm) were evaluated for their heatR-capacity using an industrial electric grill as a heat source and an IR thermometer. The highest th and ρm were de- termined in G with 0.52 mm and 497 g/m² respectively (16.33x and 15.5x higher than S). While the pst(# stomata/mm²) were regular for all materials(15-25) and consistent with the literature. Finally, in the heatR-capacity, N obtained the highest temperature tolerance of 220-240 °C, indicated by the color change (brown) and by the longest delay(10 min). While complete carbonization was between 290-297 °C(42 min) for G. In conclusion, although G showed the greatest thermal resistance to car- bonization, having the cuticle with the largest th and ρm, with a theoretical adjustment of th and ρm for N and A, the expected carbonization time would correspond to 1/3 of what occurred. According to the results obtained, a chemical composition analysis is required to deepen the thermal resistance of these plants epidermis and thus guide the selection of installed species that lead to reduce impacts during fires.

Keywords:

Cuticle, heat resitant capacity, fire, cactus, agave

Reference:

Ayil-Gutiérrez, B.A.; Sánchez-Teyer, L.F.; Rodríguez-Zapata et al. Differential Physiological Changes in Stomata in Polyploid Agave spp. Could Indicate Flexibility in CO₂ Fixation. *Agronomy* 2025, 15, 817. <https://doi.org/10.3390/agronomy15040817>

Ris work was supported by:

This work was supported by Universidad de Guanajuato- CIIC2025_[073/2025] and National laboratory "LACAPFEM" of CONACyT



BIOMATERIALS AND POLYMERS / 66

PHYSICOCHEMICAL CHARACTERIZATION, IN VITRO ANTIFUNGAL ACTIVITY AND STUDY OF THE BIODEGRADABILITY OF CHITOSAN/POLYVINYL ALCOHOL/ORANGE WASTE NANOSTRUCTURED FILMS

Autor: Zormy Nacary Correa Pacheco¹

Coautores: Silvia Bautista Baños¹; Mónica Hernández López¹

¹ CEPROBI-IPN

Autor responsable de la comunicación: zormynacary@yahoo.com

Nowadays, pollution due to single-use plastic materials is causing serious problems, so new alternatives for the circular economy must be sought. Among this, chitosan (CS) and polyvinyl alcohol (PVA) are nontoxic and biodegradable materials with film forming capacity, the chitosan being recognized with antifungal properties (Nasaj et al, 2024). On the other hand, the transformation of agricultural waste into a valuable resource is an opportunity to reduce environmental impact and enhance biodegradability in plastic films (Riaz et al., 2024). In this work, chitosan/polyvinyl alcohol/orange waste nanostructured films were elaborated by casting. Three orange waste concentrations were used: 0.125%, 0.25%, and 0.5%. PVA varied in 30% and 40%. The results of the film's morphology observed by scanning electron microscopy (SEM) and confocal laser scanning microscopy (CLSM) showed an intermediate behavior for the blends, between CS and PVA. No phase separation was observed. For the 40% PVA films, a more homogenous structure was observed as well as for 0.5% orange waste. For Fourier transform infrared spectroscopy, the changes in the intensity of the main peaks were observed as indicative of CS, PVA, and orange waste interactions. For the in vitro antifungal activity against *Botrytis cinerea*, the highest mycelial growth inhibition was observed for the CS film ($86.34 \pm 4.24\%$) followed by the 30/0.5 PVA/orange waste film ($70.30 \pm 8.40\%$). On soil composting, after 1 month evaluation, the CLSM images revealed the presence of cracks and holes. The highest weight loss was obtained for the film with 30% PVA and 0.125% orange waste with a value of 99.67%, followed by the samples with 40% PVA and 0.25% and 0.5% with values of 99.56% and 99.48%, respectively. Those films could have potential applications in postharvest fruit preservation due to their antifungal activity and biodegradability promoting sustainability.

Keywords:

biodegradability, nanoparticles, environment, polymers

Reference:

Nasaj, M. et al. Int. J. Biol. Macromol. 277 (2024) 134321. <https://doi.org/10.1016/j.ijbiomac.2024.134321>. Riaz, S. et al. Ind. Crop Prod. 215 (2024) 118587. <https://doi.org/10.1016/j.indcrop.2024.118587>.

Ris work was supported by:

IPN projects 20241301 and 20250577.



RECYCLING PET INTO CHABAZITE-FUNCTIONALIZED FIBERS: APPLICATION IN WASTEWATER TREATMENT

Autor: Joaquín Ulises Ulises Torres¹

Coautores: Rafael Ramírez Bon ¹; Susana Meraz Dávila ²

¹ Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional

² Universidad Politécnica de Santa Rosa Jauregui

Autor responsable de la comunicación: joaquin.torres.lara@cinvestav.mx

Water contamination by organic dyes is a major environmental challenge that demands sustainable and efficient solutions. This work proposes the recycling of polyethylene terephthalate (PET) by transforming it into fibers functionalized with natural chabazite zeolite, using centrifugal electrospinning. This strategy aims to harness the adsorptive and photocatalytic properties of chabazite while confining it within a polymeric matrix to enhance its handling and reusability.

The resulting fibers were characterized by scanning electron microscopy (SEM), Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), thermogravimetric analysis (TGA), and contact angle measurements. UV-Vis spectroscopy was also employed to monitor the adsorption and degradation of model dyes (methylene blue and rhodamine 6G) under dark conditions and sunlight exposure, including the study of pH effects.

Kinetic adsorption and photocatalysis experiments were carried out, yielding kinetic constants and adsorption capacities for each system. The fibers demonstrated high efficiency in dye removal and remarkable stability throughout multiple reuse cycles, maintaining consistent performance after five adsorption-washing cycles.

The success of the PET/Chabazite fibers is largely attributed to their morphological features: a continuous fibrous structure with homogeneous chabazite distribution, high surface-to-volume ratio, and favorable surface porosity, all of which enhance both contaminant adsorption and photocatalytic activity. These morphological advantages, combined with the ease of material recovery and reuse, establish the developed fibers as a sustainable, scalable, and effective alternative for wastewater treatment.

Ris work was supported by:

SECIHTI and CINVESTAV

Keywords:

Electrospun fibers, Chabazite and Wastewater treatment

Reference:

Ramírez-Aparicio, J., Sánchez-Martínez, A., & Ramírez-Bon, R. (2016). Photodecolorization of rhodamine under sunlight irradiation driven by chabazite. *Solar Energy*, 129, 45-53.

<https://doi.org/10.1016/j.solener.2016.01.050>



SUSTAINABLE POLYMERIC COMPOSITES FROM EPOXIDIZED LINSEED OIL AND RECYCLED ZINC OXIDE FROM ALKALINE BATTERIES: DECOMPOSITION TEMPERATURE, PHOTOLUMINESCENCE, AND DIELECTRIC BEHAVIOR

Autor: Enrique Vigueras Santiago¹

Coautores: Juan Carlos Rodríguez López ¹; Miguel Meléndez Lira ²; Susana Hernández López ¹

¹ *Universidad Autónoma del Estado de México*

² *CINVESTAV*

Autor responsable de la comunicación: enriquevigueras@yahoo.com.mx

In this work, we synthesized polymeric composites from epoxidized linseed oil and zinc oxide rods recovered from alkaline battery anodes in a wide range of compositions. The zinc oxide recovered from spent alkaline batteries corresponded to cells with a residual voltage between 780 and 800 mV, the point at which the complete transformation of metallic zinc to zinc oxide was observed. The recovered zinc oxide displayed a rod morphology with a photoluminescent response at 384 and 586 nm when excited at 325 nm. The polymeric composites showed an increase in degradation temperature of up to 100°C with an increasing filler percentage.

The composites' photoluminescent response was observed to depend on the zinc oxide-linseed oil weight ratio. At concentrations below 20% by weight, the photoluminescence was primarily from the epoxidized linseed oil polymer. Conversely, at higher compositions, the photoluminescence corresponded to the zinc oxide.

Dielectric behavior was studied in the frequency range of 1 MHz to 3 GHz, revealing an increase in permittivity with increasing zinc oxide concentration. However, a significant increase in the $\tan \delta$ value was observed with increasing zinc oxide, detrimentally affecting the insulating behavior of the polymer matrix due to the formation of percolating networks.

Keywords:

linseed oil, Photoluminescence, Dielectric Behavior, Decomposition Temperature

Reference:

This work is original and studies the thermal, dielectric and photoluminescent properties of polymeric compounds of epoxidized linseed oil and zinc oxide recovered from alkaline batteries.

Work was supported by:

This work was funded by SIEA-UAEM 7217/2025CIB.



DEVELOPMENT OF ECO FRIENDLY AGNPS FROM PLEUROTUS EXTRACTS FOR ANTIMICROBIAL APPLICATIONS

Autores: MA. GUADALUPE GARNICA-ROMO¹; Rafael Contreras-Chávez²

Coautor: Héctor Eduardo Martínez-Flores ³

¹ UNIVERSIDAD MICHOACANA DE SAN NICOLAS DE HIDALGO

² Student of Programa Institucional de Doctorado en Ciencias Biológicas, Universidad Michoacana de San Nicolás de Hidalgo

³ Facultad de Química Farmacobiología, Universidad Michoacana de San Nicolás de Hidalgo

Autor responsable de la comunicación: rafael.contreras@umich.mx

The development of environmentally friendly methods for nanoparticle synthesis has prompted interest in the use of edible fungi as sources of natural reducing agents. This study evaluates and compares extraction methods of bioactive compounds from two species of *Pleurotus* (*P. ostreatus* and *P. djamor*) for their application in the green synthesis of silver nanoparticles (AgNPs). Mushrooms were cultivated on agricultural substrates, and two drying methods (solar dehydrator and oven drying) were tested. Extracts were obtained using maceration and Soxhlet with solvents of varying ethanol concentrations. The total phenolic content, flavonoids, anthocyanins, ascorbic acid, and antioxidant capacity (DPPH and ABTS) were quantified. FTIR spectroscopy was used to identify functional groups involved in the reduction process. The aqueous extract obtained by maceration and solar drying presented the highest concentration of bioactive compounds in both species. These extracts were used to reduce AgNO₃ (3 mM) under controlled conditions (pH 12, 55 ± 5 °C, 20 min). The resulting nanoparticles were dried at 100 °C and calcined. SEM and XRD analysis confirmed the formation of silver nanoparticles with sizes below 200 nm. The findings suggest that *Pleurotus* extracts, particularly those obtained via green methodologies, are effective, low-cost, and sustainable agents for the synthesis of metal nanoparticles, offering potential for future applications in green nanotechnology.

Keywords:

Silver nanoparticles, *Pleurotus ostreatus*, *Pleurotus djamor*, green synthesis, bioactive compounds

Reference:

S. Devika, E. K. Elumalai, A. Manikandan, A., and M. Eswaramoorthy. Biosynthesis of silver nanoparticles using the fungus *Pleurotus ostreatus* and their antibacterial activity. *Materials Letters*, (2012), 75, 204–206. <https://doi.org/10.1016/j.matlet.2012.01.038>

Ris work was supported by:

Coordinación de Investigación Científica, UMSNH.



SYNTHESIS OF MESOPOROUS SILICA NANOPARTICLES DECORATED WITH GOLD NANOPARTICLES FOR DRUG DELIVERY

Autor: Jose Rafael Motilla Montes¹

Coautores: Celia Nohemí Sánchez Domínguez ²; Hilda Amelia Piñón Castillo ³; Hilda Esperanza Esparza Ponce ¹; Margarita Sánchez Domínguez ¹

¹ *Centro de Investigación en Materiales Avanzados*

² *Universidad Autónoma de Nuevo León*

³ *Universidad Autónoma de Chihuahua*

Autor responsable de la comunicación: jose.motilla@cimav.edu.mx

Current cancer treatment therapies, although effective, have very important side effects which minimize the probability of a favorable prognosis due to complications caused by the drug. Efforts are made to address this problem by improving existing cancer treatment techniques, such as phototherapy, or taking advantage of existing drugs and developing platforms for their direct delivery to the desired site [1]. In this sense, in this work we propose the delivery of an antineoplastic drug such as doxorubicin by encapsulating it in mesoporous silica nanoparticles decorated with gold. Through the administration of doxorubicin inside these nanoparticles the drug will be protected from the biological environment, additionally a reduction in the blood vessels formation is expected since gold nanoparticles (AuNPs) possess antiangiogenic properties. Furthermore, the use of AuNPs will allow these nanoparticles to be used as a photosensitizer for therapy. The average size of the synthesized mesoporous silica nanoparticles (MSN) is 61 ± 10.4 nm. A hemolysis assay was carried out and showed a hemolysis percentage close to-zero at concentrations of 100 and 50 ppm, revealing this compound biocompatibility. Additionally, the drug loading capacity was evaluated by UV-Vis spectroscopy; the MSNs presented a loading percentage of 7.75% and an encapsulation efficiency of 46.53% for doxorubicin. Furthermore, using an 800 nm laser and a thermal camera, the vehicle was shown to exhibit photothermal properties and increase the temperature of the surrounding environment by 1.6°C. These results are promising and demonstrate that it is possible to combine three mechanisms to attack tumor cells in a single treatment, reducing the ability of tumor cells to develop resistance, and resulting in an effective way to treat cancer.

Keywords:

Mesoporous silica nanoparticles, Drug delivery systems, Photodynamic therapy, Gold nanoparticles

Reference:

1. Couvreur, P. (2013). Nanoparticles in drug delivery. Past, present and future. *Advanced Drug Delivery Reviews*.

Ris work was supported by:

Centro de Investigación en Materiales Avanzados, Universidad Autónoma de Chihuahua y la Universidad Autónoma de Nuevo León.



GREEN SYNTHESIS OF GOLD NANOPARTICLES USING ALOE VERA AND REIR INCORPORATION INTO ELECTROSPUN PVP NANOFIBERS FOR WOUND HEALING APPLICATIONS

Autores: Britania Janet Gutiérrez Rafael¹; Orlando Zaca Morán¹; Valentín López Gayou¹

Coautores: Elsa Ventura Zapata²; Marlon Rojas López¹; Marcos García Juárez³

¹ *Departamento de Nanobiotecnología y Biosensores, Centro de Investigación en Biotecnología Aplicada, Instituto Politécnico Nacional*

² *Centro de Desarrollo de Productos Bióticos, Instituto Politécnico Nacional*

³ *Centro de Investigación en Reproducción Animal, Universidad Autónoma de Tlaxcala- Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional*

Autor responsable de la comunicación: bgutierrezr1800@alumno.ipn.mx

Nanostructured dressings, developed from bioconjugated polymers incorporating plant extracts and metallic nanoparticles, are emerging as promising tools for wound treatment and skin regeneration. *Aloe vera*, although lacking adequate mechanical properties for direct application, can be structurally enhanced by being incorporated into these systems. This approach improves its stability, bioavailability, and therapeutic efficacy, thereby enhancing its role in the wound healing process. In this study, gold nanoparticles (AuNPs) were biosynthesized using lyophilized extracts from the gel and epicarp of *Aloe vera* in a 6:4 ratio with chloroauric acid (HAuCl₄) and incorporated into electrospun polyvinylpyrrolidone (PVP) membranes. The AuNPs were characterized by UV-Vis, FTIR, and TEM, exhibiting a surface plasmon resonance band at 524 nm and average sizes of 12 and 18 nm. FTIR

analysis revealed bands corresponding to -OH, C=O, and C-O-C groups, which were also present in the extracts, suggesting their role in the reduction and stabilization of the nanoparticles. The membranes were evaluated by FTIR and SEM, revealing spectral changes attributed to the presence of AuNPs. EDS analysis confirmed the successful incorporation of gold into the nanofibrous matrix. These findings demonstrate the effective biosynthesis and incorporation of AuNPs into PVP membranes, highlighting their potential as advanced wound dressings with enhanced therapeutic properties.

Keywords:

Gold nanoparticles, Nanofibers, Aloe vera, Electrospinning, Wound healing

Reference:

A. Bachheti, R.K. Bachheti, L. Abate, and A. Husen, Current status of Aloe-based nanoparticle fabrication, characterization and their application in some cutting-edge areas, *S. Afr. J. Bot.* 147 (2022) 1058– 1069. <https://doi.org/10.1016/j.sajb.2021.08.021>

Ris work was supported by:

Instituto Politécnico Nacional por el proyecto SIP 20250124 y al SECIHTI (antes CONAHCYT) proyecto CF-2023-G-1080.



BIOMATERIALS AND POLYMERS / 456

IN SITU STUDIES AND SPR DETECTION OF MOLECULAR INTERACTION BETWEEN THE PROTEIN E SEROTYPE 2 OF DENV AND PARITAPREVIR

Autores: Natalia Hinostrroza-Moya¹; Jazmin Huerta-Cantillo²; Aldo Yair Tenorio-Barajas³; Claudia Mendoza-Barrera³; Fernando Navarro-García²; Efraín Garrido-Guerrero⁴; Víctor Altuzar³

¹ *Facultad de Ciencias Físico-Matemáticas, Benemérita Universidad Autónoma de Puebla, Puebla, 72592, Puebla, México*

² *Departamento de Biología Celular, CINVESTAV-IPN.*

³ *Facultad de Ciencias Físico-Matemáticas, Benemérita Universidad Autónoma de Puebla*

⁴ *Departamento de Genética y Biología Molecular, CINVESTA-IPN*

Autor responsable de la comunicación: natalia.hinostrroza@alumno.buap.mx

Dengue virus affects nearly 4 billion people worldwide. The World Health Organization reports that almost 390 million individuals are diagnosed with any of the four dengue serotypes every year. Currently, no specific drug has been approved for this disease; however, repurposing FDA-approved drugs developed for other conditions is a promising option. In this work, we develop a surface Plasmon resonance biosensor for the E protein of DENV-2 to validate its interaction with paritapre-

vir. Previously, in silico studies—including virtual screening and molecular dynamics—identified paritaprevir, a drug currently used as treatment of chronic hepatitis C, as a potential treatment for DENV-2. The sensorgrams of the E protein and paritaprevir enable us to determine the association rate constant k_{on} , the dissociation rate constant k_{off} , the dissociation constant K_D , and the standard free energy change ΔG^0 at 10, 20, 40, 80, and 120 μ M concentrations, using a first-order Langmuir model. It was observed that increasing paritaprevir concentrations resulted in higher biosensor responses until 70 RIU at 120 μ M, with $k_{on} = 791.9 \pm 26.8 \text{ M}^{-1}\text{s}^{-1}$, $k_{off} = (672.1 \pm 6.7) \times 10^{-4} \text{ s}^{-1}$, and $\Delta G^0 = -5.5 \text{ kcal/mol}$. Meanwhile, the response of the SPR biosensor to its antibody was 117 RIU. As expected, negative controls, caffeine, and monoclonal anti-PARP1 protein showed no response.

Keywords:

Biosensor, surface plasmon resonance, dengue virus, E-protein, paritaprevir.

Reference:

Y. Tenorio-Barajas, A. Reyes Chaparro, V. Altuzar, S. Muñoz-Aguirre, and C. Mendoza-Barrera, "Reúso de Ergotamina contra serotipos de denguevirus," Dec. 13, 2022

Ris work was supported by:

CONACYT



PREPARATION OF HYDROXYAPATITE AND CHITOSAN PARTICLES USING SPRAY-DRYING WITH POTENTIAL PHARMACEUTICAL APPLICATIONS

Autor: Henry Morelos Mijangos¹

Coautores: Efraín Rubio Rosas²; Juan José Luna Guevara¹; María Guadalupe Tenorio Arvide³; Eva Águila Almanza⁴; Heriberto Hernández Cocolletzi¹

¹ Benemérita Universidad Autónoma de Puebla, Facultad de Ingeniería Química

² Benemérita Universidad Autónoma de Puebla, Dirección de Innovación y Transferencia de Conocimiento

³ Benemérita Universidad Autónoma de Puebla, Departamento de Investigación en Ciencias Agrícolas

⁴ Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: mm223470626@alm.buap.mx

Hydroxyapatite (HAp), as well as chitosan (CS), are materials used in the pharmaceutical industry; they can be recovered from natural resources, such as chicken bones (in the case of HAp) or shrimp exoskeletons (in the case of CS), which are food waste generated in homes, restaurants and markets. Some applications of these biomaterials are, according to Luna Domínguez (2018), the reconstruction and regeneration of bone tissues, in addition to the preparation of dental prostheses and drug encapsulation, among others. In order to take advantage of these wastes, this work reports the preparation of chitosan and hydroxyapatite particles using the spray drying technique. The effect of the use of ultrasonic waves for the size reduction of HAp particles, as well as the wave conduction medium, at different mass/volume ratios is analyzed. In the first preparation, HAp and CS were injected separately, in order to verify whether by themselves they can form particles that can serve as a vehicle. Subsequently, a mixture of both materials was injected with a 70:30 HAp:CS ratio. The preparation of CS-based particles was performed in a temperature range from 130°C to 160°C, where the spherical geometry was maintained and the average diameter ranged from 1.79 μm (at 130°C) to 2.51 μm (at 160°C), based on SEM results, which could suggest that the higher the temperature the smaller the diameter. On the other hand, particles based on HAp and HAp/CS mixture presented more amorphous morphology and with a remarkable size dispersion.

Keywords:

Hydroxyapatite, Chitosan, Biomaterial, Spray-Drying, Drug Vectorization

Reference:

Luna-Domínguez, J. H., Téllez-Jiménez, H., Hernández-Cocolletzi, H., García-Hernández, M., Melo-Banda, J. A., Nygren, H., Development and in vivo response of hydroxyapatite/whitlockite from chicken bones as bone substitute using a chitosan membrane for guided bone regeneration. *Ceramics International* 44-18 (2018) 22583-22591

Ris work was supported by:

Vicerrectoría de Investigación y Estudios de Posgrado, BUAP and SECIHTI.



POLYMERIC BIOMEMBRANES FOR TEXTILE DYE REMOVAL FROM WATER

Autor: Olivia Hernandez Cruz¹

Coautores: Cesar Marquez Beltran ¹; Eric Reyes Cervantes ¹; Gerardo Enrique Cordova Perez ¹; Guillermo Garcia Pérez ²; Jocabed Jaramillo Diaz ¹; Jorge Raul Cerna ¹; Maria Ana Perez Cruz ¹; Miguel Angel Mendez ²

¹ Benemerita Universidad Autonoma de Puebla

² Universidad de las Americas Puebla

Autor responsable de la comunicación: olivia.hernandez@udlap.mx

Water pollution caused by textile dyes is a critical environmental issue due to the persistence, toxicity, and aesthetic impact of these compounds in aquatic ecosystems. In this study, we developed innovative polymeric biomembranes composed of electrospun fibers using polycaprolactone (PCL), starch, and graphene oxide (GO) for the efficient removal of textile dyes from water. The combination of PCL and starch provides a biodegradable and biocompatible matrix, while the incorporation of GO enhances the membranes' surface area, hydrophilicity, and functional groups available for dye adsorption.

Morphological and structural characterizations, including scanning electron microscopy (SEM) and Fourier-transform infrared spectroscopy (FTIR), confirmed the successful integration of starch and GO within the PCL fiber network. Adsorption tests demonstrated high dye removal efficiencies, highlighting the synergistic effect of the hybrid composition. Additionally, the membranes exhibited good mechanical stability and reusability potential, making them suitable for practical water treatment applications.

Overall, these PCL/starch/GO biomembranes represent a promising, sustainable, and environmentally friendly approach to mitigate textile dye pollution and contribute to the development of advanced wastewater treatment technologies.

Keywords:

Dye removal, polymeric biomembrane, electrospun, PCL, OG

Reference:

1.J. Enviro. Chem.Eng.2021, 9. 105012.

2.Crystals (2021), 11, 199

Ris work was supported by:

SECITI for the postdoctoral fellowship (agreement number 2331329) and VIEP (100526485-VIEP2024)



SIMULATION OF ENERGY DEPOSITION IN PROTON BEAM RERTAPY FOR PROSTATE CANCER USING SRIM

Autores: José Alberto Villanueva Sánchez¹; María Magdalena Méndez-González²

Coautor: Arturo García Bórquez ²

¹ *Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional*

² *Depto. Física, Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional*

Proton beam therapy has gained significant attention in recent years for its capacity to deliver highly localized doses to tumors while sparing surrounding healthy tissue. In this study, we perform a simulation-based analysis to estimate the energy deposition and penetration depth of proton beams in a water medium, which serves as a tissue-equivalent target. The simulations were carried out using the SRIM (Stopping and Range of Ions in Matter) software, incorporating its STRIM submodule to evaluate ion trajectories and energy loss profiles. The aim is to determine the proton energy range required to effectively reach the prostate tumor and deliver a therapeutic dose within the desired treatment zone. The resulting data allow us to identify the Bragg peak location and characterize the dose distribution, offering insights into the optimization of proton beam parameters for clinical applications in prostate cancer radiotherapy.

Keywords:

Proton Therapy, Prostate Cancer, SRIM Simulation, Energy Deposition, Bragg Peak

Reference:

Wilson, R. R. (1946). Radiological use of fast protons. *Radiology*, 47(5), 487–491.

Ris work was supported by:

Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional



NANO AND MICROFIBER-REGENERATED CELLULOSE MEMBRANES VIA ELTROSPINNING AS SELECTIVE PAPER-BASED MICROFLUIDIC DEVICES

Autores: Esmeralda Aguilar Martinez¹; Víctor Altuzar Aguilar¹; Severino Muñoz Aguirre^{None}; Claudia Mendoza Barrera¹

¹ Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: am224570122@alm.buap.mx

In developing countries, water contamination by heavy metals is a primary environmental and public health concern. Therefore, there is a need for portable, affordable, and accessible analytical tools for quick detection anywhere. A promising alternative is the creation of selective paper-based microfluidic devices (μ PADs) that have defined channels to direct fluid flow. While Whatman paper is commonly used as a substrate for μ PADs, it has sensing limitations due to its fiber diameter of about 13 μ m. In this study, cellulose acetate membranes were fabricated using single electrospinning as an alternative support for μ PADs. Variables such as acetate concentration (10, 14, 18%), voltage (15, 18, 21 kV), and injection flow (0.5, 1.25, 2 mL/h) were optimized, with solvent relation and needle-collector distance kept constant. The hydrophobic AC microfibers were regenerated before use as

μ PAD substrates. SEM, AFM, contact angle, and FTIR analyses confirmed the fibers' average diameter (389 ± 167 nm and 364 ± 175 nm), hydrophilicity (contact angles of 24.9° and 43.3°), and partial deacetylation, indicated by COO^- and O-H bands at 1550 and 3300 cm^{-1} , established at AC = 18%, V = 18 or 21 kV, and $v = 1.25$ or 2 mL/h. DSC/TGA analyses revealed a lower glass transition temperature (T_g) and mass loss compared to Whatman paper, likely due to the smaller fiber size. The membranes were then used to design and fabricate μ PADs with sensing zones functionalized with curcumin. Testing with control solutions showed that the devices did not leak.

Keywords:

μ PADs, electrospinning, regenerated cellulose, deacetylation, heavy metals

Reference:

A. Senthamizhan, B. Balusamy, and T. Uyar, "Recent progress on designing electrospun nanofibers for colorimetric biosensing applications," *Curr Opin Biomed Eng*, vol. 13, pp. 1-8, 2020, doi: <https://doi.org/10.1016/j.cobme.2019.0>



CHARACTERIZACION AND METROLOGY

CHAIRMEN

Dr. Sergio Alfonso Perez Garcia(CIMAV-MTY), alfonso.perez@cimav.edu.mx

Dra. Liliana Licea Jiménez (CIMAV-MTY), liliana.licea@cimav.edu.mx

Dr. Francisco Javier Flores Ruiz (IF-BUAP) fflores@ifuap.buap.mx

Optic and electronic spectroscopy and microscopy are very important and relevant fields of knowledge when it comes to fundamental and applied research in materials science. Materials and surfaces have been widely studied and characterized by using linear optics through reflectance, transmittance, absorbance, and scattering properties. By contrast, nonlinear optics are closely related to the understanding of materials and surfaces, since such phenomena for example, second harmonic generation, wave mixing, parametric up and down conversion to mention only a few are directly related to material features, such as, crystallinity, centrosymmetry, anisotropy and quantum properties.

This symposium is dedicated to the presentation and discussion of characterization and metrology within the following topics:

- Materials
- Surfaces
- Linear and nonlinear optical properties
- Raman characterization
- Nonlinear optical microscopy
- Ultrafast light-matter interaction
- Laser processing of materials: micro and nanostructures
- Laser-tissue interactions
- Laser-induced cavitation
- Photonics
- Biophotonics
- Opticaltrapping



CHARACTERIZATION OF THE WEAR MECHANISM OF A TRADITIONAL Z-TYPE FERTILIZER SPREADERS

Autor: DANIEL MALDONADO ONOFRE¹

Coautores: MARCO ANTONIO DOÑU RIOZ²; NOE LÓPEZ PERRUSQUIA²; VICTOR HUGO CASTREJÓN SÁNCHEZ¹; TOMAS DE LA MORA RAMÍREZ¹; ELVIS COUTIÑO MORENO¹

¹ *TECNOLÓGICO DE ESTUDIOS SUPERIORES DE JOCOTITLÁN*

² *UNIVERSIDAD POLITECNICA DEL VALLE DE MÉXICO*

Autores responsables de la comunicación: daniel.maldonado@tesjo.edu.mx, nlopezp@upvm.edu.mx, elvis.coutino@tesjo.edu.mx

This study presents the preliminary results of the characterization of the wear mechanism of the wear plate of a traditional Z-type planter, with the purpose of identifying the predominant types of deterioration and proposing improvements in its design and tribological behavior. The fertilizer spreader system operates under severe working conditions, due to the constant exposure to highly abrasive granular fertilizers, environmental humidity and mechanical vibrations, factors that accelerate the wear of the plate. To establish the actual operating conditions, a field analysis was carried out in different agricultural areas, recording parameters such as rotation speed, fertilizer and soil characteristics. Subsequently, the acquisition of the plate morphology was carried out by reverse engineering techniques, using high-resolution 3D scanning to obtain its geometry. Through morphological analysis, adhesive and abrasive wear mechanisms were identified, located mainly in the areas of greatest contact with the fertilizer. The methodology followed included the collection of worn samples, their analysis of surface hardness tests, and the digitalization of the component by means of 3D scanning. Based on these results, the redesign of the spreader plate is projected through geometric improvements and application of coatings, in order to optimize the efficiency of the system, reduce maintenance and extend the life of the component. The findings and methodological approaches are supported by recent studies that have applied similar characterization and simulation techniques [1-5].

Keywords:

Z-type Abonator, abrasive wear, reverse engineering, tribology, 3D scanning.

Reference:

- [1] [H. Zhang, M. Jiang, y Y. Li, "Study on Tribological Properties of Fertilizer Distribution Components Based on DEM Simulation," IEEE Access, vol. 10, pp. 109345-109354, 2022. doi:10.1109/ACCESS.2022.3203127
- [2] M. Y. Ali, A. Khan, y R. I. Iqbal, "Wear Mechanisms of Agricultural Machine Components under Fertilizer Abrasion," IEEE Trans. Agric. Syst., vol. 15, no. 3, pp. 205-212, 2021. doi:10.1109/TAS.2021.3115412
- [3] J. Wang et al., "Reverse Engineering and Wear Analysis of a Rotary Fertilizer Dispenser," IEEE Trans. Ind. Appl., vol. 58, no. 5, pp. 5201-5209, Sept.-Oct. 2022. doi:10.1109/TIA.2022.3184045
- [4] R. Gómez et al., "Characterization of Surface Wear in Agricultural Disks Using SEM and 3D Scanning," IEEE Lat. Am. Trans., vol. 20, no. 6, pp. 980-987, June 2022. doi:10.1109/TLA.2022.9887632
- [5] A. Singh and P. Sharma, "Improving Tribological Performance of Agricultural Components Using Advanced Coatings," IEEE Trans. Nanotechnol., vol. 21, pp. 144-150, 2022. doi:10.1109/TNANO.2022.3152145

Ris work was supported by:

TECNOLÓGICO DE ESTUDIOS SUPERIORES DE JOCOTITLÁN



STUDY OF N-TYPE POROUS SILICON FABRICATED BY ELECTROCHEMICAL ETCHING: CORRELATION BETWEEN THE MORPHOLOGY OF THE POROUS LAYER AND ITS OPTICAL AND THERMAL PROPERTIES

Autor: Samuel Alexis Salazar Flores¹

Coautores: José Bruno Rojas Trigos²; Uriel Nogal Luis³

¹ Instituto Politécnico Nacional, Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada, Unidad Legaria.

² Instituto Politécnico Nacional, Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada, Unidad Legaria

³ SECIHTI, Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada, Unidad Legaria.

Autor responsable de la comunicación: samuel_salazarf@outlook.es

Since its discovered, porous silicon has attracted an increasing interest due to the ability to modify its physical-chemical properties through structural changes, thereby expanding its range of applications, including the design of systems for solar energy conversion. In this study, porous silicon samples were fabricated using N-type (1 0 0) crystalline silicon substrates through the electrochemical etching technique. The samples were etched for periods ranging 1 to 10 minutes (in increments of 1 minute), using aqueous solutions of hydrogen fluoride at concentrations of 20%, 30%, and 40% as electrolyte, forming three experimental sets with ten samples each. The objective was to determine the optimal anodization conditions to obtain a material with enhanced photothermal properties by correlating optical and thermal behavior with the morphology of the porous silicon. The chemical composition was analyzed using energy-dispersive X-ray spectroscopy (EDS) and Fourier-transform infrared spectroscopy (FTIR). Morphological characterization, focused on pore diameter and porous layer thickness, was carried out using scanning electron microscopy (SEM). Optical properties such as reflectance, photoluminescence, absorbance, and band gap energy were evaluated using reflectance spectroscopy (RS), photoluminescence spectroscopy (PL), and photoacoustic spectroscopy (PAS). Effective thermal diffusivity was measured using frequency-modulated photoacoustic spectroscopy (PA-f). The results indicate that extending the electrochemical etching time led to a decrease in the reflectance of the samples, particularly in the ultraviolet region, where an increase in absorbance was observed, reaching values as low as 56%. Furthermore, an increase in photoluminescence intensity was observed. These effects are attributed to the enlargement of the porous cavities, which consequently resulted in a reduction of thermal diffusivity from 0.85 to 0.47 cm²/s. Additionally, the increase in HF concentration also affected the values obtained across the three experimental groups.

Keywords:

Porous silicon; Electrochemical etching; Morphology; Thermal diffusivity.

Reference:

Calderón, A., Alvarado-Gil, J. J., Gurevich, Y. G., Cruz-Orea, A., Delgadillo, I., Vargas, H., & Miranda, L. C. M. (1997). Photothermal Characterization of Electrochemical Etching Processed n-Type Porous Silicon. *Physical Review Letters*, 79(25), 5022-5025. <https://doi.org/10.1103/physrevlett.79.5022>

Ris work was supported by:

Instituto Politécnico Nacional (IPN) and Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECIHTI).



DEVELOPMENT OF AN INNOVATIVE DEVICE INSTRUMENT TO MEASURE THE EDDY CURRENT DAMPING SYSTEM FOR A SCANNING PROBE MICROSCOPE

Autor: Villagómez, Carlos Javier¹

Coautores: Reyes Cervantes, Juan Adrian¹, Fuentes-Pérez, Bernardo¹; Sánchez-Alejo Marco Antonio¹; Bouju, Xavier²

¹ Instituto de Física, Universidad Nacional Autónoma de México

² Centre d'Élaboration de Matériaux et d'Études Structurales, Toulouse, France

Autor responsable de la comunicación: cjvillagomez@fisica.unam.mx

We have extended the traditional suspended point-mass model to describe the damping system of a scanning probe microscope to a rigid-body system described by Lagrange's equations. Furthermore, we developed an innovative opto-electronic device instrument to measure the damping coefficient of the eddy current system that allows in-situ the measurements of the vertical spurious vibration in the scanner. The eddy current system is applied for a scanning tunneling microscope and successfully tested with atomic-resolution imaging.

Keywords:

Eddy current, Scanning Probe Microscope, Damping system, Vibrations, Vacuum.

Reference:

B. Voigtländer, Scanning Probe Microscopy, Atomic Force Microscopy and Scanning Tunneling Microscopy, Springer Berlin, Heidelberg (2015)



COUPLED RESONANCES: A UNIFYING FRAMEWORK FOR SYMMETRIC AND ASYMMETRIC LINESHAPES IN MATERIALS SPECTROSCOPY

Autores: Abraham Jorge Carmona Carmona¹; Alberto Herrera-Gomez²; Anthony Dutoi³; Dagoberto Cabrera-German⁴; Dulce María Guzmán Bucio⁵

¹ FCFM, Benemérita Universidad Autónoma de Puebla

² Centro de Investigación y de Estudios Avanzados del IPN - Unidad Querétaro

³ University of the Pacific

⁴ Universidad de Sonora

⁵ Centro de Investigación y Estudios Avanzados (CINVESTAV) unidad Querétaro

Autor responsable de la comunicación: aherrerag@cinvestav.mx

This work introduces a unified theoretical framework based on coupled resonances to explain both symmetric and asymmetric lineshapes commonly observed in diverse spectroscopic techniques. While Lorentzian lineshapes are fundamental to many spectroscopies (including XPS, X-ray Emission, Raman, and NMR), asymmetric peak forms are frequently encountered, particularly in electron spectroscopies like XPS and synchrotron-based methods crucial for advanced materials characterization. We propose that the interplay of coupled resonances, encompassing phenomena like quantum interference and entanglement, provides a fundamental physical origin for these distinct spectral features. The implications for materials analysis are substantial, offering enhanced accuracy in peak decomposition and the extraction of vital chemical information. We will demonstrate the versatility and predictive power of this coupled-resonance model with compelling examples from various spectroscopies applied to advanced materials, showcasing its ability to more accurately describe complex spectral features compared to conventional symmetric models.

Keywords:

Coupled-resonances, peak asymmetry, quantum interference, materials characterization

Reference:

The Coupled-Resonances Asymmetric Lineshape for Photoemission Spectra
Alberto Herrera-Gomez, Dulce Maria Guzman-Bucio,1 Dagoberto Cabrera-German, Abraham Carmona-Carmona, Vincent Crist, Anthony D. Dutoi.
Analytical Chemistry, 2025.

Ris work was supported by: Project

58518 Secihti, Mexico



SYNTHESIS OF ZnO NANOFIBERS ON FTO BY ELECTROSPINNING FOR PHOTO- FUNCTIONAL DEVICES

Autores: David Alejandro Luna Castillo¹; María de la Paz Díaz Anayaa¹

Coautores: Aime Margarita Gutierrez Peralta ²; Arturo Velasco Hernandez ¹; Claudia Elena Pérez García ¹; Francisco Javier De Moure Flores ¹; Liliana Licea Jiménez ³; Susana Meraz Dávila ⁴

¹ *Facultad de Química, Universidad Autónoma de Querétaro*

² *Universidad Autónoma de Querétaro*

³ *Subsede Monterrey, Centro de Investigación en Materiales Avanzados*

⁴ *Universidad Politécnica de Santa Rosa Jáuregui*

Autores responsables de la comunicación: dluna21@alumnos.uaq.mx, mdiaz62@alumnos.uaq.mx

Zinc oxide (ZnO) nanofibers demonstrate structural, optical, and electronic properties that make them suitable for use in optoelectronic devices and environmental remediation. In this study, ZnO nanofibers were synthesized using the electrospinning technique, which involved a precursor solution made of zinc acetate dissolved in an aqueous polyvinyl alcohol (PVA) matrix. The fibers were deposited onto fluorine-doped tin oxide (FTO) conductive substrates by applying a voltage of 15 kV at a distance of 15 cm. The samples then underwent thermal treatment to eliminate the polymeric phase and promote ZnO crystallization. Characterization using scanning electron microscopy (SEM) and X-ray diffraction (XRD) confirmed the formation of continuous one-dimensional fibers with a wurtzite-type crystalline structure. These nanostructures have a high surface-to-volume ratio and favorable charge transport properties, making them promising candidates for use as functional layers in heterojunction solar cells and as active supports in photocatalytic applications. The results underscore the potential of electrospinning as a versatile and cost-effective technique for creating functional nanomaterials for energy and environmental applications.

Keywords:

ZnO nanofibers, Electrospinning, Photo-functional Devices, Semiconductors

Reference:

V. P. Dinesh, R. Sriram kumar, A. Sukhananazerin, J. Mary Sneha, P. Manoj Kumar, and P. Biji, Novel stainless steel based, eco-friendly dye-sensitized solar cells using electrospun porous ZnO nanofibers, Nano-Structures and Nano-Objects, 19(2019).

Ris work was supported by:

FONFIVE 2024, FQU202416



EVAPORATED DROPLET RESIDUES AS A LOW-COST TOOL FOR MORPHOLOGICAL AND OPTICAL ANALYSIS OF UPCONVERSION MATERIALS

Autor: David Alejandro Chavez Campos¹

Coautores: Miguel Ángel Aguilar González ²; Carlos Eduardo Rodríguez García ³; Reyes García Díaz ⁴; Cesar Casas Gutiérrez ³; Josías Natán Molina Courtois ⁵; Yojana Jautzi Pupuri Carreón Herrera ⁵; Jorge González Gutiérrez ⁵; Mario Castelán ²

¹ *Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECIHTI)*

² *Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Unidad Saltillo*

³ *Facultad de Ciencias Físico Matemáticas, Universidad Autónoma de Coahuila*

⁴ *CONAHCYT-Universidad Autónoma de Coahuila, Facultad de Ciencias Físico Matemáticas Prol. David Berlanga S/N Edif. "A" Unidad Camporredondo C.P. 25000, Saltillo, Coahuila, México*

⁵ *Facultad de Ciencias en Física y Matemáticas*

Autor responsable de la comunicación: david.chavez@cinvestav.edu.mx

Upconversion materials are widely studied for their ability to convert low-energy infrared radiation into visible light and are typically characterized through high-cost techniques such as scanning electron microscopy (SEM) and photoluminescence (PL) spectroscopy. In this work, we propose an alternative, low-cost method based on the morphological analysis of evaporated droplet residues, a technique that has found applications in food and drug quality control [1], diagnostics, and coatings [1]. To this end, we synthesized SrLaAlO₄ doped with Er³⁺ and Yb³⁺ using a combustion method, varying the fuel-to-oxidizer ratio by adjusting the urea content (in steps of 5 wt% and 10 wt%) relative to an ideal stoichiometric composition. As expected, increasing fuel content led to smaller particle sizes. Instead of relying solely on SEM, we investigated how particle size distribution affects pattern formation during droplet evaporation. Under optical microscopy, we observed that smaller particles tended to accumulate along the droplet edge, following the typical coffee-ring pattern, while the larger ones mostly settled near the center. This distribution appears to be strongly linked to particle size and may offer a simple, indirect way to infer morphological differences. Regarding luminescent properties, optical characterization included PL spectra under 980 nm excitation and CIE 1931 chromaticity coordinates. A strong green emission was observed, with intensity variations that correlated with particle size. Smaller particles, likely due to their higher surface-to-volume ratio, exhibited enhanced emission, possibly influenced by surface-related effects. The chromaticity coordinates were consistent with these trends. Exploring the relationship between droplet residue morphology and luminescent behavior suggests that dried droplet patterns can function as a complementary and accessible tool for characterizing upconversion materials. Unlike conventional approaches, this method relies only on optical microscopy and is amenable to automated image-based analysis, paving the way for integration with computer vision and deep learning techniques.

Keywords: Phosphor, Evaporated Droplet Residues, Upconversion, Computer Vision

Reference:

J. N. Molina-Courtois, Y. J. Aguilar Morales, L. Escalante-Zarate, M. Castelán, Y. J. P. Carreón, and J. González-Gutiérrez, Pattern recognition in dried milk droplets using lacunarity and deep learning, Appl. Sci. 15 (2025) 5676. <https://doi.org/10.3390/app15105676>.

Ris work was supported by:

Project SECIHTI CF-2023-G-454 "Reconocimiento de patrones en residuos de gotas evaporadas utilizando aprendizaje profundo" and SECIHTI postdoctoral studentships "Postdoctorantes por México" awarded to D.A.C.C. and J.J.P.C.H.



SYNTHESIS AND CHARACTERIZATION OF KEPLER-TYPE Ru(III) COMPLEXES WITH DMSO AND AZOLES AS LIGANDS FOR NEUROPROTECTIVE APPLICATIONS

Autor: Uriel Espinoza Carmona¹

Coautores: José Antonio Pérez Tavares ¹; Rita Judit Patakfalvi ¹; Gabriela Camarillo Martínez ¹; Jesús Castañeda Contreras ¹; Daniel Ramírez de Alba ¹; Juan José Maldonado Ríos ¹

¹ Universidad de Guadalajara

Autor responsable de la comunicación: urielespinoza2110@gmail.com

Introduction: Kepler-type Ru (III) complexes bearing dimethyl-sulfoxide (DMSO) are robust octa- hedral scaffolds that can exchange heteroaromatic ligands and are therefore promising neuropro- tective metallodrugs able to disrupt β -amyloid aggregation and oxidative stress. **Objective:** To devise a solution- phase route for four Ru (III)/DMSO derivatives—[(DMSO)₂H][trans-RuCl₄(DMSO)₂], Na[trans- Ru(DMSO)₂Cl₄], mer-[RuCl₃(DMSO)₃] and mer-[RuCl₃(DMSO)₂L] (L = azole)—and to ver- ify their structural fingerprints by FT-IR, UV-Vis and molar conductivity. **Methodology:** (i) RuCl₃ · xH₂O was heated 24 h at 100 °C in DMSO/HCl, crystallising [(DMSO)₂H][trans-RuCl₄(DMSO)₂] (80 % yield). (ii) Ethanolic NaCl treatment (24 h) afforded Na[trans-Ru(DMSO)₂Cl₄] (90 %). (iii) Chlo- ride abstraction with AgBF₄ in DMSO (60 °C, 2 h) gave mer-[RuCl₃(DMSO)₃] (70 %). (iv) Mild reflux in acetone with one equivalent of azole (2 h) produced mer-[RuCl₃(DMSO)₂L] (65 %). **Results:** FT- IR $\nu(\text{S}\ddot{\text{O}})$ bands at 1017 cm⁻¹ for [(DMSO)₂H][trans- RuCl₄(DMSO)₂], 1115 cm⁻¹ for the sodium salt and 1020 cm⁻¹ for mer-[RuCl₃(DMSO)₃] confirm S-bound DMSO; the azole derivative displays a new $\nu(\text{C}=\text{N})$ at 1585 cm⁻¹ with concurrent attenuation of $\nu(\text{S}\ddot{\text{O}})$, evidencing selective substitution. In- tense LMCT bands lie at 300–400 nm with d–d shoulders near 450 nm; azole incorporation induces ~10 nm bathochromic shift. Molar conductivities (1 mM, 25 °C) are 105.6/269 $\mu\text{S cm}^{-1}$ [MeOH/H₂O, 1:1/2:1] for [(DMSO)₂H][trans-RuCl₄(DMSO)₂], 94.15/121.7 $\mu\text{S cm}^{-1}$ for Na[trans- Ru(DMSO)₂Cl₄] and 7.63/28.59 $\mu\text{S cm}^{-1}$ for mer-[RuCl₃(DMSO)₃], confirming 1:1 electrolytes versus a neutral mer species. **Conclusions:** The scalable three-step protocol followed by azole substitution yields Ru (III)/DMSO frameworks in 65–90 % isolated yields whose FT-IR, UV-Vis and electrochemical signatures vali- date inner-sphere S-coordination and distinct solution dissociation. These complexes furnish a solid chemical platform for forthcoming in-vitro assays aimed at mitigating amyloid aggregation and redox imbalance in neurodegenerative disease.

Keywords:

Ruthenium, Kepler compounds, Metallopharmaceuticals, Azole ligands, Neuroprotection

Reference:

Liu, Y., Ma, J., Zhang, Q., Wang, Y., y Sun, Q. (2024). Mechanism of metal complexes in alzheimer's disease. International Journal of Molecular Sciences, 25(22), 11873.

Ris work was supported by:

This work was supported by SECIHTI and the University of Guadalajara



NiS-LOADED N/S-DOPED HOLLOW CARBON SPHERES AS EFFICIENT AND STABLE ELECTROCATALYSTS FOR ALKALINE HYDROGEN EVOLUTION

Autor: Juan Carlos Carrillo Rodríguez¹

Coautores: Eduardo Martínez Guerra ²; Francisco Aguirre Tostado ³; Luz Idalia Ibarra Rodríguez ⁴; Mario Alberto Hidrogo Rico ¹

¹ Centro de Investigación en Materiales Avanzados S.C.

² Centro de Investigación en Materiales Avanzados (CIMAV-Monterrey)

³ Cimav, Unidad Monterrey

⁴ Centro de Investigación en Materiales Avanzados (CIMAV), S.C.

Autor responsable de la comunicación: juan.carrillo@cimav.edu.mx

Novel NiS-supported N/S-doped mesoporous hollow carbon spheres (NiS-N/S-HCS) were synthesized and evaluated as electrocatalysts for the hydrogen evolution reaction (HER) in alkaline media. The N/S-HCS materials were obtained via a soft-template method using 2-pyridinemethanol and 2-thiophenecarboxaldehyde as nitrogen and sulfur precursors. The resulting materials exhibited high surface area and well-defined spherical morphology. XPS analysis confirmed the incorporation of pyridinic and quaternary nitrogen, as well as thiophenic sulfur species.

NiS was subsequently deposited onto the N/S-HCS via a solvothermal method using thiourea and nickel (II) nitrate hexahydrate, with varying NiS loadings (5:95, 10:90, and 20:80 wt. %). Structural characterization revealed the formation of multiple NiS phases (millerite, polydymite, and hexagonal NiS). The distribution of these phases varied with NiS content suggesting that the N/S-doped carbon matrix influences the formation and distribution of the NiS crystalline phases.

Electrocatalytic performance toward HER was markedly improved in the doped systems, particularly for the 5:95 NiS:N/S-HCS composition, which outperformed the higher-loading variants. A control sample based on non-doped mesoporous hollow carbon spheres showed significantly lower HER activity, confirming the synergistic effect of N/S doping. Moreover, accelerated durability tests demonstrated enhanced long-term stability for the NiS-N/S-HCS catalysts, especially for the 5:95 composition.

These results position NiS-N/S-HCS as efficient and durable non-noble metal electrocatalysts for sustainable hydrogen production in alkaline environments.

Keywords:

hydrogen evolution reaction, N/S-doped mesoporous hollow spheres, NiS, electrocatalysis,

Reference:

Martin ĽDurovič, Jaromír Hnát, Karel Bouzek. Electrocatalysts for the hydrogen evolution reaction in alkaline and neutral media. A comparative review. *Journal of Power Sources* 493 (2021) 229708.

Ris work was supported by:

This work was supported by the Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECI-HTI) through the 'Estancias Posdoctorales por México' program.



SOFT-TEMPLATED N-DOPED HOLLOW CARBON SPHERES AS A PLATFORM for NiS-BASED HER ELECTROCATALYSTS

Autor: Antonio Maia de Jesus Chaves Neto¹

Coautores: Eduardo Martínez Guerra ²; Francisco Aguirre Tostado ³; Juan Carlos Carrillo Rodríguez ⁴; Luz Idalia Ibarra Rodríguez ⁵; Mario Hidrogo ⁶

¹ *Federal University of Para*

² *Centro de Investigación en Materiales Avanzados (CIMAV-Monterrey)*

³ *Cimav, Unidad Monterrey*

⁴ *Centro de Investigación en Materiales Avanzados S.C.*

⁵ *Centro de Investigación en Materiales Avanzados (CIMAV), S.C.*

⁶ *CIMAV*

Autor responsable de la comunicación: antmchaves@yahoo.com.br

A novel nitrogen-doped mesoporous hollow carbon sphere was developed using 2-pyridinemethanol as a single-source nitrogen precursor via a soft-templated synthesis route. This method yielded well-defined hollow spherical structures with high surface area and tunable surface chemistry. The incorporation of pyridinic and graphitic nitrogen sites, confirmed by XPS, indicates favorable electronic properties for electrocatalytic applications.

Nickel sulfide nanoparticles were subsequently anchored onto the N-doped hollow carbon framework through a solvothermal deposition process. At a fixed NiS loading of 5 wt%, structural analysis revealed the selective crystallization of the millerite phase—a NiS polymorph known for its intrinsic hydrogen evolution reaction (HER) activity. Strong interfacial coupling between the doped carbon matrix and NiS nanoparticles facilitated enhanced phase dispersion and electronic interaction.

Electrochemical testing demonstrated that the 5 wt% NiS/N-doped hollow carbon composite significantly outperformed both its non-doped counterpart and analogous materials with higher NiS content in alkaline HER. This optimized composition exhibited lower overpotentials and superior long-term stability, highlighting the synergistic effect of nitrogen doping and phase-selective NiS integration.

Altogether, this study presents a streamlined strategy for developing non-noble metal electrocatalysts, where rational nitrogen incorporation and controlled sulfide crystallization on hollow nanostructures converge to yield high-performance materials for alkaline water splitting.

Keywords:

NiS nanoparticles, nitrogen doping, hollow carbon spheres, HER, electrocatalysis

Reference:

Nan Jiang, Qing Tang, Meili Sheng, Bo You, De-en Jiang, Yujie Sun. *Catal. Sci. Technol.*, 2016,6, 1077- 1084

Ris work was supported by:

This project was funded by the Secretaria de Ciencia, Humanidades, Tecnología e Innovación and the Federal University of Para



WATER DROPLETS AS LIQUID LENSES FOR LASER-BASED MATERIAL PROCESSING

Autores: Rodrigo Rena Gonzalez¹; Tupak Ernesto Garcia Fernandez²; Mayo Villagran Muniz¹; Enrique Esparza Alegria³

¹ *Instituto de Ciencias Aplicadas y Tecnología, Universidad Nacional Autónoma de México*

² *Universidad Autónoma de la Ciudad de México*

³ *Independiente*

Autor responsable de la comunicación: rodrrena@gmail.com

This work presents an innovative strategy for laser-assisted material processing using distilled water droplets as temporary liquid lenses. When deposited on a solid, transparent substrate, these sessile droplets act as optically transparent converging elements that reshape the spatial distribution of incoming laser radiation. The geometric and optical characteristics of the droplets, including contact angle, base radius, height, volume, and focal length, were systematically characterized to understand their focusing behavior. The focal length of each droplet was experimentally deter-

mined using white light transmission. To evaluate their performance in laser-material interaction, a pulsed Nd:YAG laser was focused through individual droplets onto aluminum and photographic paper substrates. The material response was monitored in real time via photoacoustic detection using a piezoelectric sensor. Laser-induced effects, such as melting, surface restructuring, and crater formation, were analyzed through optical microscopy and profilometry. Additionally, the photoacoustic signal generated by laser absorption in the droplet and the transparent substrate was also studied. Results show that water droplets can serve as low-cost, reconfigurable optical elements capable of locally modulating laser intensity, enabling precise energy delivery without the need for conventional optics. This approach is suitable for a variety of laser-based processes, including micromachining, surface texturing, and localized material modification. The dynamic nature of liquid lenses makes them promising tools for adaptive laser processing platforms. This study contributes to the emerging field of fluid-based optics and demonstrates the potential of using simple liquid structures in advanced photonic applications for materials science and surface engineering.

Keywords:

Liquid lenses, Laser-material interaction, Surface modification, Photoacoustic detection

Reference:

rodrrena@gmail.com

Ris work was supported by:

PAPIIT IN111725



OPTICAL AND ELECTRICAL DIAGNOSTICS OF REACTIVE MAGNETRON SPUTTERING PLASMAS FOR RIN FILM ENGINEERING

Autor: Estrella Teran-Hinojosa¹

Coautores: Noemi Abundiz Cisneros²; Roberto Machorro Mejía³; Roberto Sangines⁴

¹ *Centro de Nanociencias y Nanotecnología*

² *CONAHCyT, Centro de Nanociencias y Nanotecnología, UNAM*

³ *Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México*

⁴ *SECIHTI, Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México*

Autor responsable de la comunicación: estrellatrn@gmail.com

Magnetron sputtering is a widely used technique for the deposition of thin films, particularly for producing inhomogeneous interference filters, where the refractive index changes smoothly during deposition. Process stability and film characteristics are influenced by the dynamics of plasma, its interaction with reactive gases, and the energy delivered to the system, making precise control of deposition parameters crucial for replicating desired optical properties. Optical emission spectroscopy (OES), combined with electrical signal analysis, provides a non-intrusive approach to monitor plasma behavior in real time. This work presents a study on the relationship between plasma behavior and thin film deposition conditions in a reactive magnetron sputtering system. Monitoring plasma emission lines and voltage/current signals was performed under various reactive gas flows and discharge configurations. The results show that combining optical and electrical diagnostics gives us a better understanding of the deposition process and improves control during the fabrication of advanced inhomogeneous filters

Keywords:

reactive magnetron sputtering, plasma diagnostics, optical emission spectroscopy, inhomogeneous filters

Reference:

R. Sanginés, N. Abundiz-Cisneros, O. Hernández Utrera, C. Diliégros-Godines, and R. Machorro-Mejía, J Phys D Appl Phys 51, 095203 (2018). <https://10.1088/1361-6463/aaa8d4>

Ris work was supported by:

Ministry of Science, Humanities, Technology and Innovation (SECIHTI) [IxM SECIHTI, 1081; CF-2023- I-704] and PAPIIT-UNAM [BG101123]



OPUNTIA FICUS-INDICA YOUNG CLADODES CHARACTERIZATION USING NORMALIZED DIFFERENCE VEGETATION INDEX.

Autores: Diana Camila Del Razo Pintor¹; Francisco Hernández Rosas²; Irvin Adrián Vázquez Ruiz¹; Ivan Rodrigo Santacruz Bravo¹; Juan Hernández-Rosas³

Coautores: Noe Sierra Romero ¹; Rodolfo Vera Amaro ¹

¹ Instituto Politécnico Nacional-Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas

² Km. 348 Carretera Federal Córdoba-Veracruz, Manuel León, Municipio de Amatlán de los Reyes, Veracruz, México
C. P. 94953

³ Instituto Politécnico Nacional

Autores responsables de la comunicación: ddelrazop1700@alumno.ipn.mx, ivazquezr1600@alumno.ipn.mx, rbravo9_ivan8@outlook.com

In this work, we characterized prickly pear crops of the edible nopal-verdura variety (*Opuntia ficus-indica*) by taking images with a multispectral camera mounted on an Unmanned Aerial Vehicle (UAV) during an autonomous flight, but we also take images at the plant scale. Our research has focused on studying young cladodes of *Opuntia ficus-indica* used in traditional Mexican cuisine because they surprisingly present a range of Normalized Difference Vegetation Index (NDVI) values close to those of healthy crop vegetation or tropical rainforests, which is quite different to the reported values associated to cactus plants. Indeed, healthy cacti show lower near-infrared reflectance compared to healthy leaves of green plants. Consequently, NDVI, as a parameter related to reflectance, should exhibit the same behavior. However, the young cladodes of the nopal-vegetable variety display a greenness different to the rest of the plant, perhaps the result of thousands of years of domestication, which is confirmed by our NDVI results, regardless of whether the plant is healthy or presents some type of moderate phytosanitary phenomenon.

Keywords:

multispectral camera, reflectance, opuntia cladodes, image analysis, vegetation index.

Reference:

H. Chamorro-Sevilla, A Erazo, "Estudio multiespectral del cultivo de tuna para determinar los índices NDVI, CWSI y SAVI, a partir de imágenes SENTINEL 2A, en el cantón Guano, provincia de Chimborazo, Ecuador" *Enfoque UTE* 10, 55–66 (2019).

Ris work was supported by:

Instituto Politécnico Nacional and the Milpa Alta's municipal government



INFLUENCE OF Bi/Fe RATIO ON THE NANOSCALE FERROELECTRIC BEHAVIOR OF BiFeO₃ THIN FILMS UNDER DIFFERENT ANNEALING ATMOSPHERES

Autor: Carolina Janani Diliegros Godines¹

Coautores: Francisco Javier Flores-Ruiz²; Janeth Alejandra Ramírez-Fernández³; Ma. Estela Calixto Rodríguez¹; Victoria Guadalupe Herréra-Pérez³

¹ *Instituto de Física BUAP*

² *SECIHTI-Instituto de Física BUAP*

³ *Facultad de Ciencias Físico Matemáticas, BUAP*

Autor responsable de la comunicación: janani.diliegros@gmail.com

One-layer thin films of BiFeO₃ (thickness~50 nm) were deposited by the dip-coating sol-gel technique using an acetic acid route. The influence of the Bi/Fe ratio (from 1.1 to 1.25) as well as the annealing atmosphere (O₂, N₂ and air) was studied at the nanoscale using piezoresponse force microscopy. The writing process at 5V shows a well-defined pattern for lower Bi/Fe ratios. However, the annealing in N₂ kept the stoichiometric phase of BiFeO₃ even at higher Bi/Fe ratios, as well as a better polling of the ferroelectric domains. For all the Bi/Fe ratios the hysteresis loops are well defined. The technique used to grow the thin films, as well as the sintering and annealing process shows high quality thin films.

Keywords:

BiFeO₃, PFM, Sol-gel

Reference:

Semicond. Sci. Technol. 39(2 024) 045003 (11pp)

Author approval:

I confirm

Author will attend:

I confirm

Work was supported by:

VIEP-BUAP 2025, FOINS-CONACYT 2016-01-, CF-2023-I-1429



RE OPTICAL RESPONSE OF LAYERED [LAYER_1/LAYER_2]_N METAMATERIALS: A STUDY THROUGH THE TRANSFER MATRIX FORMALISM

Autor: Karla Selene Ortiz Márquez¹

Coautores: Javier González Medrano ¹; Francisco Alberto Amador Ramírez ; Felipe Pérez Rodríguez ¹; Francisco Javier Flores Ruiz ²

¹ *Instituto de Física, Benemérita Universidad Autónoma de Puebla*

² *SECIHTI-Instituto de Física, Benemérita Universidad Autónoma de Puebla*

Autor responsable de la comunicación: om224470401@alm.buap.mx

In this work, we use the transfer matrix formalism to study the optical response of stacked periodic plate systems using reported experimental refractive indices (n and k). We show that a proper implementation of formalism allows anticipating and optimization the optical response of designs that include metal-metal, metal-dielectric, or dielectric-dielectric nanostructures for the development of optical filters. We emphasize that the transfer matrix can be computed virtually in any wavelength range. In the case of periodic systems, we show the importance in the choice of the first layer on which the electromagnetic wave will impinge (or light input) and changes in the optical response with the angle of incidence. We present a periodic structure $\{\text{Cu}[10 \text{ nm}]/\text{Ag}[8.1 \text{ nm}]\}_N$ with reflectance for p and s polarization presenting a dip between 327 nm and 333 nm that occur when the light is incident on the silver layer, but if the configuration is reversed the dip is attenuated, indicating that the interaction of the electromagnetic wave with the silver plate is determinant in the intensity of the dip.

Keywords:

Transfer matrix formalism, Multilayer, Metamaterials

Reference:

Markoš, P., & Soukoulis, C. M. (2008). Wave Propagation: From Electrons to Photonic Crystals and Left- Handed Materials (STU-Student edition). Princeton University Press. <http://www.jstor.org/stable/j.ctt7s2wj>

His work was supported by:

The authors acknowledge CONAHcyT for the grants received through the projects FOINS-CONAHcyT 2016-01-2488 and CF-2023-I-1429.



RE OPTICAL RESPONSE OF STACKED NON-PERIODIC PLATE SYSTEMS USING THE TRANSFER MATRIX FORMALISM

Autores: Brenda Miranda Guevara¹; Francisco Javier Flores Ruiz²

Coautores: Carolina Janani Diliegros Godines¹; Felipe Pérez Rodríguez¹; Francisco Alberto Amador Ramírez¹; JG Medrano¹

¹ Instituto de Física "Ing. Luis Rivera Terrazas", Benemérita Universidad Autónoma de Puebla

² SECIHTI-Instituto de Física "Ing. Luis Rivera Terrazas", Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: marioparrahurtado@gmail.com

Low emissivity (low-E) optical filters can control the emission of thermal radiation (heat) over a desired wavelength (λ) range. Applications include energy-efficient windows to reduce indoor heat transfer while allowing visible light to pass through, and solar filters to improve energy conversion efficiency by tuning emission angles, among others. Here, we study low-E optical filters with structure $[\text{Cd}_2\text{SnO}_4/\text{X}/\text{Al}_2\text{O}_3/\text{Cd}_2\text{SnO}_4]_C$ where X is Al_2O_3 , Ag, Al, Cu, and Ti, and C alludes to the unit cell repeat number. Then, for $C = 1$, we have a non-periodic system, while for $C > 1$, the structure is periodic. We chose Cd_2SnO_4 because it is a good material for solar cell applications and possesses mechanical and tribological properties suitable for environmental exposure.

We use experimental n and k indices linked to the thickness of the layers composing the low-E filter in the transfer matrix formalism to compare the optical response in terms of transmittance (T), reflectance (R), and absorbance (A). For $C = 1$, Ag, Al, Cu, and Ti reduce transmittance for $\lambda > 700$ nm; for $C > 1$, the transmittance reduction was more efficient, pointing out the effect of periodicity.

For $400 \text{ nm} < \lambda < 700 \text{ nm}$, $T_{\text{Ag}} > T_{\text{Ti}} > T_{\text{Cu}} > T_{\text{Al}}$, but $A_{\text{Al}} > A_{\text{Cu}} > A_{\text{Ti}} > A_{\text{Ag}}$, thus, the best low-E response of the proposed structure was achieved with $\text{Ag} > \text{Ti} > \text{Cu} > \text{Al}$. Our analysis extends the understanding of low-E filters using Cu, Ti, and Al layers instead of Ag.

Keywords:

Low emissivity (Low-E) optical filters, Cd_2SnO_4 -based multilayers

Reference:

Markos, P., & Soukoulis, C. M. (2008). Wave propagation: from electrons to photonic crystals and left-handed materials. In Wave Propagation. Princeton University Press.

Ris work was supported by:

The authors acknowledge CONAHcyT for the grants received through the projects FOINS-CONACyT 2016-01-2488 and CF-2023-I-1429.



ELECTRON PARAMAGNETIC RESONANCE IN THE SODIUM PHOSPHATE GLASSES DOPED WITH MnO

Autores: Herlinda Montiel Sánchez¹; Guillermo Alvarez Lucio²

¹ *Instituto de Ciencias Aplicadas y Tecnología UNAM*

² *Colegio de Ciencia y Tecnología, Universidad Autónoma de la Ciudad de México, Plantel Cuautepec,*

Autores responsables de la comunicación: herlinda.montiel@icat.unam.mx, memodin@yahoo.com

The electron paramagnetic resonance (EPR) in $(100-x)(85\text{P}_2\text{O}_5+15\text{Na}_2\text{O})+x\text{MnO}$ glasses ($0.5 \leq x \leq 14$ wt%) are studied at 300 K and 77 K. All samples exhibit EPR spectra, which are characteristic to Mn^{2+} ions, and they show a predominant resonant line at $g = 2.0$ due to manganese ions in an environment close with octahedral symmetry. The shapes of the EPR spectra change with the increase in MnO content; in particular, for a low MnO content ($x < 1$ wt%), this resonant line shows a resolved six-line hyperfine structure. A weak resonance signal at $g = 4.3$ is also observed, attributed to the rhombic surroundings of the Mn^{2+} ions. EPR parameters suggest that in these glasses, the Mn^{2+} ions participate in superexchange interactions at low MnO content and in dipole-dipole interactions at higher concentrations.

We thank R. Zamorano by the employment of the EPR magnetometer and J. Contreras by the synthesis of samples.

Keywords:

Electron paramagnetic resonance, MnO glasses,

Reference:

His work was supported by:

The authors acknowledge the PAPIIT-UNAM IN113624 project for financial support.



MAGNETO-ELECTRONIC TRANSPORT IN CO-BASED AMORPHOUS MULTILAYERS

Autor: Enrique Francisco Pinzón Escobar¹

Coautores: Alejandro Esparza García ¹; María Herlinda Montiel Sánchez ¹

¹ *Departamento de Micro y Nanotecnologías, Instituto de Ciencias Aplicadas y Tecnología, Universidad Nacional Autónoma de México*

Autor responsable de la comunicación: enrique.pinzon@icat.unam.mx

Amorphous metallic magnetic layers are materials that lack long-range atomic crystalline order and exhibit high permeability, low coercivity, soft magnetic properties, and an absence of magnetocrystalline anisotropy, all of which are desirable features for sensor and data storage applications. In this work, we report the magnetoelectronic transport properties of VITROVAC-6030/Au/Magnetic-layer structures, using VITROVAC-6030, Permalloy, or Nickel as the magnetic layer. The multilayers were deposited by magnetron sputtering at room temperature onto silica glass substrates, with VITROVAC-6030 layers of 30 nm, 60 nm, and 125 nm thicknesses, a 5 nm Au layer, and a 30 nm magnetic layer. Electrical DC transport properties were measured using the four-probe Smits method. All samples exhibited ohmic behavior; however, the resistivity varied among the three multilayer structures, demonstrating electrical anisotropy and a dependence on the thickness of the VITROVAC layer. Magnetic characterization revealed that the VITROVAC/Au/Permalloy structure exhibited the lowest coercive field and highest saturation magnetization. In contrast, the VITROVAC/Au/Ni structure showed the highest values of coercive field and lowest saturation magnetization, attributed to the magnetocrystalline anisotropy of Ni. For the VITROVAC/Au/VITROVAC and VITROVAC/Au/Ni multilayers, resistivity as a function of VITROVAC thickness was found to correlate inversely with the product of the saturation magnetization (M_s) and coercive field (H_c). On the other hand, for VITROVAC/Au/Permalloy multilayers, the resistivity correlated with the exchange length as a function of VITROVAC thickness. The results suggest that magnetic coupling and magnetoelectronic transport are strongly influenced by shape anisotropy and magnetoelastic forces at the VITROVAC/substrate interface.

Author for correspondence: enrique.pinzon@icat.unam.mx

Keywords:

VITROVAC-6030, Amorphous magnetic alloys, Magnetic Multilayers, Spintronics, Magnetron Sputtering.

Reference:

C. Cirillo, C. Barone, H. Bradshaw, et al., Magnetotransport and magnetic properties of amorphous NdNi₅ thin films, *Sci Rep* 10, 13693 (2020). <https://doi.org/10.1038/s41598-020-70646-2>.

Ris work was supported by:

PAPIIT-UNAM IN113624 Project



COMPARATIVE ANALYSIS OF THE REFRACTIVE INDEX OF GRAPHENE OXIDE AND EGCG-REDUCED GRAPHENE

Autores: Jesús Gilberto Flores Rivas¹; María Magdalena Méndez-González²

Coautor: Dionisio Manuel Tun Molina ²

¹ *Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional*

² *Depto. Física, Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional*

This study presents a comparative optical characterization of graphene oxide (GO) and reduced graphene oxide (rGO) obtained via green reduction using epigallocatechin gallate (EGCG). Experimental measurements of the refractive index (n) reveal a significant increase in rGO relative to GO, a change attributed to structural modifications introduced during the reduction process. EGCG effectively removes oxygen-containing functional groups—such as hydroxyl and epoxy moieties—leading to partial restoration of the sp^2 -hybridized carbon lattice and enhanced π -electron conjugation. The increase in refractive index is closely linked to the higher electronic density and polarizability of rGO. Moreover, the reduction process narrows the electronic bandgap, altering the material's optical response.

Keywords:

Graphene oxide, reduced graphene oxide, EGCG, refractive index, optical properties

Reference:

Liu, J., Fu, S., Yuan, B., Li, Y., & Deng, Z. (2010). Toward a green chemistry approach to reduce graphene oxide using epigallocatechin gallate. *Journal of Materials Chemistry*, 20(35), 7251–7254.
<https://doi.org/10.1039/C0JM00505A>

Ris work was supported by:

Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional



ELECTRICAL AND MAGNETIC STUDY OF METAL OXIDE COMPOSITES

Autor: María José Jolalpa Yescas¹

Coautores: Alejandro Esparza García ¹; María Herlinda Montiel Sánchez ¹

¹ *Fotofísica y Películas Delgadas, Instituto de Ciencias Aplicadas y Tecnología, Coyoacán, 04510 Ciudad de México, México.*

Autor responsable de la comunicación: alejandro.esparza@icat.unam.mx

With the rapid development of increasingly sensitive and precise devices, especially those operating in the GHz frequency range, implementing advanced technologies to shield these systems from electromagnetic interference (EMI) has become crucial. Recent research has focused on developing a new generation of electromagnetic shielding materials using advanced coatings and composites. These materials aim to combine key features such as low cost, easy sintering, lightweight, improved corrosion resistance in both acidic and basic environments, and high mechanical flexibility under stress. Among the most promising strategies is the development of ferrite-based nanocomposites. Ferrites, like magnetic ceramic materials, possess high electrical resistivity and can absorb electromagnetic fields due to their high energy dissipation. By incorporating a metal such as aluminum, the relaxation frequency of the ferrite can be shifted toward higher frequencies, potentially enhancing its EM absorption capabilities, an important step toward effective electromagnetic shielding. This project presents a method for preparing composites containing strontium ferrite and aluminum. The materials were deposited by magnetron sputtering, using a target composed of aluminum and strontium ferrite, a magnetic oxide scarcely reported in the literature, offering a novel route for high-performance shielding materials. The microstructure of the films will be analyzed to determine the amount of oxide and aluminum deposited, as well as the spatial distribution of these components within the composite layer. Additionally, the electrical and magnetic properties were characterized and will be discussed.

Keywords:

Strontium Ferrite, Magnetron sputtering, Electromagnetic properties, Composites

Reference:

Salman Naeem Khan, Amna Mir, Saima Manzoor, Rafia Raees, Effect of rare earth doping on the electromagnetic response of hard ferrites SrFe₁₂O₁₉ for potential application in high-frequency devices, Materials Chemistry and Physics, Volume 320, 2024.

Ris work was supported by:

Authors acknowledge the PAPIIT-UNAM IN113624 project for the financial support and M.I. Raúl Ruvalcaba for his support in mechanical designing.



ENHANCED RAMAN SIGNAL IN TiO₂-SiO₂ AEROGELS USING LINEAR AND CIRCULAR POLARIZATION

Autor: Leonardo Frias Gasparri^{None}

Coautores: Carlos Antonio Pineda Arellano ¹; Claudio Frausto Reyes ; Juan Manuel López Téllez ; MELISSA DE JESÚS RODRÍGUEZ FLORES ¹; Rodolfo Marínez Manuel

¹ *Centro de Investigaciones Óptica*

Autor responsable de la comunicación: leonardo.friaspasparri@cio.mx

Aerogels are porous materials with high specific surface area, low density, and unique thermal and optical properties, making them attractive for applications such as catalysis, sensors, and energy storage. Raman spectroscopy, on the other hand, is a widely used technique for the structural characterization of materials, particularly useful for identifying crystalline phases. In hybrid TiO₂-SiO₂ aerogels, it allows the detection of the anatase phase and bands associated with defects in the silica matrix. However, amorphous SiO₂ typically yields weak Raman signals with high noise levels, complicating spectral interpretation. This work proposes the implementation of linear and circular polarization in Raman spectroscopy as a strategy to enhance spectral quality in the analysis of TiO₂-SiO₂ aerogels. A sample was synthesized via the sol-gel method, assisted by a solvothermal treatment and dried at ambient pressure, followed by controlled calcination. The aerogel was analyzed using Raman spectroscopy with linear, right circular, and left circular polarization. Complementary characterizations were performed using X-ray diffraction (XRD) and Fourier-transform infrared spectroscopy (FTIR) to confirm the phases present. By processing the Raman signal obtained from linearly and circularly polarized measurements, a spectrum was generated, exhibiting improved signal visibility and enhanced resolution of characteristic bands, thus facilitating phase identification and interpretation. It is concluded that the use of polarization in Raman spectroscopy represents a promising approach to enhance spectral resolution and signal clarity in systems with low Raman response, such as TiO₂-SiO₂ aerogels.

Keywords:

Aerogel, Raman Spectroscopy, Polarization, TiO₂-SiO₂

Reference:

Berrones-Guerrero, J. D., Frausto-Reyes, C., De La Torre-L., M. H., Ortiz-Morales, M., & M. López-T., J. (2022). Impact on the Raman spectra of liquids when a polarized light source is used. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*.

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECIHTI)



SYNTHESIS, CHARACTERIZATION, AND DNA INTERACTION OF A NEW COPPER(II) COORDINATION COMPLEX WITH KETOCONAZOLE AS LIGAND

Autor: Juan José Maldonado Rios¹

Coautores: Brenda Mata Ortega ¹; Daniel Ramírez de Alba ¹; José Antonio Pérez Tavares ¹; María de los Ángeles Sotelo Olague ¹; Rita Judit Patakfalvi ¹; Uriel Espinoza Carmona ¹

¹ *Universidad de Guadalajara*

Autor responsable de la comunicación: juan.maldonado6972@alumnos.udg.mx

Introduction: Transition metal coordination complexes are promising therapeutic agents due to their controlled reactivity and ability to interact with biomolecules such as DNA. Copper(II), in particular, stands out for its redox properties, acting as a structural modulator of DNA and exhibiting antimicrobial activity. Ketoconazole, an antifungal azole derivative, can coordinate with metal centers and potentially enhance or alter its biological activity. In this study, a new Cu(II)-ketoconazole complex was synthesized and characterized, and its interaction with DNA was evaluated using spectroscopic techniques. **Objective:** To synthesize, characterize, and evaluate the interaction of the Cu(II)-ketoconazole complex with DNA through spectrophotometric titration studies and DNA melting temperature analysis. **Methodology:** The compound

[Cu(bpca)(H₂O)₂]NO₃ · 2H₂O was synthesized following previously reported methods. For the Cu(II)-ketoconazole complex, a methanolic solution of [Cu(bpca)(H₂O)₂]NO₃ · 2H₂O was prepared and ketoconazole was added to obtain the coordinated complex in crystalline form. DNA interaction tests were carried out using 2.5 mM solutions of the compounds dissolved in Tris-NaCl buffer. For DNA melting assays, a 2:1 compound-to-DNA ratio was used, and the temperature was monitored from 40–90 °C. Spectrophotometric titrations were conducted with 35 mM compound solutions and varying DNA concentrations. **Results:** The obtained compounds were characterized by infrared spectroscopy. Their interactions with DNA were evaluated using UV-Vis spectroscopy through melting point and titration assays. **Conclusions:** In this study, the complexes [Cu(bpca)(H₂O)₂]NO₃ · 2H₂O and Cu(II)-ketoconazole were synthesized and characterized, and their interactions with DNA were assessed through melting point and spectrophotometric titration techniques. The results indicate that all three compounds interact mainly through electrostatic interactions.

Keywords:

Copper(II) complex, Ketoconazole, DNA interaction, Spectrophotometric titration, Melting temperature assay

Reference:

Castro, I., Faus, J., Julve, M., Amigó, J. M., Sletten, J., & Debaerdemaeker, T. (1990). Copper(II)-assisted hydrolysis of 2,4,6-tris(2-pyridyl)-1,3,5-triazine. Part 3. Crystal structures of diaqua[bis(2-pyridylcarbonyl)amido]copper(II) nitrate dihydrate and aquabis(pyridine-2-carboxamide)copper(II) nitrate monohydrate. *Journal of the Chemical Society, Dalton Transactions*, (3), 891–897.

Ris work was supported by:

Universidad de Guadalajara and SECIHTI



DYNAMIC SPECKLE IMAGING FOR SURFACE ACTIVITY ANALYSIS IN LIVE BIOLOGICAL SAMPLES

Autores: Assad Alejandro Climent-Tame¹; Tupak García-Fernández²

Coautores: Mayo Villagrán-Muniz³; María Elizabeth Álvarez-Sánchez⁴; Laura Isabel Vázquez-Carrillo⁴

¹ *Facultad de Ciencias, Universidad Nacional Autónoma de México. Circuito. Exterior S/N, C.U., Coyoacán, 04510 CDMX, México.*

² *Universidad Autónoma de la Ciudad de México, Unidad San Lorenzo Tezonco. Prolongación San Isidro 151, San Lorenzo Tezonco, Iztapalapa, 09790 CDMX, México.*

³ *Instituto de Ciencias Aplicadas y Tecnología, Universidad Nacional Autónoma de México. Circuito. Exterior S/N, C.U., Coyoacán, 04510 CDMX, México.*

⁴ *Laboratorio de Patogénesis Celular y Molecular Humana y Veterinaria, Posgrado en Ciencias Genómicas, Universidad Autónoma de la Ciudad de México (UACM), San Lorenzo 290, Col. Del Valle, Mexico City 03100, Mexico*

Autor responsable de la comunicación: assad.climent@gmail.com

Dynamic speckle imaging is a non-invasive optical technique sensitive to subtle activity on and beneath material surfaces. While increasingly employed in physical systems, its potential for characterizing live biological materials at interfaces remains underutilized. This study explores its application in differentiating live populations of the protozoan parasite *Trichomonas vaginalis*, a causative agent of trichomoniasis, from those exposed to Metronidazole, a widely-used antiparasitic drug. Parasites were deposited onto microscope slides and coverslips, forming thin-layer biological interfaces observed under 10x magnification. Image sequences were acquired using a CCD camera, first under white-light illumination for positional referencing, followed by speckle pattern imaging using a 632.9 nm He-Ne laser. Paired 15-second video sequences were recorded at 30 frames per second over a 9-hour period across various slide regions. Data analysis included modified second-order statistical techniques, particularly inertia moment calculations derived from time-history co-occurrence matrices of speckle patterns, tailored to account for parasite motility. Additional speckle activity

metrics, Fujii's method and the Generalized Differences Method, were adapted to reduce noise from artifacts and debris. Results demonstrate significant differences in optical activity between treated and untreated parasites, revealing measurable drug-induced changes in surface dynamics. These findings underscore the promise of dynamic speckle imaging as a low-cost, easily implementable tool for monitoring microscale biological behavior at interfaces, and highlight its relevance for surface analysis across biological and material science contexts.

Keywords:

dynamic speckle, surface characterization, biological interfaces, optical activity, *Trichomonas vaginalis*

Reference:

assad.climent@gmail.com

Ris work was supported by:

CONAHCYT-CBF2023-2024-1625, UACM-CCYT-2025- CON-03, CCYT-2025-CON-04, UNAM- PAPIIT IN111725.



CHARACTERIZATION AND METROLOGY / 283

CHARACTERIZATION OF THE MAGNETIC DYNAMIC BEHAVIOR IN MAGNETIC POLYMER COMPOSITE TOROIDS FABRICATED WITH 3D PRINTING

Autor: Luis Enrique Guerra Camacho¹

Coautores: Enrique Francisco Pinzón Escobar¹; María Herlinda Montiel Sánchez¹

¹ *Instituto de Ciencias Aplicadas y Tecnología, Universidad Nacional Autónoma de México*

Autor responsable de la comunicación: guerrale@pceim.unam.mx

Among the new technologies that have become known as “Industry 4.0” for their capacity to revolutionize industrial production additive manufacturing can be found. 3D Printing is an additive manufacturing technique that allows users to fabricate intricate patterns and complex geometries, enabling fast prototyping through Computer-Aided Design (CAD). However, 3D Printing of magnetic materials has so far been elusive for practical applications, given the difficulty in predicting the magnetic behavior during the 3D Printing process. In this work, the magnetic dynamic behavior of different 3D-printed toroids with different infill densities is investigated. The 3D-printed toroids are made from a commercially brand magnetic polymer composite filament, in which iron particles are embedded within a PLA matrix. Impedance and permeability measurements were performed by means of an impedance analyzer and a Rowland-Ring configuration, respectively, and are compared to an only-PLA toroid. Results show that the amount of magnetic content in a 3D-printed toroid affects its inductive behavior at nearly 100 KHz frequencies but has a limited effect on its resonance frequency at approximately 200 MHz frequencies. These results suggest that 3D-printed toroids could potentially serve as low-cost and high-production alternatives to conventionally fabricated ceramic transformers and electric protection devices for low-frequency applications.

Keywords:

3D-printing, Magnetic permeability, Impedance Measurement, Magnetic polymer composite.

Reference:

L. M. Bollig, M. V. Patton, G. S. Mowry and B. B. Nelson-Cheeseman, “Effects of 3-D Printed Structural Characteristics on Magnetic Properties,” in IEEE Transactions on Magnetics, vol. 53, no. 11, pp. 1-6, Nov. 2017, Art no. 2300806, doi: 10.1109/TMAG.2017.2698034

Ris work was supported by:

The authors acknowledge the PAPIIT-UNAM IN113624 project for financial support.



PHOTONIC BANDGAPS IN PHOTONIC CRYSTALS FOR HIGH-PERFORMANCE OPTICAL DEVICES: A COMPARATIVE BIOINSPIRED APPROACH

Autor: María Magdalena Méndez-González¹

Coautores: Alexa Cano Ayon ²; Dionisio Manuel Tun Molina ¹

¹ *Depto. Física, Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional*

² *Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional*

Photonic crystals (PCs), whose optical behavior arises from periodic dielectric modulation at the nanoscale, have emerged as essential components in high-performance photonic technologies. Inspired by natural systems—such as the structurally colored wings of Morpho butterflies and iridescent cuticles of beetles—these materials integrate advanced electromagnetic theory with nanoengineering to achieve highly selective control over light propagation. This study presents a comparative analysis of the photonic bandgap (PBG) ranges of artificial photonic crystals employed in optical sensing, biochemical detection, wavelength-selective filtering, waveguiding, integrated photonic circuits, and anti-counterfeiting coatings. The synthetic structures are contrasted with naturally occurring photonic crystals found in butterfly scales, beetle exoskeletons, tropical bird feathers, and marine organisms. Through this comparison, we elucidate the design principles underlying both biological and engineered PBGs, highlighting the spectral positioning, bandwidth, and structural periodicity as key parameters for functional adaptation. The insights gained from this bioinspired perspective offer valuable strategies for tailoring photonic band structures to meet the specific performance requirements of next-generation optical devices.

Keywords:

Photonic Crystals, Photonic Bandgap, Structural Coloration, Periodic Nanostructures, Iridescence, Bioinspiration

Reference:

Yablonovitch, E. (1987). Inhibited spontaneous emission in solid-state physics and electronics. *Physical Review Letters*, 58(20), 2059.

His work was supported by:

Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional



LUMINESCENCE PHENOMENA: MATERIALS AND APPLICATIONS

CHAIRMEN

Dr. Vicente Vargas: (BUAP), chentever@hotmail.com

Dr. Uriel Balderas: (IIM-UNAM), jubalderas@materiales.unam.mx

This symposium centers on the science and technology of luminescence, in its broader sense, including photo-, thermo-, electro- and mechano-luminescence. The aim is to gather international experts as well as students to discuss the recent progresses in this highly inter- and multi-disciplinary area, with particular attention to the synthesis characterization, and applications of materials exhibiting advanced luminescence properties.

The scope of the conference will cover the following areas:

- Photoluminescence
- Cathodoluminescence
- Ionoluminescence
- Bioluminescence
- Thermoluminescence
- Electroluminescence
- Mechano-, Sono- and Chemi-Luminescence
- Theoretical aspects of luminescence
- Nanophosphors: Physics and materials
- Crystalline, amorphous and glass-ceramic materials
- Polymeric and hybrid materials
- Novel Synthesis
- Materials Characterization
- Quantum cutting and up-conversion
- Combination of luminescent and plasmonic effects
- Light emitting devices
- Displays
- Solar cells



ALKALINE METAL-DOPED CARBON DOTS FOR LUMINESCENCE ENHANCEMENT AND NONLINEAR PROPERTIES: THEIR USE IN BIOIMAGING

Autores: Sergio Romero Servin¹; Gabriel Ramos Ortiz¹

Coautores: Liss Flores Villavicencio²; Ramon Carriles Jaimes¹

¹ *Centro de Investigaciones en Optica*

² *Universidad de Guanajuato*

Autor responsable de la comunicación: garamoso@cio.mx

Recently, carbon dots (Cdots) have gained significant relevance in the field of biophotonics due to their optical and photophysical properties, as well as interesting characteristics such as biocompatibility, low cytotoxicity, and versatility in their manufacture through green synthesis routes. Cdots are promising materials for applications in the fields of photocatalysis, fluorescence sensing, bioimaging, and energy conversion, among others.

In this work, a family of Cdots ranging in size from 3 to 7 nm and featuring a semi-crystalline graphitic structure was synthesized using citric acid and urea as precursor materials. These Cdots were doped with alkali metals and manufactured through a hydrothermal synthesis route. This work demonstrates their use for bioimaging with laser scanning microscopy under one- and two-photon excitation. The presented Cdots are characterized by enhanced fluorescence quantum efficiency up to 30% with the addition of lithium and two-photon nonlinear absorption cross sections of 30,000 GM. The obtained bioimages correspond to DAPI-labeled neuroblastomas in the cell nucleus and the synthesized carbon dots used as cellular markers for the cytoplasm.

Keywords:

Cdots, NPs, luminescence, nonlinear absorption

Reference:

- 1.-Coordination Chemistry Reviews 498 (2024) 215468.
- 2.- J. Mater. Chem. 22 (2012) 24230.
- 3.- Chem Comm 52 (2016) 1311.

Ris work was supported by:

Centro de Investigaciones en Optica



FLUORESCENCE MODULATION OF RHODAMINE B AND CARBON DOTS EMBEDDED IN HYBRID GELS BY SILVER NANOPARTICLES

Autores: Itzel Arizbe Olivares Torres¹; Josefina Alvarado Rivera²

¹ *Departamento de Física, Universidad de Sonora*

² *SECIHTI-Cinvestav Unidad Querétaro*

Autor responsable de la comunicación: josefina.alvarado@cinvestav.mx

Silver nanoparticles (Ag NPs) exhibit localized surface plasmon resonance (SPR) arising from the interaction between conduction-band electrons and incident photons, making them valuable for fluorescence enhancement in various media. In this work, we investigate the interaction of Ag NPs with rhodamine B (RB) and carbon dots (CDs) embedded in SiO₂-PMMA hybrid gels, exploring their potential for organic light-emitting devices (OLEDs). CDs were synthesized hydrothermally from citric acid and ethylenediamine, while Ag NPs were prepared via the Lee-Meisel method. RB was dissolved in ethanol before incorporation into the hybrid gel. The SiO₂-PMMA matrix was synthesized via sol-gel processing using tetraethyl orthosilicate, methyl methacrylate, 3-(trimethoxysilyl)propyl methacrylate, ethanol, water, and nitric acid. From the resulting precursor solutions, 2 ml were extracted, placed into rectangular containers, let dry at an ambient temperature for two weeks, and dried in a convection oven up to 75°C [1]. The gels were characterized using FTIR, UV-Vis absorption, fluorescence spectroscopy, and confocal microscopy, confirming the homogeneous distribution of RB and CDs. SEM and XPS analyses verified their intact incorporation despite acidic synthesis con-

ditions that could compromise Ag NP stability. Photoluminescence studies (excitation: 350–400 nm) revealed that the hybrid matrix exhibits weak intrinsic emission, enhanced by Ag NPs interacting with matrix defects. However, while CDs/Ag NP gels showed emission quenching and band broadening, RB/Ag NP gels displayed enhanced matrix luminescence but quenched RB emission. This suggests that Ag NPs primarily interact with structural defects rather than the fluorophores, likely due to insufficient proximity for SPR-mediated enhancement. Confocal microscopy confirmed uniform

dispersion of RB and CDs, validating the synthesis approach. These findings highlight the selective plasmonic effects of Ag NPs in hybrid gels, offering insights for developing organic materials with adequate optoelectronic properties for device applications.

Keywords:

Hybrid matrix, silver nanoparticles, carbon dots, rhodamine B, intrinsic luminescence

Reference:

[1] I. A. Olivares Torres et al. *J. Sol-Gel Sci. Technol.* 106 (2023) 186-198. <https://doi.org/10.1007/s10971-023-06048-3>

Ris work was supported by:

Hybrid gels, carbon dots, rhodamine B, silver nanoparticles,



THEORETICAL STUDIES OF THE PHOTOLUMINESCENCE PHENOMENON OF SILICENE USING DFT AND HF METHODS

Autor: Ivan Aquino Sanchez¹

¹ *Instituto Tecnológico de Puebla*

Autor responsable de la comunicación: angelj3236p@hotmail.com

This work presents a comprehensive analysis of the photoluminescence spectra of triangular silicene sheets of different sizes, with the aim of determining and observing the various types of behaviors and characteristics of the designed and calculated nanostructures. The studied structures are 8 TSS (triangular silicene sheets), divided into two groups according to their shape and size. An analysis of the relationship between the nanostructures and the utilization of silicene as a potential candidate for hydrogen storage for use as fuel or as an energy vector is also presented.

Keywords:

photoluminescence, silicene, sheets, hydrogen, triangular.

Reference:

Arrieta, D. I., Huamán, Y. E., Gutiérrez, M. C., Montalvo, R. A., & Rivera, P. H. (2014). Sistemas cristalinos bidimensionales. *Revista de investigación de física*, 17(01), 1-12.

Ris work was supported by: Instituto

Tecnológico de Puebla



LUMINESCENCE PHENOMENA / 46

SYNTHESIS AND CHARACTERIZATION OF LUMINESCENT COPPER HALIDE FILMS FOR LIGHTING APPLICATIONS.

Autor: Rosalía Nava Leana¹

Coautores: Andrés Godínez García ¹; Iván Enrique Martínez Merlin ¹; Jesús Uriel Balderas Aguilar ²; Ulises Elí Cercas Balderas ³; Víctor Augusto Castellanos Escamilla ¹

¹ *Instituto Tecnológico de Tlalnepantla*

² *Instituto de Investigaciones en Materiales -UNAM*

³ *Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional*

Autor responsable de la comunicación: r60306863@gmail.com

Currently, white light emitting diodes (WLEDs) are fabricated using yellow YAG:Ce³⁺ phosphors in combination with blue LED chips. However, these materials contain rare earth elements, the cost of which is high due to their low abundance worldwide. Currently, there are different perovskite-type materials with lead content that have been used as light emitters; although effective, the use of lead represents a serious toxicological risk for both living beings and the environment. This situation has motivated the search for alternative materials, free of rare earths and lead, to reduce the environmental impact. In this work, luminescent films based on copper halides were synthesized using the Aerosol-Assisted Chemical Vapor Deposition (AACVD) technique, with the aim of evaluating their potential for lighting applications. The materials reported are composed of copper iodide (CuI) and copper bromide (CuBr), and the organic ligand tetrapropylammonium bromide (TPA-Br). Several studies have shown that the use of polymers can improve the optical properties of luminescent materials, in particular by increasing the emission intensity. Therefore, in this work, films were synthesized both with and without polymers, and the effect of the number of layers (one and three) on the optical properties of the material was also evaluated. The films obtained were characterized by photoluminescent spectroscopy, a technique by which the emission spectrum of all samples is in the range of 450 to 780 nm, thus covering the visible spectrum. Although the shape of the spectrum remains constant both in films that were mixed with polymer and those that were not mixed, a clear increase in the emission intensity is observed in those containing polymers, indicating an improvement in the luminous efficiency attributable to their incorporation.

Keywords:

AACVD, copper halides, LED, luminescence, thin films.

Reference:

J. J. Wang et al., "Highly Luminescent Copper Iodide Cluster Based Inks with Photoluminescence Quantum Efficiency Exceeding 98%," J. Am. Chem. Soc., vol. 142, no. 8, pp. 3686–3690, Feb. 2020, doi: 10.1021/jacs.9b12908.

Ris work was supported by:

Tecnológico Nacional de México campus Tlalnepantla, SECIHTI por el apoyo y recursos proporcionados. De igual forma al MC. Ulises Elí Cercas Balderas por su valiosa contribución.



SYNTHESIS OF Er³⁺, Tm³⁺ AND Yb³⁺ DOPED Gd₂O₃ NANOSTRUCTURES WITH POLYOLS AND THE STUDY OF THEIR UPCONVERSION PROPERTIES

Autor: Irvin Daniel Villar Gutiérrez¹

Coautores: Ciro Falcony Guajardo ¹; Erika Armenta Jaime ²; Haggeo Desirena Enríquez ³; Silvia Elena Castillo Blum²

¹ Centro de Investigación en Estudios Avanzados, Unidad Zacatenco, Ciudad de México.

² Facultad de Química, Universidad Nacional Autónoma de México, Circuito Exterior S/N, Ciudad de México C.P. 04510, México.

³ Centro de Investigaciones en Óptica, 37150 León, Guanajuato, Mexico.

Autor responsable de la comunicación: irvin.villar@cinvestav.mx

This work presents the synthesis of Gd₂O₃ nanostructures doped with Er³⁺, Tm³⁺, and Yb³⁺ via a low-temperature (60°C) sol-gel method followed by annealing at 700°C. We systematically investigated the effect of precursors (LnCl₃ vs Ln(NO₃)₃) and dispersing agents (diethylene glycol vs polyethylene glycol, PEG) on the structural and optical properties of the nanostructures. X-ray diffraction and high-resolution transmission electron microscopy (HRTEM) analyses confirmed the formation of crystalline nanoparticles with cubic structure (space group Ia 3, lattice parameter $a = 10.79 \text{ \AA}$) and an average size of ~20 nm. The homogeneous distribution of lanthanide ions within the Gd₂O₃ matrix was verified by SEM-EDS elemental mapping. Infrared spectroscopy and thermogravimetric analysis demonstrated the presence of residual polyols on the nanoparticle surfaces. The study shows how the selection of precursors and dispersing agents in sol-gel synthesis does not significantly influence the luminescent properties of the materials.

Upconversion luminescence spectra under 980 nm excitation revealed characteristic emissions in the visible and near-infrared regions, corresponding to Er³⁺ transitions $^4F_{9/2} \rightarrow ^4I_{15/2}$ (660 nm, red) and $^4I_{13/2} \rightarrow ^4I_{15/2}$ (1535 nm, infrared), as well as Tm³⁺ transition $^3H_4 \rightarrow ^3H_6$ (812 nm). Detailed power-dependent emission analysis confirmed that these emissions occur through a two-photon absorption mechanism.

These results highlight the potential of these nanostructures for bioimaging and biosensing applications, particularly due to their emission in optimal biological windows (650-900 nm and 1500-1800 nm) and the reported low toxicity of the Gd₂O₃ matrix.

Keywords:

Gadolinium oxide, Sol-gel, Nanoparticles, Upconversion luminescence.

Reference:

Wen, H., & Wang, F. (2013). Lanthanide-Doped Nanoparticles. Synthesis, Property, and Application. In Nanocrystalline Materials: Their Synthesis-Structure-Property Relationships and Applications (pp. 121-160). Elsevier Ltd

Ris work was supported by:

DGAPA-PAPIIT; UNAM IN227523, PAIP 50009036 & CINVESTAV, ZACATENCO.



GREEN SYNTHESIS of MoS₂ NANOPARTICLES VIA LASER FRAGMENTATION: EFFECT OF THE SOLVENT ON MORPHOLOGY AND OPTICAL PROPERTIES.

Autores: Jonás Sánchez Juárez¹; Patricia Maldonado Altamirano¹

Coautores: Jaime Santoyo Salazar ²; Ma. de los Ángeles Hernández Pérez ³; Montserrat Gema Córdova Julián ¹

¹ *Departamento de Física, Escuela Superior de Física y Matemáticas*

² *Departamento de Física, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional*

³ *Departamento de Metalurgia, Escuela Superior de Ingeniería Química e Industrias Extractivas*

Autor responsable de la comunicación: pma8410@gmail.com

Molybdenum disulfide (MoS₂) is a two-dimensional transition metal dichalcogenide with tunable optical and electronic properties, which makes it a promising candidate for applications in opto- electronics, sensing, and energy conversion. In this work, we report the green synthesis of MoS₂ nanoparticles and quantum dots via pulsed laser fragmentation in liquids (LFL), a top-down physical approach that allows precise control of particle size without chemical precursors or toxic byproducts. MoS₂ powders were suspended in methanol and 2-propanol and irradiated with a Nd:YAG laser at 532 nm (50 Hz, 12 ns pulse width). The influence of the solvent on the morphology, composition, and optical properties of the resulting nanoparticles was investigated through a comprehensive set of characterization techniques. Transmission electron microscopy (TEM) and high-resolution TEM (HRTEM) revealed spherical nanoparticles smaller than 10 nm, with average sizes and crystalline features varying with time and solvent. Samples in methanol showed larger particles initially, which evolved into fullerene-like or layered structures, while 2-propanol favored smaller and more stable quantum dots. Scanning electron microscopy (SEM) and EDS confirmed particle agglomeration and formation of nanostructured films upon deposition. XPS and XRD analyses revealed the presence of secondary phases such as molybdenum oxides and elemental sulfur, more prevalent in methanol-based samples, likely due to oxidation processes. UV-Vis absorption spectra showed time-dependent blue shifts consistent with quantum confinement, and calculated bandgap values matched the particle sizes observed by TEM. Photoluminescence spectra exhibited emissions between 1.8 and 3.2 eV, attributed to size effects, structural defects, and possible secondary phases. Raman spectroscopy confirmed the formation of nanostructures by peak shifts relative to bulk MoS₂. These findings demonstrate the strong influence of solvent environment on the outcome of laser-based synthesis and open possibilities for the tailored fabrication of MoS₂ nanostructures using green, scalable methods.

Keywords:

Nanoparticles, Photoluminescence, Raman, Physical synthesis, green synthesis

Reference:

Vincenzo Amendola et al. Room temperature laser synthesis in liquid oxide, metaloxide core shells, and doped oxide nanoparticles. Chemistry-A European Journal, 26:9206-9242, 2020. doi.org/10.1002/chem.202000686.

Ris work was supported by:

This work was supported by master's scholarships awarded to JSJ and MCJ and a postdoctoral fellowship awarded to PMA, all funded by the Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECIHTI)



PHOTOLUMINESCENCE AND JUDD-OFELT STUDIES ON Pr^{3+} ACTIVATED $\text{CdO-B}_2\text{O}_3$ INVERT GLASSES: ADVANCED REDDISH SOLUTIONS FOR CROP ILLUMINATION

Autor: William Romero Romo¹

Coautores: Abraham N. Meza Rocha²; Benito Flores Desirena¹; Omar Soriano Romero¹; Rosendo L. Lozada Morales¹; Salvador Carmona Téllez²; Vicente Vargas García¹

¹ Benemérita Universidad Autónoma de Puebla, Posgrado en Física Aplicada, Facultad de Ciencias Físico Matemáticas

² Secretaría de Ciencia, Humanidades, Tecnología e Innovación - Benemérita Universidad Autónoma de Puebla, Posgrado en Física Aplicada, Facultad de Ciencias Físico Matemáticas

Autor responsable de la comunicación: will.ro93@gmail.com

$\text{CdO-B}_2\text{O}_3$ inverted glasses activated with Pr^{3+} were prepared using molar compositions of 80 % CdO and 20 % B_2O_3 . X-ray diffraction patterns revealed the amorphous nature of the glasses. Optical band gap values around 3.18 eV indicate suitable transparency for Pr^{3+} ions. Under excitation at 446 nm, the Pr^{3+} -doped glasses display emission transitions centered at 487, 527, 603, 645, 706, and 729 nm. Particularly, the emission centered at 603 nm ($^1D_2 \rightarrow ^3H_4 + ^3P_0 \rightarrow ^3H_6$), overlaps with the chlorophyll *a* absorption spectrum, suggesting potential applications in reddish crop illumination. At higher Pr^{3+} concentrations, the emission is quenched due to an increase in the cross-relaxation rate. Judd-Ofelt parameters show the trend $\Omega_2 > \Omega_6 > \Omega_4$. Furthermore, energy transfer processes between Pr^{3+} ions are mainly governed by dipole-dipole multipolar interactions, in agreement with the Inokuti-Hirayama model.

Author approval:

I confirm

Author will attend:

I confirm

Keywords:

Rare earths, Judd-Ofelt, invert glasses

Reference:

Romero-Romo, W., Meza-Rocha, A., Soriano-Romero, O., Lozada-Morales, R., García, V. V., Desirena, B. F., & Carmona-Téllez, S. (2025). Photoluminescence and Judd-Ofelt studies on Pr^{3+} activated $\text{CdO-B}_2\text{O}_3$ invert glasses: advanced reddish solutions for crop illumination. *Ceramics International*. <https://doi.org/10.1016/j.ceramint.2025.04.001>

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECIHTI)



DEVELOPMENT OF $\text{Al}_2\text{O}_3\text{-Li}_2\text{O-B}_2\text{O}_3$ INVERTED GLASSES DOPED WITH Dy^{3+} , Sm^{3+} , AND $\text{Dy}^{3+}/\text{Sm}^{3+}$ FOR YELLOW/ORANGE LASER MEDIUM AND YELLOWISH-ORANGE PHOSPHOR APPLICATIONS

Autores: Abraham Nehemías Meza Rocha¹; Rosendo L. Lozada Morales²; omar Soriano Romero²

¹ SECIHTI-Facultad de Ciencias Físico Matemáticas BUAP

² Facultad de Ciencias Físico Matemáticas BUAP

Autor responsable de la comunicación: omar.soriano.romero@gmail.com

$\text{Al}_2\text{O}_3\text{-Li}_2\text{O-B}_2\text{O}_3$ (ALB) inverted glasses doped with Dy^{3+} , Sm^{3+} , and $\text{Dy}^{3+}/\text{Sm}^{3+}$ were prepared by the melt-quenching method. X-ray diffraction patterns exhibit a characteristic broadband centered at $2\theta = 23^\circ$, indicative of the amorphous nature of glass materials. The FTIR spectra display the main vibrational band at 1214 cm^{-1} corresponding to the orthoborate $[\text{BO}_3]^{3-}$ group. The absorption coefficient spectra exhibit an absorption edge around 350 cm^{-1} , as well as the characteristic feature bands of Dy^{3+} and Sm^{3+} . The emission spectra, under 350 nm ($6\text{H}_{15/2} \rightarrow 4\text{M}_{15/2} + 6\text{P}_7/2$) and 402 nm ($6\text{H}_5/2 \rightarrow 6\text{P}_3/2$) excitations, yield yellow, orange, and yellowish-orange light for Dy^{3+} , Sm^{3+} , and $\text{Dy}^{3+}/\text{Sm}^{3+}$ doped samples, respectively. Finally, the optimal emitting ALB: Dy and ALB: Sm samples were analyzed by the Judd-Ofelt theory to evaluate their radiative properties for laser applications.

Keywords:

yellow, orange and yellowish light, inverted glasses, energy transfer

Reference:

Soriano-Romero, O., Huerta, E. F., Meza-Rocha, A. N., & Caldiño, U. (2023). Orange and yellow emissions through Sm^{3+} and $\text{Tb}^{3+}/\text{Sm}^{3+}$ doped potassium-zinc phosphate glasses for WLED applications. *Ceramics International*, 49(22), 36353-36359.

Ris work was supported by:

O. Soriano-Romero thanks Secretaría de Ciencia, Humanidades, Tecnología e Innovación for the post-doctoral fellowship (grant 9331465)



Er³⁺-DOPED Cs₂TeCl₆: SYNTHESIS AND OPTICAL CHARACTERIZATION

Autores: Eduardo Pérez Domínguez¹; Abraham Nehemías Meza Rocha²; Omar Soriano Romero³

¹ Benemérita Universidad Autónoma de Puebla

² Facultad de Ciencias Físico Matemáticas

³ Facultad de Ciencias Físico Matemáticas BUAP

Autor responsable de la comunicación: edpedom@gmail.com

Since the emergence of perovskites as photovoltaic materials, replacing silicon solar cells, more stable and non-toxic alternatives have been long needed. To address the stability issue, one proposed alternative is the double vacancy-ordered 0-dimensional perovskites, which tend not to exhibit phase changes upon exposure to air, unlike conventional APbX₃. However, when reducing the dimensionality, these types of crystals exhibit better properties in the field of optoelectronics. Thus, in this work, the Cs₂Te_{1-x}Cl₆: Er_x crystal is synthesized via a solid-state reaction, and its luminescent properties are investigated. It is found that the Te optical transitions give rise to self-trapped excitons, and the [ErCl₆]³⁻ octahedra exhibit both down-shifting and up-conversion luminescence. Furthermore, structural properties are characterized by X-ray diffraction and Raman spectroscopy.

Keywords:

perovskites, lanthanides, phosphor, stable, non-toxic

Reference:

Zi, Lu, et al. "Highly efficient and stable Cs₂TeCl₆: Cr³⁺ perovskite microcrystals for white light emitting diodes." *Journal of Materials Chemistry C* 11.7 (2023): 2695-2702.

Ris work was supported by:

SECIHTI



UNRAVELING THE PHOTOLUMINESCENCE MECHANISMS IN LOW-DIMENSIONAL CESIUM LEAD HALIDE PEROVSKITES

Autor: Fernando Quintero Borbon¹

Coautores: Eduardo Martinez Guerra ²; Francisco Servando Aguirre-Tostado ²; Mario Alberto Hidrogro Ricoz

¹ CIMAV

² Centro de Investigación en Materiales Avanzados SC, Unidad Monterrey

Autor responsable de la comunicación: fernando.quintero@cimav.edu.mx

Low-dimensional cesium lead halide perovskites have emerged as promising materials for optoelectronic applications due to their high photoluminescence quantum yields, tunable emission properties, and enhanced stability compared to their hybrid organic-inorganic counterparts. Despite their potential, the underlying mechanisms responsible for their luminescence remain under debate, with reports suggesting contributions from band-to-band recombination, self-trapped excitons, defect-mediated processes, and quantum confinement. In this work, we investigate the photoluminescence (PL) mechanisms in cesium lead halide films synthesized via aerosol-assisted chemical vapor deposition (AACVD). Through a combination of steady-state PL, time-resolved PL (TRPL), scanning electron microscopy (SEM), X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), and Raman spectroscopy, we correlate the optical behavior with structural, morphological, and chemical properties. Our results reveal that the emission characteristics are governed by a complex interplay of crystal phase, dimensionality, and surface composition, with evidence supporting both band-edge and defect-related recombination pathways. These insights contribute to a better understanding of luminescence in low-dimensional perovskites and support their rational design for light-emitting and photonic devices.

Keywords:

High luminescence, Low dimensional perovskites, AACVD, Thin films characterization

Reference:

Bao, J., Hadjiev, V.G. Origin of Luminescent Centers and Edge States in Low-Dimensional Lead Halide Perovskites: Controversies, Challenges and Instructive Approaches. *Nano-Micro Lett.* 11, 26 (2019).

Ris work was supported by:

Partial financial support was received from SECIHTI-Fronteras Grant #58518



ELECTROLUMINESCENCE IN BiFeO₃

Autor: Zaira Jocelyn Hernandez Simon¹

Coautores: Jose Alberto Luna Lopez ¹; José Álvaro David Hernández de la Luz ¹; Gabriel Omar Mendoza Conde ¹; Eduardo Flores ²; Jaqueline Vázquez Zúñiga ¹; Adolfo David Quintero González ¹; Xochitl Aleyda Moran Martínez ¹

¹ *Centro de Investigaciones en Dispositivos Semiconductores, Benemérita Universidad Autónoma de Puebla*

² *Departamento de Física Aplicada, Centro de Investigación de Estudios Avanzados, Unidad Mérida*

Autor responsable de la comunicación: imezaira@gmail.com

The material known as BiFeO₃ (BFO) has attracted significant attention from the scientific community due to its numerous properties, including ferroelectricity, ferromagnetism, and multiferroelectricity. Additionally, BFO shows potential in the field of energy, particularly in the areas of solar cells and photocatalytic processes. In the domain of optoelectronics for BFO, several studies have documented a photoluminescence phenomenon within the visible spectrum. The photoluminescence exhibited by BFO is conventionally ascribed to band-to-band or band-edge transitions, near-band edge emissions, and defect level emissions. The emission of these particles is typically ascribed to the process of energy level formation within the mid-gap. Despite the existence of well-established reports on its photoluminescence spectrum, the phenomenon of electroluminescence in the BiFeO₃ has not been previously reported until the recently published article [1]. In this investigation, an electroluminescent effect is obtained in heterostructures fabricated with BiFeO₃ microstructures on a p-type silicon substrate and transparent indium tin oxide contacts. These results are important in that the heterostructures exhibited the electroluminescent effect under both positive and negative bias, with a broad spectrum and diverse conduction mechanisms. In the presence of negative bias, the emission process requires the application of reduced voltages (initiating at -6V with a maximum emission intensity observed at -20V) and currents of approximately 100 mA. Furthermore, the emission displays remarkable stability. When the device is subjected to positive bias, emission occurs at the device's edge at higher voltages (starting at 30V) and lower currents of approximately 10mA.

Keywords:

Electroluminescence, BiFeO₃, Microstructures, Spray Pyrolysis, Photoluminescence

Reference:

[1] SIMÓN, Zaira Jocelyn Hernández, et al. Electroluminescence in BiFeO₃ and the role of defects. *Materials Science in Semiconductor Processing*, 2025, vol. 188, p. 109168.

Ris work was supported by:

Zaira Hernández acknowledges support from SECIHTI Postdoc program [CVU number: 774431]. The authors acknowledge to CINVESTAV-Merida and CIDS-BUAP laboratories for their help in the sample's characterizations.



YPO₄:Eu³⁺:Yb³⁺ CERAMIC POWDERS OBTAINED BY HYDROTHERMAL METHOD

Autor: María del Rosario González García¹

Coautores: Antonieta García Murillo ¹; Felipe de Jesús Carrillo Romo ¹

¹ *Instituto Politécnico Nacional-Centro de Investigación e Innovación Tecnológica*

Autor responsable de la comunicación: rosgg79@outlook.com

YPO₄:Eu³⁺ and Yb³⁺ ceramic powders were obtained through a hydrothermal method. Both pure and Eu³⁺-doped, as well as Yb³⁺- co-doped YPO₄ ceramic powders, were synthesized using this method, followed by thermal treatment at 750 °C for 3 hours to enhance crystallization. Various characterization techniques were employed to analyze structural properties, including X-ray diffraction (XRD). Infrared spectroscopy (IR) and Raman spectroscopy were utilized for chemical analysis. Morphological and elemental analyses were performed using scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS). Photoluminescence (PL) studies were conducted to examine the luminescent properties and the behavior of the pure material in the presence of different lanthanide ions within the structure. The XRD results indicated a cubic structure with peak shifts attributed to including larger ions in the YPO₄ matrix. Additionally, modifications of the lattice parameters were observed due to the ionic radii of Eu³⁺ and Yb³⁺. The IR spectra revealed bonds associated with M-O, P-O, and O-P-O at approximately 1000, 642, and 618 cm⁻¹, confirming the presence of Eu³⁺ and Yb³⁺ ions in the chemical composition of the YPO₄ ceramic powders. The micrographs displayed quasi-spherical morphologies with nanometric sizes, showing the presence of Y, O, P, Eu, and Yb in weight percentages like those used during synthesis. Finally, the emission and excitation spectra were acquired at wavelengths of 230 and 980 nm. These spectra revealed the energy transitions (5D₀-7F₁, 5D₀-7F₂, 5D₀-7F₃, 5D₀-7F₄) of Eu³⁺ and the energy transfer to Yb³⁺. Based on the results obtained, these materials exhibit excellent potential as candidates for optical and biological devices, sensors, and more.

Keywords:

phosphors, ytterbium, europium, luminescence

Reference:

J. Wu, C. Liu, H. Jia, Y. Qi, Z. Liu, Y. Hu, Optical properties, energy transfer and thermal stability of spherical nano-phosphor YPO₄:Eu³⁺:Sm³⁺, College of Materials and Metallurgy, Inner Mongolia University of Sciences and Technology (2022) 22-2313. <https://doi.org/10.1016/j.jlumin.2022.118791>.

Ris work was supported by:

By SECIHTI for financial support for the doctorate. By the support laboratories in materials characterization CNMN-IPN, CREA CIITEC, and CIO.



Al₂(WO₄)₃ DOPED WITH EU EMBEDDED IN GLASS FOR LASER APPLICATIONS AT 613nm

Autor: Piero Alessandro Pérez Ramos¹

Coautores: Abraham Nehemías Meza Rocha ²; Omar Soriano Romero ³; Rosendo L. Lozada Morales ⁴; Salvador Carmona Téllez ⁵

¹ Facultad de Ciencias Físico Matemáticas

² Facultad de Ciencias Físico Matemáticas

³ Benemerita Universidad Autónoma de Puebla

⁴ Facultad de Ciencias Físico Matemáticas BUAP

⁵ CONAHCYT

Autor responsable de la comunicación: piero.perez@alumno.buap.mx

Since the development of the red light-emitting diode (R-LED) by Nick Holonyak in 1962, LEDs have become indispensable for many daily applications, from illumination in displays to laser diodes [1- 3]. In this direction, Al₂(WO₄)₃ is a very attractive choice for a crystalline matrix due to its high thermal stability - over 800°C - aside from delivering naturally punctual symmetric C1 sites for Al and interstitial sites that can be used for the incorporation of Eu³⁺ ions. Taking the latter into account, this job presents the synthesis and characterization of Al₂(WO₄)₃ doped with Eu³⁺ and its application in PiGs (Phosphor in Glass). The structural characterization was carried out by XRD, and the obtained results fit with the chart PDF-70-4478. Taking that information into account, the crystallite size was determined to be 41.8 nm. The Raman spectra reveal a main vibration at 1052 cm⁻¹ that is related to the symmetric vibration of the (WO₄)₂-unit. The study emphasizes the analysis of the luminescent properties of Eu³⁺ and its tonality modulation under different activation energies. Emission bands from Eu³⁺ obtained from the phosphors and PiGs are analyzed under the Judd-Ofelt theory framework to determine candidates for laser applications at 613 nm.

Keywords:

Luminescence, Europium, Tungstate, Laser, Phosphor

Reference:

- [1] <https://doi.org/10.1016/j.jallcom.2018.08.302>
- [2] <https://doi.org/10.1134/1.1473604>
- [3] <https://doi.org/10.1039/D3RA03241H>
- [4] [https://doi.org/10.1016/S0022-4596\(02\)00221-9](https://doi.org/10.1016/S0022-4596(02)00221-9)
- [5] <https://doi.org/10.1016/j.ccr.2015.02.015>

Ris work was supported by:

Secihti



Sm₂O₃-Eu₂O₃ AEROGELS FUNCTIONALIZED WITH TTA: SYNTHESIS AND CHARACTERIZATION

Autor: Alan Daniel Alcantar Mendoza¹

Coautores: Antonieta García Murillo ¹; Felipe de Jesús Carrillo Romo ¹; María del Rosario González García ¹

¹ *Instituto Politécnico Nacional, Centro de Investigación e Innovación Tecnológica*

Autor responsable de la comunicación: a_daniel_am@outlook.com

Aerogels based on lanthanide elements are promising materials for advanced technologies as they combine the essential properties of aerogels -such as high surface area and porosity- with the efficient luminescent characteristics of lanthanide ions. The epoxide-assisted sol-gel method was employed to produce a single aerogel of samarium sesquioxide (Sm₂O₃) and a mixed aerogel of samarium sesquioxide with europium sesquioxide (Sm₂O₃:Eu₂O₃) at a ratio of 50 mol%. However, thermal treatment is generally required to enhance the luminescent properties of rare earth elements, which can jeopardize the porous structure of the aerogel. To mitigate the issue, the organic compound thenoyltrifluoroacetone (TTA) was included to functionalize the aerogels using the antenna effect. Aerogels obtained through supercritical drying in CO₂ (scCO₂) demonstrate a mesoporous morphology with a uniform distribution of the elements, as confirmed by energy-dispersive X-ray (EDX) analysis. The aerogels exhibited an amorphous structure in X-ray diffraction (XRD) and did not show signs of TTA functionalization. However, the Sm₂O₃:Eu₂O₃/TTA aerogel displayed intense luminescence in the visible region due to the 5D₀-7F_J transitions. Eu³⁺ ions, which enhanced by the interaction of the antenna effect.

Keywords:

aerogels, Sm₂O₃, Eu³⁺, thenoyltrifluoroacetone, antenna effect

Reference:

García-Murillo, A., Alcantar-Mendoza, A.D., Carrillo-Romo, F.d.J. et al. Use of the antenna effect on ceramic powders Yb₂O₃:Eu³⁺; Tb³⁺ (to promote luminescence). Bull Mater Sci 47, 158 (2024). <https://doi.org/10.1007/s12034-024-03213-4>

Ris work was supported by:

This work was funded by SECIHTI (A1-S-28234) and SIP-IPN (20253493, 20253397), with characterization support from CNMN-IPN, LabCREA-CIITEC, and CICATA Legaria.



CHARACTERIZATION OF ZINC OXIDE FROM SPENT ALKALINE BATTERIES: PHOTOLUMINESCENCE AND ASPECT RATIO

Autor: Enrique Viguera Santiago¹

Coautores: Juan Carlos Rodríguez López¹; Miguel Meléndez Lira²; Nidia García Rosales³; Susana Hernández López¹

¹ *Universidad Autónoma del Estado de México*

² *CINVESTAV*

³ *Instituto Tecnológico de Jocotitlán*

Autor responsable de la comunicación: enriqueviguera@yahoo.com.mx

In this work, we characterized materials recovered from the anodes of spent alkaline batteries based on their residual voltage. We mechanically extracted the materials and washed them with water until the wash water showed a neutral pH. The water was then evaporated in an open environment to recover solid residues from the anode.

We observed that for voltages below 800 mV, the recovered materials were zinc oxide. However, for values above this, a mixture of zinc oxide and metallic zinc was present, which we confirmed using X-ray diffraction and differential scanning calorimetry. Scanning electron microscopy revealed a rod morphology with an aspect ratio that depended on the residual voltage.

Photoluminescence measurements were carried out at room temperature using a 5 mW Kimmon He-Cd laser as an excitation source with a wavelength of 325 nm. Photoluminescence emission was analyzed using a 27.5 cm focal length monochromator equipped with a Hamamatsu photomultiplier. The computer-controlled photoluminescence setup employed the Lock-in technique.

The recovered materials showed emission at 385 nm and in the visible range between 589 and 595 nm. The ultraviolet emission was greater than the visible emission in most samples. However, for spent batteries with a residual voltage of 780 mV and 1 V, the visible emission was greater than the ultraviolet emission. Photoluminescence is due to interstitial defects, as revealed by Raman spectra. Preliminary results show that mechanically recovered zinc oxide has potential for applications, being an abundant material with an aspect ratio dependent on the residual voltage.

Keywords:

zinc oxide, alkaline batteries, photoluminescence

Reference:

This work is original, and it studies the photoluminescence of materials recovered from exhausted alkaline batteries in terms of residual voltage.

Ris work was supported by:

This work was funded by SIEA-UAEM 7217/2025CIB.



INFLUENCE OF HTLS ON THE PHOTOLUMINESCENT EMISSION OF LEAD HALIDE PEROVSKITES

Autor: Gilberto Alarcón-Flores¹

Coautores: Ismael Garduño-Wilches²; Juan Martinez pastor³; Miguel Aguilar-Frutis¹; Pablo P Boix⁴; Rafael Abargues⁵; Raul Ivan Sánchez Alarcón³

¹ Instituto Politécnico Nacional, Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada

² Cátedras Conahcyt/Instituto Politécnico Nacional, Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada

³ UMDO, Instituto de Ciencia de los Materiales, Universidad de Valencia

⁴ Instituto de Tecnología Química UPV-CSIC

⁵ UMDO, Instituto de Ciencia de los Materiales, Universidad de Valencia

Autor responsable de la comunicación: galarcon@ipn.mx

In the present work, we synthesized thin films of lead halide perovskites on hole transport layers (HTLs) such as PEDOT:PSS, MeO-2PACz, and NiOx using the spin coating technique, in order to observe their influence on the photoluminescent emission of the perovskites. The experimental deposition conditions will be presented, including the use of the green solvent anisole as an antisolvent and the omission of a glove box. The HTLs showed high transparency of 96%, as revealed by UV-Vis measurements, and had an influence on the reduction of the perovskite emission, as shown by the photoluminescence and UV-Vis results. The operating conditions of the evaporator for the electron transport layer C60, the CBP layer, and the silver contact will also be described. The solar cell obtained using NiOx as the HTL showed an efficiency of 13.69%, a fill factor (FF) of 68.28%, $J_{sc} = 21.03 \text{ mA/cm}^2$, and $V_{oc} = 953 \text{ mV}$.

Keywords:

Hole Transport Layers, Lead Halide Perovskites, Solar Cell, Photoluminescent emission

Reference:

Tun Wang, Dong Ding, Hao Zheng, Xin Wang, Jiayuan wang, Hong Liu, and Wenzhong Shen. Efficient Inverted Planar Perovskite Solar Cells Using Ultraviolet/Ozone-Treated NiOx as the Hole Transport Layer. Sol. RRL 2019, 3 1900045, DOI: 10.1002/solr.201900045

Ris work was supported by:

The IPN-SIP for Project Nos. SIP-2024-2420 and SIP-2025-0662



OPTICAL CHARACTERIZATION OF CARBON QUANTUM DOTS SYNTHESIZED FROM AVOCADO PEEL IN DIFFERENT SOLVENTS

Autor: Alejandra Guadalupe Cruz Sánchez ¹

Coautores: José Guadalupe Quiñones Galván¹; Laura Patricia Rivera Reséndiz¹

¹ *Universidad de Guadalajara*

Autor responsable de la comunicación: alejandra.cruz5842@alumnos.udg.mx

In recent years, interest in Carbon Quantum Dots (CQDs) has increased due to their physical and chemical properties, such as low toxicity for biological applications, simplified synthesis routes and low cost. The surface of CQDs synthesized from food waste contains functional groups such as carboxyl, hydroxyl, and alkynyl groups, among others. The photoluminescence emission arises from quantum confinement of the particles in combination with trap states generated by the interactions between surface functional groups and the surrounding medium, as well as structural defects in the carbon lattice. In this work, the origin of the photoluminescence of CQDs synthesized from avocado peel waste and dispersed in different solvents was investigated. The absorption properties were analyzed using UV–Vis spectroscopy, and the emission was evaluated through Photoluminescence (PL) under two excitation wavelengths, 365 and 405 nm, to investigate the mechanisms potentially responsible for the emission. The solvent-dependent variation in the optical bandgap, obtained using the Tauc model, indicates an interaction between surface functional groups and the solvent. Although the obtained bandgap was lower than the excitation wavelengths, no significant contributions were observed in the violet region of the spectra, which would be associated with quantum confinement. Bandwidth values above 25 nm were found through the deconvolution of the spectra, which are associated with surface emissions. A clear dependence of the emission on the excitation wavelength was also observed, attributed to the presence of functional groups on the nanoparticle surface that interact with the solvent, promoting the formation of trap states between the valence and conduction bands. Consequently, the observed emission arises primarily from the surface, while the contribution from core quantum confinement is minimal.

Keywords:

Carbon quantum dots, avocado peel waste, photoluminescence mechanism

Reference:

M.A.G. Balanta, W.J.F. da Silva Filho, M.C.G. Souza, R.M.N. De Assunção, A. Champi, and R.F. Cuevas, Deconvolution of photoluminescence spectra and electronic transition in carbon dots nanoparticles from microcrystalline cellulose, *J. Lumin.* 255 (2023) 119607.

Ris work was supported by:

Universidad de Guadalajara



MECHANO-CHEMICAL SYNTHESIS OF THE $\text{Cs}_2\text{NaBiCl}_6$ SYSTEM ACTIVATED WITH Ag^+ AND Nd^{3+}

Autor: Iván Juárez Rayón¹

Coautores: Abraham Meza Rocha ; Omar Soriano Romero ²; Rosendo L. Lozada Morales ²

¹ FCFM-BUAP

² Facultad de Ciencias Físico Matemáticas BUAP

Autor responsable de la comunicación: ivanjuarez25@gmail.com

Lead-free halide perovskites have been regarded as highly important over the last decade, due to their potential applications in optoelectronics, solar cells, photocatalysis, and sensors, among others. Among their most remarkable qualities are their non-toxicity, enhanced stability, and high quantum efficiency. In this work, the synthesis and structural and optical characterization of the $\text{Cs}_2\text{NaBiCl}_6$ material, doped with Ag^+ and Nd^{3+} ions, are presented for potential applications in the infrared region. The synthesis was carried out through a mechanochemical technique followed by a thermal treatment at 200°C. X-ray diffraction patterns revealed a high phase purity and a strong match with reported reference patterns. Raman spectroscopy was used to detect vibrational modes corresponding to the $[\text{BiCl}_6]^{3-}$ octahedron, centered at 113 and 279 cm^{-1} . It was observed that the incorporation of Ag^+ ions did not alter the crystal structure, but it induced a distortion associated with the pseudo-Jahn-Teller effect, modifying the valence band dominated by Bi^{3+} . This distortion favored the formation of self-trapped excitons (STEs), enabling an electronic recombination that allowed a partially allowed transition between Bi^{3+} levels: $^3\text{P}_0 \rightarrow ^1\text{S}_0$, resulting in an emission centered at 650 nm. In addition to Ag^+ ions, Nd^{3+} ions were introduced through the substitution of Bi^{3+} , resulting in emissions in the IR region. Excitation and emission spectra revealed a Stokes shift greater than 100 nm, which confirmed the presence of self-trapped excitons. Moreover, average lifetimes in the microsecond range were observed. Finally, a computational analysis using CASTEP was performed, revealing an indirect band gap for the pristine matrix, whereas a direct band gap—consistent with the experimental value—was obtained when the matrix was activated with Ag^+ ions. In summary, a potential solution has been provided for lead-free applications with high emissions in the IR region and low-cost synthesis.

Keywords:

Luminescence, Excitons, Perovskites, DFT.

Reference:

<https://doi.org/10.1016/j.jpcs.2018.02.032>

Ris work was supported by:

SECITHI with CVU number 748084.



WHITE ELECTROLUMINESCENCE AND LOW CURRENT CONSUMPTION IN DEVICES BASED ON CARBON-BASED NANOMATERIALS AND SILICON OXIDES

Autor: Gabriel Omar Mendoza Conde¹

Coautores: JOSE ALBERTO LUNA LOPEZ¹; Zaira Jocelyn Hernández Simón¹; José Álvaro David Hernández de la Luz¹; Karim Monfil Leyva¹; Javier Flores Méndez²

¹ CIDS-IC-BUAP

² Facultad de Ciencias de la Electrónica (FCE), Benemérita Universidad Autónoma de Puebla (BUAP)

Autor responsable de la comunicación: jose.luna@correo.buap.mx

This work reports the emission of white electroluminescence (EL) in devices based on carbon-based nanomaterials and silicon oxides. These devices are formed by a heterostructure of porous silicon (PSi), graphene oxide (GO)/carbon nanotubes (CNTs), silicon-rich-oxide (SRO) thin films, and zinc oxide (ZnO) as a transparent conductor oxide (contact), forming MOS-type structures; Si-n/PSi/GO/SiOX/ZnO and Si-n/PSi/CNTs/SiOX/ZnO. The current consumption in these devices has been reduced by approximately three orders of magnitude compared to the current currents commonly reported for electroluminescent devices. The white EL emission is corroborated by the EL spectra, which are very broad (from 400 to 750 nm) and are attributed to the different nanostructured defects present in the materials that make up the heterostructures. The devices exhibited EL only in negative bias. According to our analysis of the I-V curves, the space-charge limited current conduction mechanism is the dominant carrier conduction mechanism in the region where the EL takes place. The electroluminescence exhibited by these devices starts at a current of 1.1 μA and is the entire area electroluminescent at approximately 3 μA reaches its maximum value at 9 μA , for the heterostructures with GO, while for heterostructures with CNTs, the EL emission starts at 10 μA and for entire area is approximately 80 μA . We demonstrated that producing white emission LEDs on a Si substrate can result in significant energy savings.

Keywords:

electroluminescence, porous silicon, graphene oxide, carbon nanotubes, silicon-rich-oxide, heterostructures

Reference:

G.O. Mendoza Conde, J.A. Luna Lopez, et. al., Nanocomposites of silicon oxides and carbon: its study as Luminescent Nanomaterials, *Nanomaterials* 13 (7) (2023) 1271, <https://doi.org/10.3390/nano13071271>

Ris work was supported by:

SECIHTI BASIC SCIENCE G-952-2025 and VIEP PROJECT-518-2025



SYNTHESIS AND STUDY OF THE STRUCTURAL PROPERTIES OF ZnO Co-DOPED WITH Er AND Zr.

Autor: Ricardo Valle Ramirez¹

Coautores: Julián J. Carmona Rodríguez ¹; Omar Soriano Romero ²; Rosendo Lozada Morales ²; Vicente Vargas García ²

¹ *Universidad Tecnológica de la Mixteca*

² *Benemerita Universidad Autónoma de Puebla*

Autor responsable de la comunicación: riquey29@gmail.com

High-efficiency in the near-infrared (NIR) light sources result in novel functional materials with potential applications in some specific fields, for instance, luminescent materials with multi-modes in biosystems. The synthesis of the co-doped with erbium ion Er and zirconium into the zinc oxide (ZnO) host by the sol-gel method, is presented in this work. The Er concentration was kept fixed at 1.25 at.%, while the Zr concentration was varied to 2.5, 3, 3.5, 4, and 5 at.%. The incorporation to Er enhances optical properties of ZnO due to its partially filled 4f energy level, surrounded by full 5s and 5p orbitals, Er ions are better luminescent materials because of the sharp and intense emission due to their 4f intra-shell transitions. The emission spectra were observed in the near-infrared NIR with a laser excitation at 980 nm, this corresponds to the characteristic emission of Er associated with the intraelectronic transition $4I_{13/2} \rightarrow 4I_{15/2}$ centered at 1545 nm. Additionally, the ZnO:Er/Zr presented the Upconversion (UC) luminescence properties, associated with Er. The emission spectra are localized into the visible region, with a laser excitation at 980 nm, the characteristic emission of Er are associated to the intraelectronic transitions $4S_{3/2} \rightarrow 4I_{15/2}$ (548 nm) and $4F_{9/2} \rightarrow 4I_{15/2}$ (660 nm). The NIR UC luminescent properties of ZnO:Er/Zr indicate that this material can be used for optical probes in biosystems.

Keywords:

Erbium, Near-infra Red, photoluminescence, sol-gel, zinc oxide.

Reference:

J. He, M.-F. Luo, L.-Y. Jin, M. He, P. Fang, and Y.-L. Xie, Raman spectrum of Er-Y-codoped ZrO_2 and fluorescence properties of Er^{3+} , Chin. J. Chem. Phys. 20 (2007) 90–94.

Ris work was supported by:

UTM-BUAP



LUMINESCENT PROPERTIES OF Al_2O_3 - Li_2O - B_2O_3 GLASSES ACTIVATED WITH Tb_2O_3

Autores: Abraham Meza¹; Karen Stephania Álvarez Reyes²; Vicente Vargas García³; Ximena Monserrat Mora Aquino²; Omar Soriano Romero⁴

¹ CONAHCYT-BUAP

² Facultad de Ciencias Físico Matemáticas - BUAP

³ FCFM-BUAP

⁴ CIIEC-BUAP

The lithium borate glasses have different applications and have been widely studied, their optical and structural properties, such as high strength of the atomic bonding, the high thermal stability, transparency between the ultraviolet to near infrared regions, among others. The synthesis by melt quenching and the characterisation of the inverted glasses of Al_2O_3 - Li_2O - B_2O_3 activated with Tb_2O_3 are reported in this work. The composition of the glass is 10 mol% of Al_2O_3 , 60 mol% of Li_2O and 30 mol% of B_2O_3 (10 Al_2O_3 -60 Li_2O -30 B_2O_3). The glass was activated with the percentages of 0.1 mol%, 0.25 mol%, 0.5 mol%, 0.75 mol% and 1 mol% of Tb_2O_3 . The optical bandgap is calculated with the absorption spectra; the direct bandgap (EDg) values are between 3.77 and 3.55 eV. The photoluminescence spectra are the characteristic of the electronic transition of Tb^{3+} , for the excitation spectra of the glasses in the region of 300 to 550 nm, show the characteristics energy levels $7F_6 \rightarrow 5L_9$ (352 nm), $7F_6 \rightarrow 5L_{10}$ (369 nm), $7F_6 \rightarrow 5G_6 + 5D_3$ (377 nm) and $7F_6 \rightarrow 5D_4$ (484 nm), these were observed for the emission localised at 541 nm. The emission spectra in the region of 450 to 700 nm for the excitation localised at 378 nm show the characteristic energy levels $5D_4 \rightarrow 7F_6$ (487 nm), $5D_4 \rightarrow 7F_5$ (541 nm), $5D_4 \rightarrow 7F_4$ (484 nm) and $5D_4 \rightarrow 7F_3$ (621 nm). The photoluminescent properties indicate that this inverted glass can be used in illumination and green laser technologies.

Keywords:

Lithium borate glasses, Melt quenching, Optical properties, Luminescent properties.

Reference:

O.B. Aljewaw, M.K.A. Karim, H.M. Kamari, M.H.M. Zaid, A.A. Salim, M.H.A. Mhareb, Physical and spectroscopic characteristics of lithium-aluminium-borate glass: Effects of varying Nd_2O_3 doping contents, *J Non Cryst Solids* 575 (2022) 121214. <https://doi.org/10.1016/j.jnoncrysol.2021.121214>.

Ris work was supported by:

none



STUDY OF THE STRUCTURAL AND LUMINESCENT PROPERTIES OF CsVO₃:Nd³⁺/Yb³⁺ AND THE ENERGY TRANSFERS BETWEEN Nd³⁺ AND Yb³⁺

Autor: María Esmeralda González Hernández¹

Coautores: Abraham Meza Rocha ; Omar Soriano Romero ¹; Rosendo L. Lozada Morales ¹; Vicente Vargas García ²

¹ *Facultad de Ciencias Físico Matemáticas BUAP*

² *FCFM-BUAP*

Autor responsable de la comunicación: megohe2001@gmail.com

This work studied the structural and luminescent properties of CsVO₃ crystals synthesised by the State Solid Reaction doped with Nd³⁺ ion (0.5, 1, 1.5, 3, 4.5 and 6 mol%), seeking the optimal percentage to subsequently be co-doped with Yb³⁺ ions, thus obtaining: CsVO₃: Nd³⁺/Yb³⁺. The State Solid Reaction is a versatile and eco-friendly technique potentially applicable in the industry. The X-Ray Diffraction patterns shows that the crystalline structure is the characteristic of the CsVO₃, the incorporation of the Nd³⁺ ion causes the structure to be modified. The excitation spectra of CsVO₃:Nd³⁺ (from 200 nm to 400 nm) show that the band has the maximum at 323 nm, this absorption band corresponding to 1A₁ → 1T₂ transition associated to [VO₄]³⁻. While the emission spectra from 400 nm to 800 nm, show that the band has the maximum at 535 nm, the band emission in the PL spectra is made up of 3T₁ → 1A₁ (548 nm) and 3T₂ → 1A₁ (486 nm) transitions. The Near-Infrared (NIR) emission of CsVO₃:Nd³⁺ was obtained excited at 808 nm with a pumping power around 370 mW, the maximum in the emission band at 1063 nm corresponding to 4F_{3/2} → 4I_{11/2} transition of the Nd³⁺, while the NIR emission of CsVO₃:Nd³⁺/Yb³⁺ presents a band around 983 nm corresponding to the 4F_{5/2} → 4F_{7/2} transition of Yb³⁺. Near-infrared photoluminescence is useful for applications in optoelectronics and photovoltaics and for such purposes CsVO₃:Nd³⁺/Yb³⁺ is very promising.

Keywords:

Photoluminescence, Cesium vanadate, State solid reaction, Neodymium, Ytterbium, Crystalline structure.

Reference:

J. Luo, A. Yang, X. Wang, K. Liu, First-principles study on the electronic structures and optical properties of CsVO₃, *Ferroelectrics*. 564 (2020) 52–58. <https://doi.org/10.1080/00150193.2020.1761701>.

Ris work was supported by:

Conahcyt.



SYNTHESIS AND CHARACTERIZATION OF METAL-HALIDE PHOSPHOR Cs_2TeCl_6 MODIFIED WITH Er^{3+} .

Autores: Eduardo Pérez Domínguez¹; Abraham Meza Rocha; Omar Soriano Romero²

¹ Benemérita Universidad Autónoma de Puebla

² Facultad de Ciencias Físico Matemáticas BUAP

Autor responsable de la comunicación: edpedom@gmail.com

Since the emergence of perovskites as photovoltaic materials, replacing silicon solar cells, more stable and non-toxic alternatives have been long needed. To address the stability issue, one proposed alternative is the double vacancy-ordered 0-dimensional perovskites, which tend not to exhibit phase changes upon exposure to air, unlike conventional APbX_3 . However, when reducing the dimensionality, these types of crystals exhibit better properties in the field of optoelectronics. Thus, in this work, the $\text{Cs}_2\text{Te}_{1-x}\text{Cl}_6:\text{Er}_x$ crystal is synthesized via a solid-state reaction, and its luminescent properties are investigated. It is found that the Te optical transitions give rise to self-trapped excitons, and the $[\text{ErCl}_6]^{3-}$ octahedra exhibit both down-shifting and up-conversion luminescence. Furthermore, structural properties are characterized by X-ray diffraction and Raman spectroscopy.

Keywords:

perovskites, lanthanides, phosphor, stable, non-toxic

Reference:

Zi, Lu, et al. "Highly efficient and stable $\text{Cs}_2\text{TeCl}_6:\text{Cr}^{3+}$ perovskite microcrystals for white light emitting diodes." *Journal of Materials Chemistry C* 11.7 (2023): 2695-2702.

His work was supported by:

SECIHTI



STRUCTURAL ANALYSIS OF CESIUM METAVANADATE PHOSPHOR BY PYTHON PROGRAM

Autores: Cesar Vladimir Meza Lezama¹; Abraham Meza Rocha¹; Vicente Vargas García²

¹ *Facultad de Ciencias Fisico Matemáticas-BUAP*

² *FCFM-BUAP*

Autor responsable de la comunicación: vladmezalezama@gmail.com

The CsVO₃ materials have recently been extensively studied because it has excellent photoluminescent properties, which allow the CsVO₃ to be used in different applications. For example, the quantum dots (QDs) composite of CsVO₃ perovskite was utilised in the photocatalysis; the high quantum efficiency of these materials enables them to be used in manufacturing WLEDs. This work shows the luminescence and structural properties of Cs_xVO_y ($x=1, 1.5, 2, 2.5$ and 3 ; $y=3, 3.25, 3.5, 3.75$ and 4). The emission spectra of the CsVO₃ were obtained using the excitation of 365 nm; this spectrum is a broad band in the region of 400 to 700 nm with the maximum at 535 nm. The excess causes changes in the crystalline structure, which modifies the luminescent properties of the Cs_xVO_y ($x=1, 1.5, 2, 2.5$ and 3 ; $y=3, 3.25, 3.5, 3.75$ and 4). So, in this work, the crystalline properties are studied using the Python programming language to calculate the crystal size by the Debye-Scherrer method and the Williamson-Hall method. Additionally, with the Williamson-Hall method it is possible to obtain other parameters, like strain. This structural study is essential to understand the correlation that exists between luminescent properties and the crystalline structure.

Keywords:

Cesium metavanadate, Crystalline structure, Optical properties, Luminescent properties.

Reference:

H. Miyazaki, Y. Mimar, Flexible white-light-emitting thin-film CsVO₃ devices obtained using cesium vanadate aqueous solution, *Optical Materials* 114 (2021) 2-5. <https://doi.org/10.1016/j.optmat.2021.111004>.

Ris work was supported by:

SECIHTI



BLUE, GREEN LUMINESCENCE RESPONSE OF GREEN SYNTHETIZED GRAPHENE OXIDE NANOPARTICLES OBTAINED BY CONTROL NUMERIC ASSISTED LASER ABLATION FROM LEMON AND TANGERINE PEELS

Autores: Francisco Severiano Carrillo¹; Marco Antonio Aguila Juárez²

Coautores: Abdú Orduña Díaz ²; Orlando Zaca Moran ¹

¹ *Instituto Politecnico Nacional - Centro de Investigación en Biotecnología Aplicada*

² *IPN-CIBA tlaxcala*

Autores responsables de la comunicación: balarama_1@yahoo.com.mx, maguilaj2500@alumno.ipn.mx

The physical and chemical properties of graphene oxide nanoparticles (GONs) obtained by laser ablation from lemon and tangerine were studied in this work. The GONs showed different chemical and physical properties depending from the peel used as source. Scanning electron microscopy characterization showed that the size of the GONs depends on the peel used to obtain them. The characterization obtained by energy dispersive spectroscopy showed that GONs are mainly composed of carbon and oxygen. The morphological analysis was realized through transmission electron microscopy and the formation of graphene was observed. Selected area electron diffraction patterns were used to study the crystallinity of the GONs obtained. Fourier transform infrared spectroscopy shows the chemical changes among the GONs obtained from the different peels used as source. Raman spectra demonstrate the obtention of GONs and their defect densities were estimated. The X-ray patterns suggest that the samples obtained are composed of different carbon structures. Ultraviolet-visible spectroscopy shows that the GONs has different absorptions bands related to the peels used as source. Photoluminescence analysis demonstrate that the GONs obtained from all peels has luminescent properties, those obtained from lemon shows the greater intensity. The main emission was observed 435 and 496 nm and are related to the characteristic graphene oxide.

Keywords:

Graphene oxide, laser ablation, graphene oxide luminescence, carbon materials

Reference:

<https://doi.org/10.1016/j.nwnano.2025.100091> **Ris**

work was supported by:

SECIHTI



THERMOLUMINESCENCE RESPONSE OF $\text{CaMoO}_4:\text{Dy}^{3+}$ EXPOSED TO UV RADIATION

Autor: Andrés Alfonso Saavedra Romero¹

Coautores: Omar Soriano Romero²; Salvador Carmona Téllez²

¹ *Facultad de Ciencias Físico-Matemáticas, Benemérita Universidad Autónoma de Puebla*

² *Secretaría de Ciencia, Humanidades, Tecnología e Innovación-Benemérita Universidad Autónoma de Puebla, Pos-grado en Física Aplicada, Facultad de Ciencias Físico Matemáticas*

Autor responsable de la comunicación: alfromero1997@gmail.com

Every day, we are continuously exposed to different radiation sources like the UV light from the sun or even the radio frequency emitted by our communication devices. Keeping this in mind several passive dosimeters have been developed, in particular, solid state dosimeters has shown high sensitivity in a small volume, which is useful for store information for a period of time [1]. Furthermore, the thermoluminescent dosimeters (TLDs) are solid state dosimeters which present thermally stimulated luminescence, after the interaction with the ionizing radiation electrons are excited and get trapped at energy levels within the crystal structure of the material, once the material is heated the electrons are released and the emitted light intensity is measured. In this work we present a detailed analysis of the glow curves of $\text{CaMoO}_4:\text{xDy}^{3+}$ ($\text{x} = 0.05, 0.1, 0.5, 1.0$) exposed to UV radiation ($\lambda = 254 \text{ nm}$), in order to get a better understanding of the dosimetric properties of the crystal.

Keywords:

Thermoluminescence, Dosimetry, Crystals, Luminescence, Characterization

Reference:

[1] Fowler, J. F. Solid State Dosimetry. Physics in Medicine & Biology, Vol 8(1). (1963). DOI 10.1088/0031-9155/8/1/201

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación - 000417 - DOCTORADO EN CIENCIAS: FÍSICA APLICADA



LAMINATION-ASSISTED INTEGRATION OF AACVD-DEPOSITED PEROVSKITE FILMS

Autor: Jesús Alberto Becerril Landeros¹

Coautores: Ciro Falcony Guajardo ²; Jesus Uriel Balderas Aguilar ³; LUIS ALBERTO BECERRIL LANDEROS

⁴

¹ *Instituto politécnico nacional*

² *Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional - Zacatenco, Departamento de Física*

³ *Instituto de Investigaciones en Materiales - UNAM*

⁴ *Cinvestav Zacatenco*

Autor responsable de la comunicación: jesus_becerril_1@hotmail.com

The development of scalable deposition techniques for large-area perovskite films has gained significant attention in recent years. However, many of these techniques are not yet optimized for multilayer device architectures. Aerosol-Assisted Chemical Vapor Deposition (AACVD) has demonstrated potential for depositing various perovskite semiconductors. Nonetheless, its solution-based and temperature-dependent nature presents challenges when depositing additional layers onto previously formed perovskite films.

In this work, we propose a lamination-based approach to join perovskite layers deposited by AACVD, evaluating the effects of temperature and pressure during the lamination process. We tested APbX₃-type perovskites (A = MA and Cs; X = Cl, Br), analyzing their hardness-to-modulus (H/E) ratios in relation to the efficiency of material transfer between films. To enhance interfacial bonding, we also explored the use of solvents with varying polarities to soften the perovskite surface prior to lamination.

Characterization techniques including optical microscopy, Scanning Electronic Microscopy (SEM), profilometry, X-Ray Diffraction (XRD) and photoluminescence (PL) spectroscopy were employed to assess the structural and optical properties of the films before and after lamination. Our results show that temperature plays a critical role in the lamination process, and that high-polarity solvents can effectively soften the perovskite surface, enabling successful material transfer without compromising film integrity.

Keywords:

Perovskite, lamination, AACVD, solvents.

Reference:

Lanaghan, C. L., Okia, O., Coons, T., Yadavalli, S. K., Palmer, J. R., Zhang, M., ... & Dasgupta, N. P. (2024). Understanding Process-Structure Relationships during Lamination of Halide Perovskite Interfaces. *ACS Applied Materials & Interfaces*, 16(43), 58657-58667.

Ris work was supported by:

Secihti, Cinvestav



ENHANCING VISIBLE-LIGHT PHOTOCATALYSIS THROUGH THE IMMOBILIZATION OF TiO_2 -InP NANOPARTICLES ON POROUS SILICON

Autor: Ángel Adalberto Duran Ledezma¹

Coautores: Gustavo Hilario Perez²; Margarita Lizeth Alvarado Noguez³; Miguel García Rocha⁴; José Didino García Aguilar⁵; Patricia Rodríguez Fragozo⁶; J.G. Mendoza Alvarez⁷; Daladier Alonso Granada Ramírez⁸

¹ Instituto Politécnico Nacional, SEPI-ESIME unidad Ticomán.

² Instituto Politécnico Nacional

³ Centro de Investigación y de Estudios Avanzados del I.P.N., Departamento de Física, A.P. 14-740,

⁴ Centro de Investigación y de Estudios Avanzados, Departamento de Física,

⁵ Centro de Estudios Científicos y Tecnológicos N° 16 "Hidalgo"

⁶ Centro de Investigación y de Estudios Avanzados del I.P.N., Departamento de Física.

⁷ Centro de Investigación y de Estudios Avanzados del I.P.N., Departamento de Física,

⁸ Universidad Autónoma de Puebla

Autor responsable de la comunicación: gustavohilariop@gmail.com

We report the fabrication and characterization of a hybrid photocatalytic system based on TiO_2 -InP nanoparticles immobilized on porous silicon (p-Si) thin films. The p-Si substrates were obtained by electrochemical anodization of crystalline silicon (c-Si) wafers, resulting in porous layers with variable morphology. TiO_2 -InP nanoparticles were previously synthesized via colloidal methods, and their combination aims to enhance light absorption in the visible range through semiconductor heterojunction formation. Structural and compositional characterizations were carried out using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), and energy-dispersive X-ray spectroscopy (EDS). Morphological analysis was performed using scanning electron microscopy (SEM) and transmission electron microscopy (TEM), enabling evaluation of pore structure and nanoparticle distribution. Optical characterization included UV-Vis absorption and photoluminescence (PL) spectroscopy, while time-resolved photoluminescence (TRPL) measurements were used to determine charge carrier lifetimes. This work aims to optimize the photocatalytic performance of semiconductor heterostructures by exploiting the synergy between TiO_2 and InP within a porous silicon matrix.

Keywords:

Porous silicon, photocatalysis, TiO_2 -InP, nanoparticles, electrochemical anodization

Reference:

F. A. Harraz, "Porous silicon chemical sensors and biosensors: A review", *Sensors Actuators B: Chem.*, vol. 202, pp. 897-912, octubre de 2014. Accedido el 22 de junio de 2025. [En línea]. Disponible: <https://doi.org/10.1016/j.snb.2014.06.048>

Ris work was supported by:

This work was partially supported by postdoctoral fellowship CONAHCYT and Instituto Politécnico Nacional (SIP-IPN Project Number 20240630 and 20241177)



STUDY OF THE PHYSICOCHEMICAL AND LUMINESCENT PROPERTIES OF THE TbTPTZ@HKUST-1 COMPOSITE.

Autores: Christian Javier Salas Juárez; César Giovanni Contreras Pérez; Hiram Isaac Beltrán Conde

Autor responsable de la comunicación: cesargio941204@gmail.com

Authors: César Giovanni Contreras Pérez, Christian Javier Salas Juárez, Hiram Isaac Beltrán Conde.

Department of Basic Sciences, Autonomous Metropolitan University of Azcapotzalco. San Pablo Avenue No. 420, Nueva el Rosario, Azcapotzalco, Mexico City, 02128, Mexico.

Metal-organic networks (MOFs) have emerged as versatile materials due to their characteristics of high porosity, tunable structure and chemical stability. This work presents the infiltration of luminescent lanthanide compounds (Tb-TPTZ) into the HKUST-1 MOF, using 3 methodologies: i) infiltration of the already formed complex, ii) infiltrating the metal ion and subsequently the coordination compound, and iii) infiltrating first the coordination compound and subsequently the metal ion, with the aim of designing luminescent composites with improved thermal and photo-physical properties. The luminescent compound TbTPTZ infiltrates the cavities of the HKUST-1, obtaining the TbTPTZ@HKUST-1 composite. This aims to optimize: i) light emission, ii) photothermal stability, iii) quantum yield, and iv) lifetime, with respect to the free luminescent compound. The TbTPTZ@HKUST-1 composites obtained were characterized by X-ray diffraction (XRD), luminescence spectroscopy, and Fourier transform infrared spectroscopy (FTIR) in order to demonstrate the integration of the luminescent species into the MOF and to ensure that the resulting properties are due to the composite material. Preliminary results using differential UV-vis spectroscopy of the mother liquor show that a proportion of the TbTPTZ is included in the HKUST-1 material. Thus, both HKUST-1 and TbTPTZ compounds are present in the generated crystalline powders. The luminescent response of the final product is similar to that of the uninfiltated TbTPTZ complex, and further studies will be carried out to modulate luminescent behavior.

Keywords:

Metal-organic frameworks, luminescent materials, optical properties, infiltration, lanthanides.



LUMINESCENCE PROPERTIES OF $\text{Cs}_2\text{LiIn}_{1-x}\text{Tb}_x\text{Cl}_6$ ACTIVATED BY Sb^{3+} IONS.

Autor: Jesús Uriel Balderas Aguilar¹

Coautor: José Luis Arreola Acevedo ¹

¹ *Instituto de Investigaciones en Materiales - UNAM*

Autor responsable de la comunicación: jose.arreolaa.a@gmail.com

In recent years, perovskite and perovskite-related structures materials have been of great interest primary due to their semiconducting, luminescent and photovoltaic properties, among others. It has also been proved that the performance of these type of materials can be modulated by doping or substituting the atomic positions in the structure, and recent studies are focused in taking advantage of this fact to obtain tailored materials for many applications. Here, we studied how the changes of relative proportion of Tb^{3+} ions in the perovskite-derived structure $\text{Cs}_2\text{LiIn}_{1-x}\text{Tb}_x\text{Cl}_6$ impact on the luminescent properties of the materials, and furthermore, we aimed to develop a platform in which we can successfully integrate lanthanide ions for their many applications, task that had been a challenge to do in conventional semiconductors because of the low coordination number in their structures.

Specifically the use of terbium ions allow us to use its luminescence as a witness of the synthesis route effectiveness to allow the Tb^{3+} ions to be introduced to the structure immediately after the synthesis. A systematic experimental methodology was applied to identify the optimal composition for maximizing energy transfer to Tb^{3+} and to elucidate the individual and combined effects of Tb^{3+} and Sb^{3+} on the structural and luminescent properties, as confirmed by X-ray diffraction and spectroscopic analyses. We were able to find the optimal synthesis conditions in which the luminescence contribution of the Tb^{3+} is maximized relative to the matrix's contribution.

Keywords:

photoluminescence, perovskite-derived structures, lanthanide substitution.

Reference:

Mir, W. J., Sheikh, T., Arfin, H., Xia, Z., & Nag, A. (2020). Lanthanide doping in metal halide perovskite nanocrystals: spectral shifting, quantum cutting and optoelectronic applications. *NPG Asia Materials*, 12(9). <https://doi.org/10.1038/s41427-020-0187-1>

Ris work was supported by:

PAPIIT IA104025



SYNTHESIS AND CHARACTERIZATION OF HALIDE PHOSPHOR $\text{Cs}_2\text{CdBr}_2\text{Cl}_2$ ACTIVATED WITH Sb^{3+}

Autores: Yelinni Pineda Montiel; Abraham Meza Rocha; Omar Soriano Romero¹

¹ *Facultad de Ciencias Físico Matemáticas BUAP*

Autor responsable de la comunicación: yelinni@outlook.com

All inorganic halide 2D perovskites have emerged as promising alternatives to traditional 3D counterparts for improved environmental stability. In this work we report the synthesis of 2D perovskite $\text{Cs}_2\text{CdBr}_2\text{Cl}_2$ activated with Sb^{3+} , manufactured via the solvent evaporation method to ensure a high quality crystalline phase. The structural phase purity of the material is assessed through Raman spectroscopy and its photoluminescent behavior is investigated using excitation and emission spectra. Additionally, the experimental band gap is determined from diffuse reflectance spectroscopy. The results reveal that $\text{Cs}_2\text{CdBr}_2\text{Cl}_2$ exhibits a wide emission spectrum and a large Stokes shift, attributed to the formation of self-trapped excitons (STEs) due to the incorporation of Sb^{3+} . These findings demonstrate its potential for optoelectronic applications and its viability as a stable, lead free perovskite for future device integration.

Keywords:

perovskite, photoluminescence, spectroscopy, excitons, two-dimensional

Reference:

Xu, Haiping, et al. "2D Perovskite Mn^{2+} -doped $\text{Cs}_2\text{CdBr}_2\text{Cl}_2$ scintillator for low-dose high-resolution X-ray imaging." *Advanced Materials* 35.26 (2023): 2300136.

His work was supported by:

SECIHTI



LUMINESCENCE STUDY OF $\text{Ca}_3(\text{VO}_4)_2$: Sm^{3+} FOR HORTICULTURE APPLICATIONS

Autor: Andrea Sanchez Sanchez¹

Coautores: Andrés Alfonso Saavedra Romero ²; Omar Soriano Romero ³; Salvador Carmona Téllez ⁴

¹ Benemerita Universidad Autonoma de Puebla

² Benemérita Universidad Autónoma de Puebla

³ Facultad de Ciencias Físico Matemáticas BUAP

⁴ CONAHCYT

Autor responsable de la comunicación: andrea.sanchezs@alumno.buap.mx

Recently, vanadate crystalline materials have received a lot of interest due to their high luminescent efficiency, resonant excitation with commercial NUV chips ($\lambda_{\text{ex}} = 350 \text{ nm}$), high thermal stability, excellent chemical stability [1]; and extraordinary dopant solubility. These qualities make vanadate matrices suitable for the incorporation of lanthanides to modulate their emissions to specific hues. Keeping this in mind, in this work we present the synthesis and characterization of $\text{Ca}_3(\text{VO}_4)_2$ activated with Sm^{3+} ions. The synthesis was developed by single-state reaction and Raman Spectroscopy and XRD profiles of the synthesized samples are shown. In particular, luminescence properties are studied by means of excitation and emission spectroscopies. Finally, we show evidence of the possible applications for crop illumination.

Keywords:

$\text{Ca}_3(\text{VO}_4)_2$, Sm^{3+} , Luminescence, Horticulture, Raman, XRD, Spectroscopies Emission and Excitation.

Reference:

[1] T. Nakajima, M. Isobe, T. Tsuchiya, Y. Ueda, & T. Manabe. "Correlation between luminescence quantum efficiency and structural properties of vanadate phosphors with chained, dimerized, and isolated VO_4 tetrahedra". J. Phys. Chem. C. 114(11) (2010) 5160-5167.

Ris work was supported by:

I thank the Luminescence Lab (FCFM-BUAP), Dr. Rosendo Lozada for his guidance, and my advisors and co-authors for their essential contributions. This work would not exist without them.



CHARACTERIZATION OF THE INVERTED $10\text{Al}_2\text{O}_3$ - $70\text{Na}_2\text{O}$ - $20\text{B}_2\text{O}_3$ GLASS DOPED WITH LANTHANIDES EMITTING IN THE INFRARED

Autor: Daniel Morales Tepayotl¹

Coautores: Abraham Meza²; Omar Soriano Romero³

¹ Benemérita Universidad Autónoma de Puebla

² CONAHCYT-BUAP

³ Facultad de Ciencias Físico Matemáticas

Autor responsable de la comunicación: dmt802493@gmail.com

Al_2O_3 - Na_2O - B_2O_3 inverted glasses doped with Nd^{3+} and Nd^{3+} - Yb^{3+} were synthesised by melt-quenching. X-ray diffraction patterns are composed of two broad bands centred at $2\theta = 25$ and 30° , attributed to two types of vitreous networks. The FTIR spectra of all samples present a main vibration peak centred at 1000 cm^{-1} related to $[\text{BO}_3]^{2-}$. The absorption spectra exhibit a border edge around to 400 nm , also the absorption spectra of samples doped with Nd^{3+} show nine absorption bands located at $431, 474, 530, 586, 628, 685, 740, 806$ and 881 nm associated to transitions $\text{Nd}^{3+}: 4\text{I}_9/2 \rightarrow 1\text{P}_2, 2\text{D}_3/2+2\text{G}_9/2+4\text{G}_{11/2}, 4\text{G}_5/2+2\text{G}_7/2, 2\text{H}_{11/2}, 4\text{F}_9/2, 4\text{F}_7/2+4\text{S}_3/2, 4\text{F}_5/2+2\text{H}_9/2$ y $4\text{F}_3/2$, respectively.

For the co-doped system, Nd^{3+} - Yb^{3+} shows a characteristic band absorption for $\text{Yb}^{3+}: 4\text{I}_9/2 \rightarrow 4\text{F}_3/2$ centred at 974 nm . The emission spectra were measured under 808 nm ($\text{Nd}^{3+}: 4\text{I}_9/2 \rightarrow 4\text{F}_3/2$). The emission spectra obtained present a three-emission centred in 880 ($4\text{F}_3/2 \rightarrow 4\text{I}_3/2$), 1060 ($4\text{F}_3/2 \rightarrow 4\text{I}_{11/2}$) and 1330 ($4\text{F}_3/2 \rightarrow 4\text{I}_{11/2}$) nm for the glasses doped with Nd^{3+} , while for the co-doped system, a broad band emission of Yb^{3+} due to the energy transfer from Nd^{3+} to Yb^{3+} . Furthermore, the radiative properties of the sample with optimal emission properties were analysed the radiative properties using the Judd-Ofelt theory.

Keywords:

$\text{Nd}^{3+}/\text{Yb}^{3+}$ co-doping, glasses, Absorption, Emission, Energy transfer, Judd-Ofelt theory

Reference:

Naresh, V., & Lee, N. (2019). NIR luminescence and energy transfer kinetics in $\text{Nd}^{3+}/\text{Yb}^{3+}$ co-doped sodium aluminium bismuth fluoro-borosilicate glasses. *Ceramics International*, 45(17), 22649-22659.

Ris work was supported by:

Catedra Moshinsky



THERMOLUMINESCENCE ANALYSIS OF $\text{CaMoO}_4: \text{Dy}^{3+}$ UNDER UV RADIATION FOR DOSIMETRY APPLICATIONS

Autor: Omar Soriano Romero¹

Coautores: Andrés Alfonso Saavedra Romero²; Salvador Carmona Téllez³

¹ *Facultad de Ciencias Físico Matemáticas BUAP*

² *Benemérita Universidad Autónoma de Puebla*

³ *CONAHCyT*

Everyday, we are continuously exposed to different radiation sources like the UV light from the sun or even the radio frequency emitted by our communication devices. Keeping this in mind several passive dosimeters have been developed, in particular, solid state dosimeters have shown high sensitivity in a small volume, which is useful for store information for a period of time [1]. Furthermore, the thermoluminescent dosimeters (TLD) are solid state dosimeters which present thermally stimulated luminescence, after the interaction with the ionizing radiation electrons are excited and get trapped at energy levels within the crystal structure of the material, once the material is heated the electrons are released and the emitted light intensity is measured. In this work we present a detailed analysis of the glow curves of $\text{CaMoO}_4: x\text{Dy}^{3+}$ ($x = 0.05, 0.1, 0.5, 1.0$) exposed to UV radiation ($\lambda = 254 \text{ nm}$), in order to get a better understanding of the dosimetric properties of the crystal.

Keywords:

Thermoluminescence, Dosimetry, Crystals, Luminescence, Characterization

Reference:

[1] Fowler, J. F. Solid State Dosimetry. Physics in Medicine & Biology, Vol 8(1). (1963). DOI 10.1088/0031-9155/8/1/201

Work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación - 000417 - DOCTORADO EN CIENCIAS: FÍSICA APLICADA



STUDY OF CQDS WITH DOWN CONVERSION EFFECT TO IMPROVE EFFICIENCY OF BiFeO₃/PbS HETEROJUNCTION SOLAR CELL

Autor: Pedro Ezequiel Castellanos Hernández¹

Coautores: Rubén Ruelas Lepe ¹; Oscar Ceballos Sánchez ¹; Araceli Sánchez Martínez ¹

¹ *Ingeniería de Proyectos, CUCEI, Universidad de Guadalajara. Av. José Guadalupe Zuno # 48, Industrial los Belenes, Zapopan, Jalisco, México*

Autor responsable de la comunicación: ezequiel.castellanos@alumnos.udg.mx

This work focuses on studying the electrical properties of BiFeO₃/PbS-based solar cells. For this, an n-type BiFeO₃ (BFO) thin film deposited by the spin-coating method was used as a window layer, while a p-type PbS thin film deposited chemical bath method was employed as an absorbent layer. To improve the photovoltaic effect, a carbon quantum dot (CQDs) thin film with a down-conversion effect was deposited on top of the window layer in the PbS/BiFeO₃/FTO/Glass solar cell. The structural characterization by X-ray diffraction (XRD) showed that the PbS thin film has a cubic structure, while the BFO thin film presents a rhombohedral-type structure. Well-defined diffraction peaks were observed. On the other hand, UV-Vis spectroscopy clearly showed the absorption edges for PbS and BFO. Also, UV-Vis spectroscopy evidenced the enhanced light absorption capability when the CQDs were added to the BiFeO₃/PbS structure. The electrical characterization (I-V curves) allowed the evaluation of the sheet resistance of the films. Also, the photovoltaic response of the solar cells, with and without CQDs, was analyzed using a solar simulator under 1 sun illumination (100 mW/cm²).

Keywords:

CQDs, Solar cell, BiFeO₃, PbS

Reference:

O. Ceballos-Sanchez et al., Study of BiFeO₃ thin film obtained by a simple chemical method for the heterojunction-type solar cell design, J Alloys Compd, vol. 832, Aug. 2020, doi: 10.1016/j.jallcom.2020.154923.

Ris work was supported by:

Becas Nacionales para Estudios de Posgrado CONAHCYT 2024-2026



ANALYSIS OF Cs₃Bi₂Cl₉ AND Cs₃Bi₂Br₉ COMPOUNDS BY DENSITY FUNCTIONAL THEORY

Autor: Cristina Rodríguez Guijarro

Coautores: Abraham Nehemías Meza Rocha ¹; Rosendo L. Lozada Morales ²

¹ Facultad de Ciencias Físico Matemáticas

² Facultad de Ciencias Físico Matemáticas BUAP

Autor responsable de la comunicación: rg224570521@alm.buap.mx

Lead-free metal halide perovskites have garnered attention because they represent an alternative to lead-based perovskites. The perovskite Bi-based family Cs₃Bi₂X₉ (X= Cl, Br) has properties that make it interesting for optoelectronics devices. To understand the optoelectronic properties of Cs₃Bi₂Cl₉ and Cs₃Bi₂Br₉, we perform DFT calculations, using the generalized gradient approximation (GGA) of Perdew-Burke-Ernzenhof (PBE). The band structure shows that Cs₃Bi₂Cl₉ has an indirect band gap, so this material doesn't have photoluminescence (PL) by itself, whilst the band structure for Cs₃Bi₂Br₉ shows that its band gap is direct, which means that it can present PL. For Cs₃Bi₂Cl₉, the Partial Density of States (PDOS) shows that the valence band is mainly composed of Cl-3p orbitals, while the conduction band is composed of Bi-6p orbitals, in the other hand, for Cs₃Bi₂Br₉ the (PDOS) shows that the valence band is mainly composed of Br-4p orbitals, while the conduction band is composed of Bi-6p orbitals.

Keywords:

Lead-free, perovskites, DFT, metal halide, Bi-based

Reference:

A.N. Meza-Rocha, I. Camarillo, R. Lozada-Morales, U. Caldiño, Reddish-orange and neutral/warm white light emitting phosphors: Eu³⁺, Dy³⁺ and Dy³⁺/Eu³⁺ in potassium-zinc phosphate glasses, J. Lumin. 183 (2017) 341.

His work was supported by:

Benemerita Universidad Autónoma de Puebla



ALL-INORGANIC Sb^{3+} ACTIVATED PHOSPHOR $\text{Cs}_2\text{CdBr}_2\text{Cl}_2$ WITH BROADBAND EMISSION

Autores: Yelinni Pineda Montiel; Abraham Nehemías Meza Rocha¹; Omar Soriano Romero²

¹ *Facultad de Ciencias Físico Matemáticas*

² *Facultad de Ciencias Físico Matemáticas BUAP*

Autor responsable de la comunicación: yelinni@outlook.com

All inorganic halide 2D perovskites have emerged as promising alternatives to traditional 3D counterparts for improved environmental stability. In this work we report the synthesis of 2D perovskite $\text{Cs}_2\text{CdBr}_2\text{Cl}_2$ activated with Sb^{3+} , manufactured via the solvent evaporation method to ensure a high quality crystalline phase. The structural phase purity of the material is assessed through Raman spectroscopy and its photoluminescent behavior is investigated using excitation and emission spectra. Additionally, the experimental band gap is determined from diffuse reflectance spectroscopy. The results reveal that $\text{Cs}_2\text{CdBr}_2\text{Cl}_2$ exhibits a wide emission spectrum and a large Stokes shift, attributed to the formation of self-trapped excitons (STEs) due to the incorporation of Sb^{3+} . These findings demonstrate its potential for optoelectronic applications and its viability as a stable, lead free perovskite for future device integration.

Keywords:

perovskite, luminescence, inorganic, spectroscopy, two-dimensional

Reference:

Xu, Haiping, et al. "2D Perovskite Mn^{2+} -doped $\text{Cs}_2\text{CdBr}_2\text{Cl}_2$ scintillator for low-dose high-resolution X-ray imaging." *Advanced Materials* 35.26 (2023): 2300136.

Ris work was supported by:

SECIHTI



INFLUENCE OF OXYGEN IMPURITIES ON THE PHOTOLUMINESCENCE OF CaF_2 AND MgF_2 FILMS DEPOSITED BY CHEMICAL SPRAY

Autor: José Iván Olivera Ruiz¹

Coautor: Ciro Falcony Guajardo²

¹ Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional - Zacatenco, Programa de Doctorado de Nanociencias y Nanotecnología

² Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional - Zacatenco, Departamento de Física

Autor responsable de la comunicación: jose.olivera@cinvestav.mx

The influence of oxygen impurities on the photoluminescence (PL) properties of thin films of CaF_2 and MgF_2 produced by chemical spray deposition is investigated. These alkaline-earth fluorides are of great interest for various optical applications due to their wide bandgap, high optical transparency, and low refractive index, highlighting the importance of impurity control to optimize their performance. The films were deposited onto glass substrates at temperatures ranging from 350°C to 500 °C. The oxygen concentration in the films was controlled by varying key process parameters, including deposition temperature, precursor concentration, and solvent type. The correlation between oxygen presence and PL characteristics was evaluated. In addition to photoluminescence, the structural and optical properties of the films were characterized using X-ray diffraction (XRD), UV-Vis spectroscopy, fixed-angle and fixed-wavelength ellipsometry, energy-dispersive X-ray spectroscopy (EDX), X-ray photoelectron spectroscopy (XPS), and scanning electron microscopy (SEM).

Keywords:

Photoluminescence, Oxygen impurities, Calcium fluoride, Magnesium fluoride, Chemical spray deposition.

Reference:

Luis V. Rodríguez De Marcos, Juan I. Larruquert, José A. Méndez, Nuria Gutiérrez-Luna, Lucía Espinosa-Yáñez, Carlos Honrado-Benítez, José Chavero-Royán, and Belén Perea-Abarca, "Optimization of MgF_2 -deposition temperature for far UV Al mirrors," Opt. Express 26, 9363-9372 (2018)

Ris work was supported by:

SECIHTI



SYNTHESIS AND OPTICAL AND STRUCTURAL CHARACTERIZATION OF COLLOIDAL SOLUTIONS OF SILICON NANOCRYSTALS AND ZINC OXIDE QUANTUM DOTS

Autor: Olga Lucero Illescas Sanchez¹

Coautores: Gabriel Omar Mendoza Conde ¹; José Alberto Luna López ¹; Karim Monfil Leyva ¹; Xochitl Aleyda Moran Martínez ¹; Yosemik Arjuna León Nataret ²

¹ Benemérita Universidad Autónoma de Puebla

² Instituto de Nanotecnología Aplicada

Autor responsable de la comunicación: illescasolga@gmail.com

This work describes the synthesis of silicon nanocrystals (Si-nc) and zinc oxide quantum dots (ZnO QDs) using the colloidal method, as well as their optical and structural properties. Optical characterizations were performed using UV-Vis, PL, and Raman, while structural characterizations were done with XRD and morphological characterization with SEM. Due to their nanometric and semiconducting nature, these colloidal solutions exhibit very interesting photoluminescent properties in the ranges of 500 to 850 nm for Si-nc and 400 to 700 nm for ZnO QDs. Their band gap energies are approximately 3.9 to 4.1 eV for Si-nc and 2.5 to 3.7 eV for ZnO QDs. In Raman spectroscopy, the characteristic band of Si-nc is defined at 512 cm⁻¹, and the band for ZnO QDs is approximately at 98.9, 415, 933 and 1087 cm⁻¹. In XRD, the corresponding planes for Si-nc are well-defined at $\vartheta = 28^\circ$ (111), $\vartheta = 48^\circ$ (220), $\vartheta = 57^\circ$ (311), $\vartheta = 69^\circ$ (400), and $\vartheta = 76.6^\circ$ (311). For ZnO QDs, the following diffraction peaks are observed: $\vartheta = 32^\circ$ (100), $\vartheta = 47^\circ$ (102), $\vartheta = 57^\circ$ (110), $\vartheta = 63^\circ$ (103), and $\vartheta = 68^\circ$ (112). Using SEM, the morphology was observed, and EDS provided the material's composition. All the obtained properties are very interesting for applications in photovoltaic devices, light-emitting devices, health applications, water remediation, and biomedicine, among other important and interesting applications.

Keywords:

Quantum Dots, Silicon nanocrystals, Zinc oxide, colloidal, morphology.

Reference:

J.A. Luna López, A. Garzón Román, E. Gómez Barojas, J. Martínez Juárez and J. Carrillo López. Synthesis of colloidal solutions with silicon nanocrystals from porous silicon. *Nanoscale Res Lett.* 2014 Oct 13;9(1):571. doi: 10.1186/1556-276X-9-571.

Ris work was supported by:

SECIHTI BASIC SCIENCE G-952-2025 and VIEP PROJECT-518-2025



SOLVENT-FREE GRINDING SYNTHESIS COMBINED WITH A HALIDE DOPING STRATEGY IN A ZERO- DIMENSIONAL HYBRID COPPER HALIDE FOR WHITE-LIGHT EMISSION

Autores: Disnel Ferrera¹; Jesus Uriel Balderas-Aguilar¹

Coautores: Carmen Ortiz-Cervantes ²; Diego Solís-Ibarra ¹; Ioantani Donizette Alvarez de Jesus ¹; Juan Carlos Alonso-Huitrón ¹

¹ *Instituto de Investigaciones en Materiales*

² *Instituto de Química*

Autor responsable de la comunicación: disfer96@gmail.com

Commercial phosphor-converted white LEDs (pc-WLEDs) typically consist of two main components: (1) a cost-effective, highly efficient InGaN blue-emitting chip, and (2) a high-performance wavelength-converting layer composed of rare-earth-doped phosphors (e.g., YAG:Ce³⁺ and Eu²⁺). However, these rare-earth elements are both scarce and expensive, and their phosphor synthesis demands high temperatures (~1700 °C), further increasing production costs and undermining sustainability. In this study, we introduce a solvent-free, room-temperature grinding method performed under ambient conditions to synthesize (MTPP)₂Cu₄Br_{6-x}I_x (x = 0–6; MTPP = methyltriphenylphosphonium), a zero-dimensional hybrid copper halide, as a potential alternative to rare-earth-based phosphors. By adjusting the Br/I ratio, we tune the material's visible-light absorption and photoluminescence emission while maintaining high photoluminescence quantum yields (PLQYs). Thermogravimetric analysis (TGA) confirms the material's good thermal stability, suitable for use as a phosphor converter. A composite made from poly(ethylene-vinylacetamide) and our halide-tuned materials was applied to a commercial ~450 nm blue LED chip, yielding white-light emission with luminous efficiencies of 30–40 lm/W, a high color rendering index (CRI ≈ 90), and tunable correlated color temperatures from cool to warm white. This rare-earth-free and environmentally friendly strategy offers a promising, sustainable alternative for next-generation solid-state lighting technologies.

Keywords:

Zero-dimensional hybrid copper halide, Solvent-free grinding synthesis, Phosphor-converted white LED

Reference:

Li, B., Jin, J., Liu, X., Yin, M., Zhang, X., Xia, Z., & Xu, Y. (2024). Multiphase Transformation in Hybrid Copper (I)-Based Halides Enable Improved X-ray Scintillation and Real-Time Imaging. *ACS Materials Letters*, 6(4), 1542-1548.

Ris work was supported by:

We acknowledge financial support from Grant UNAM DGAPA PAPIIT No IA104025 and Zacarías Rivera Alvarez, Miguel A. Canseco Martinez, Karla E. Reyes Morales, Victor M. Guerrero Sosa, Adriana Tejada Cruz, Teresa Escobedo Pérez for their valuable contributions.



SYNTHESIS AND CHARACTERIZATION OF MISIM TYPE ELECTROLUMINESCENT DEVICES USING SPRAY PYROLYSIS

Autor: Aguilar Frutis, Miguel Angel¹; Alarcón Flores Gilberto¹; Falcony Guajardo Ciro²; Garduño Wilches, Ismael Arturo³; Martínez Espino, Bernardo¹; Olarte, Jennifer¹

1 INSTITUTO POLITECNICO NACIONAL, CICATA U. Legaria, Miguel Hidalgo, C.P. 11500 CDMX

2 Centro de Investigación y de Estudios Avanzados del IPN, Unidad Zacatenco, Depto. Física, Gustavo A. Madero, 07360, CDMX

3 Cátedras SECIHTI Instituto Politécnico Nacional, CICATA-Legaria, Miguel Hidalgo, C.P. 11500, CDMX

Autor responsable de la comunicación: maguilarf@ipn.mx

In this work we present the synthesis and characterization of MISIM type electroluminescent devices consisting of arrays of glass/ITO/Al₂O₃-Ag/ZnS:Mn/Al₂O₃/Au layer materials. The synthesis was carried out by spray pyrolysis at temperatures from 450-550 °C. The role of the dielectric layers, the presence of the silver nanoparticles within the Al₂O₃ dielectric, as well as of the active layer, were studied. Photoluminescence emission was studied as a function of the applied ac voltages and frequencies. A further characterization of the devices included HR-SEM, XRD, EDS and UV-vis spectroscopy. Efficient and stable MISIM devices were successfully synthesized and characterized.

Keywords:

MISIM Devices, Thin Films, Al₂O₃, ZnS:Mn, Spray Pyrolysis

Reference:

Photoluminescence and electroluminescence properties of Cu-doped ZnS thin films fabricated by ultrasonic spray pyrolysis, A.C Verduzco, J.U.B. Aguilar, J.C.A. Huitrón
Journal of Alloys and Compounds 1022, 179834 (2025)

Ris work was supported by:

INSTITUTO POLITECNICO NACIONAL



MICROWAVE-ASSISTED SOLVOTHERMAL SYNTHESIS OF β -NaYF₄: Yb, Er, Nd UPCONVERSION NANOPARTICLES

Autor: Padilla-Rosales, Isela ¹.

Coautores: Jiménez Lesly¹; López-López, Stephan Mario²; Vázquez-López Carlos ²; Dorosz Dominik ¹.

¹ Faculty of Materials Science and Ceramics, AGH University of Krakow

² Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional

Autor responsable de la comunicación: stephan.lopez@cinvestav.mx

This study reports the synthesis of β -NaYF₄:Yb, Er, Nd upconversion nanoparticles (UCNPs) using a microwaveassisted solvothermal method with nonpolar solvents. The synthesis was carried out at 290 °C for 30 minutes, employing lanthanide acetates and acetylacetonates as precursors, with NH₄F and NaOH serving as the sources of fluorine and sodium, respectively. The influence of several transition metal co-dopants on the structural and photoluminescent properties of the UCNPs was investigated. The resulting nanoparticles were characterized by X-ray diffraction (XRD), transmission electron microscopy (TEM), and photoluminescence spectroscopy. The analyses confirmed the formation of β -NaYF₄ nanoparticles with uniform morphology and sizes below 100 nm. Co-doping with transition metals was found to significantly change crystallinity, particle morphology, and upconversion emission intensity. These results demonstrate that the microwaveassisted solvothermal technique is a rapid, efficient, and one-step method for synthesizing highly crystalline and enhanced luminescent β -NaYF₄:Yb, Er, Nd UCNPs. Compared to conventional hydrothermal or thermal decomposition methods, this method offers shorter reaction times and improved control over particle size.

Keywords:

nanoparticles, upconversion, microwave-assisted synthesis, lanthanides, photoluminescence

Reference:

Padilla-Rosales, I., et al., "Microwave-Assisted Solvothermal Synthesis of β -NaYF₄: Yb, Er, Nd Upconversion Nanoparticles", in review (not published yet).

Ris work was supported by:

European Financial Support Program for Technology and Research, Conahcyt and Cinvestav



LANTHANIDE UPCONVERSION NANOPARTICLES AS A TEMPERATURE SENSOR

Autor: Gloria Lesly Jiménez Miranda ¹

Coautores: Dorosz Dominik¹; Meza Abraham²; Morales Tepayotl Daniel³; Vázquez López Carlos⁴

¹ AGH University of Kraków

² CONAHCYT-BUAP

³ Benemérita Universidad Autónoma de Puebla

⁴ Department of Physics, Center for Research and Advanced Studies of I.P.N

Autor responsable de la comunicación: dmt802493@gmail.com

Luminescent nanothermometry offers a minimally invasive approach to detecting localized temperatures at the submicrometer level in environments where conventional thermometers are ineffective —e.g., in cellular functions and microelectronics. 1 Among luminescent nanomaterials with temperature-dependent spectral features, lanthanide upconversion nanoparticles (Ln-UCNPs) have emerged as excellent candidates due to their sharp, well-defined multi-wavelength emission, long decay times, and high photostability. Their unique ability to convert near-infrared (NIR) wavelengths into ultraviolet and visible light (UV-vis) is beneficial in biomedical temperature sensing, as NIR excitation enables deeper tissue penetration with reduced scattering and absorption, making them promising as remote and minimally invasive temperature sensors. This is particularly important in early disease detection, temperature changes in the biological tissue are often associated with disruptions (diseases) in normal biological processes, even a 1 °C variation. However, their practical application is hindered by their low quantum yield, sensitivity, and reliance on external calibration systems. 1 This research investigates the microwave-assisted synthesis and characterization of LiYF₄:Er, Nd, with a focus on their performance as temperature sensors under safe NIR excitation (808 nm). Compared to conventional solvothermal methods, microwave-assisted synthesis offers improved temperature control and reduced reaction times, resulting in better morphology control and fewer surface defects, enhancing luminescent properties. The optical performance of the Ln-UCNPs was evaluated before and after functionalization to determine the influence of surface modification. Additionally, the biocompatibility of the coated samples was assessed using the MTT assay to evaluate cell viability.

Keywords:

Lanthanides, nanoparticles, Luminescence nanothermometry, sensor, Microwave-assisted synthesis

Reference:

M. Liu et al., Toward Accurate Photoluminescence Nanothermometry Using Rare-Earth Doped Nanoparticles for Biomedical Applications, *Acc. Chem. Res.* 4 (2024) 30-61

Ris work was supported by:

Project



JUDD-OFELT ANALYSIS APPLIED TO Dy^{3+} -DOPED $\text{K}_2\text{O-SrO-P}_2\text{O}_5$ INVERTED GLASSES: EXPERIMENTAL STUDY AND NEURAL NETWORK PREDICTION

Autor: Rosario Libertad Cruz Flores ¹

Coautores: Meza Rocha, Abraham Nehemías²; Méndez Blas, Antonio¹; Soriano Romero, Omar²

¹ Instituto de Física- Benemérita Universidad Autónoma de Puebla

² Facultad de Ciencias Físico Matemáticas

Autor responsable de la comunicación: libertad@ifuap.buap.mx

This work presents the results of a structural and spectroscopic study of nearly inverted composition $\text{K}_2\text{O-SrOP}_2\text{O}_5$ (KSP) glasses doped with trivalent dysprosium ions (Dy^{3+}). Analysis of the optical transitions between the 4f electronic levels of Dy^{3+} and its local environment was carried out using Judd-Ofelt (JO) theory. The calculation of JO intensity parameters (Ω_2 , Ω_4 , and Ω_6) revealed significant information about the asymmetry of the dopant ion's environment. This asymmetry favors electric dipole transitions, increasing the probability of radiative emission. The results were reflected in notable radiative laser parameters, including a high quantum yield (η_{QY}) of 67% and a low non-radiative relaxation rate (WNR) of 438 s^{-1} . These characteristics suggest promising potential for applications in yellow-emitting lasers, corresponding to the $^4\text{F}_9/2 \rightarrow ^6\text{H}_{13/2}$ transition. However, it is well established that the calculation of JO parameters depends on a wide range of experimental variables. Given the extensive literature with reported values exhibiting variability, it is strategic to explore innovative methods to predict and optimize this analysis. In this context, experimental data from various Dy^{3+} -doped vitreous systems reported in the literature were compiled. Subsequently, an Artificial Neural Network (ANN) model was implemented to predict and optimize the Ω_2 , Ω_4 , and Ω_6 parameters specifically for the $\text{K}_2\text{O-SrO-P}_2\text{O}_5: \text{Dy}^{3+}$ vitreous system, using refractive index, density, and Dy^{3+} ion concentration as input variables. The results obtained with the ANN demonstrated an acceptable degree of precision, showing estimates consistent with conventional theoretical calculations and an average relative error below 5%.

Keywords:

Judd Ofelt, inverted glass, dysprosium, artificial neural network

Reference:

Cruz-Flores, R. L., Soriano-Romero, O., Caldiño, U., Lozada-Morales, R., Carmona-Téllez, S., Méndez-Blas, A., & Meza-Rocha, A. N. (2025). Optical spectroscopy of Dy^{3+} -activated $\text{K}_2\text{O-SrO-P}_2\text{O}_5$ near-inverted glasses for yellow laser applications. *Ceramics International*.

Ris work was supported by:

SECIHTI the Ph.D. scholarship (grant No.2022-000018-02NACF-02499)



GRAPHENE OXIDE (GO): ITS SYNTHESIS AND OPTICAL AND STRUCTURAL CHARACTERIZATION.

Autor: Olga Lucero Illescas Sanchez¹

Coautores: Gabriel Omar Mendoza Conde ¹; José Alberto Luna López ¹; Karim Monfil Leyva ¹; Xóchitl Aleyda Moran Martínez ¹; Yosemite Arjuna León Nataret ²

¹ Benemérita Universidad Autónoma de Puebla

² Instituto de Nanotecnología Aplicada

Autor responsable de la comunicación: jose.luna@correo.buap.mx

This work describes the synthesis and production of graphene oxide obtained through the modified Hummers method, as well as its optical and structural properties. Optical characterizations were performed using UV-Vis, PL, and Raman spectroscopy, while structural characterizations were conducted using XRD and morphological analysis via SEM. This material exhibits very interesting photoluminescent properties in the range of 300 to 700 nm, and its band gap energy is approximately between 4.5 and 5.9 eV. In Raman spectroscopy, the two characteristic bands of graphene oxide, the D, the G band and 2D are clearly defined. In XRD, the planes corresponding to graphene oxide are well defined at $\theta = 10.4^\circ$ and 19° , and those of graphite at $\theta = 26.6^\circ$ and 42.5° . SEM analysis revealed the morphology, a multilayer material was shown, and EDS was used to determine the material's composition. All the obtained properties are very interesting for applications in water remediation, photovoltaic devices, and biomedicine, among other important and promising applications.

Keywords:

graphene oxide, photoluminescence, modified Hummers method, multilayer

Reference:

F. Sargin, F. Ak Azem, K. Kanbur, I. Birlik and A. Turk. Evaluating the impact of sonication process on graphene oxide structural properties.
doi:10.28948/ngmuh.1470478

Ris work was supported by:

SECIHTI BASIC SCIENCE G-952-2025 and VIEP PROJECT-518-2025



INFRARED LIGHT-EMITTING DIODE STRUCTURE DEPOSITED VIA AEROSOL- ASSISTED CHEMICAL VAPOR DEPOSITION USING $\text{CsPbCl}_3:\text{Yb}^{3+}$ AS THE EMITTER LAYER

Autor: LUIS ALBERTO BECERRIL LANDEROS¹

Coautores: Ciro Falcony Guajardo ²; Jesus Uriel Balderas Aguilar ³

¹ *Cinvestav Zacatenco*

² *Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional - Zacatenco, Departamento de Física*

³ *Instituto de Investigaciones en Materiales - UNAM*

Autor responsable de la comunicación: beceland25@gmail.com

Metal halide perovskites have emerged as leading candidates for next-generation optoelectronic devices, thanks to their outstanding photophysical properties. Among these, ytterbium-doped CsPbCl_3 stands out due to its ability to enable quantum-cutting energy transfer, resulting in near-infrared (NIR) emission around 984 nm. Achieving scalable and eco-friendly fabrication of these materials is critical for their technological adoption. In this work, we demonstrate the fabrication of a complete perovskite-based light-emitting diode (PeLED) structure using exclusively Aerosol-Assisted Chemical Vapor Deposition (AACVD) under ambient conditions. The device structure, $\text{glass/FTO/ZnO/CsPbCl}_3:\text{Yb}^{3+}/\text{NiO}_x/\text{ITO/glass}$, was fabricated using aqueous solutions and green antisolvents, to control nucleation and crystallinity. These treatments improved film coverage, reduced surface roughness, and yielded a high photoluminescence quantum yield (PLQY) of 68.12% from the Yb^{3+} emission. To preserve perovskite integrity during multi-layer processing, a lamination strategy was developed. This approach avoided degradation of the perovskite films by water or ozone exposure during deposition. Preliminary electrical measurements showed rectifying behavior and light-induced current response, demonstrating the feasibility of this method for future PeLED integration. This study underscores the potential of AACVD and lamination strategies for scalable, sustainable fabrication of perovskite optoelectronic devices.

Keywords:

PeLEDs, AACVD, $\text{CsPbCl}_3:\text{Yb}^{3+}$, lamination, green antisolvent

Reference:

Becerril, L., Balderas, J., Hernández, J., Rodríguez, B., Alonso, J., & Falcony, C. (2023). Water as the only solvent for CsPbCl_3 and NIR-emitting $\text{CsPbCl}_3:\text{Yb}^{3+}$ films by antisolvent-enhanced crystallization in aerosol-assisted chemical vapor deposition. *Advanced Materials Technologies*, 8(9), 2201890.

Ris work was supported by:

Secihti, Cinvestav



INFLUENCE OF ACID ADDITIVES ON THE CRYSTALLIZATION AND MORPHOLOGY OF LEAD FREE CANBIC PEROVSKITE FILMS

Autor: Bibiana Rodríguez García¹

Coautores: Ciro Falcony Guajardo²; Jesus Uriel Balderas Aguilar³

¹ CINVESTAV

² Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional - Zacatenco, Departamento de Física

³ Instituto de Investigaciones en Materiales - UNAM

Autor responsable de la comunicación: bibiana.rodriguez@cinvestav.mx

Advancing deposition techniques for functional materials is crucial for the development of next-generation optoelectronic devices. Lead-free double perovskites represent a promising and environmentally friendly alternative, but their integration as thin films remains a significant challenge.

In this study, we investigate the effect of acid additives—hydrochloric acid (HCl) and acetic acid (HAc)—on the growth and emissive properties of $\text{Cs}_2\text{Na}_{0.4}\text{Ag}_{0.6}\text{In}_{0.99}\text{Bi}_{0.01}\text{Cl}_6$ (CANBIC) thin films fabricated via Aerosol-Assisted Chemical Vapor Deposition (AACVD). CANBIC powder was synthesized through mechanochemical grinding of metal halides and dissolved in a solvent mixture of N,N-dimethylformamide, dimethyl sulfoxide, and either HCl or HAc. The resulting precursor solution was atomized with an ultrasonic mist generator and carried with nitrogen to a heated substrate to form thin films under controlled flow, temperature, and layering conditions. The films were characterized using X-ray diffraction, photoluminescence spectroscopy, profilometry, and scanning electron microscopy. Results show that films prepared with HAc are approximately twice as thick and exhibit twice the integrated photoluminescence intensity compared to those made with HCl, but also display increased surface roughness due to a more porous, reticular morphology, underscoring the significant influence of acid type on film structure and optical behavior. Despite identical processing parameters, the choice of acid led to distinct outcomes, likely due to changes in the colloidal behavior of the precursor solution. As perovskite precursor solutions are known to form charged colloidal aggregates, we propose that acid additives influence electrostatic interactions, modulating colloidal stability, particle size, and crystallization dynamics. While the exact nature of these complex precursor systems remains under investigation, our findings underscore the crucial role of acid chemistry in tuning film formation and optical properties. A better understanding of these interactions is essential for optimizing the deposition of lead-free perovskites and enabling their practical use in sustainable optoelectronic technologies.

Keywords:

Lead-free perovskites, AACVD, Thin Films, Photoluminescent properties

Reference:

Amoroso, D. et al. The central role of colloids to explain the crystallization dynamics of halide perovskites: A critical review. *Matter* 7, 2399–2430 (2024).

Ris work was supported by:

CINVESTAV, SECIHTI



ERBIUM TEMPERATURE SENSING: A NEW STRATEGY TO IMPROVE SENSITIVITY BY USING ATOMIC EXCHANGE IN HOST LATTICE

Autor: RAUL ISAAC LOPEZ ESQUIVEL¹

Coautor: Ciro Falcony Guajardo ¹

¹ *Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional (CINVESTAV)*

Autor responsable de la comunicación: raul.lopez@cinvestav.mx

Temperature is a physical variable that has accompanied humanity since ancient times. As evidence, sensors of temperature worldwide comprise a market of approximately USD 5.13 billion. However, the constant technological evolution in areas such as micromedicine, microbiology, microelectronics, photonics, etc, has reached a level in which conventional sensors are incapable of performing temperature measurements at sub-micrometric scales due to limited contact area. A solution to this problem that has gained interest in the scientific field in the last 10 years is the optical temperature sensors by using trivalent rare earth ions (Ln^{3+}), despite the large number of studies in the area and numerous investigations, no existing theory to help predict the behavior of increasing or decreasing the temperature-sensing effects when a certain ion is introduced into a host lattice. Additionally, only a small quantity of studies of cubic perovskite-type phase materials doped with Ln^{3+} are focused on optical thermometry. This work presents a new strategy to improve or decrease temperature sensitivity by using atomic exchange in a host lattice of BaHfO_3 and SrHfO_3 (Ba-Sr exchange) which can be summarized in interesting improvement factors such as theoretical band-gap (ΔE), maximum relative sensitivity (SRMAX), and the resolution in temperature (δT). In this way, the minimum change in temperature that can be detected by using this material was improved from 0.02 K to 0.01 K and this does not seem to be an isolated or particular case, since it has been observed that same behavior is analogous in BaZrO_3 and SrZrO_3 materials.

Keywords:

luminescence, perovskite, temperature sensing, lanthanides, optical nanothermometry

Reference:

C.D.S. Brites, P.P. Lima, N.J.O. Silva, A. Millán, V.S. Amaral, F. Palacio, L.D. Carlos, Thermometry at the nanoscale, *Nanoscale* 4 (2012) 4799–4829, <https://doi.org/10.1039/c2nr30663h>.

Ris work was supported by:

Consejo Nacional de Humanidades, Ciencias y Tecnologías (CONAHCYT), Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional (CINVESTAV).



LUMINESCENCE PHENOMENA / 432

HIGHLY LUMINESCENT POLYMER AND ITS APPLICATION IN THE NONLINEAR EXCITATION OF A PHOTSENSITIZER AT NEAR-INFRARED WAVELENGTHS

Autores: Gabriel Ramos Ortiz¹; Samayrani Camarena López¹; Olivia Hernández Cruz¹; Enoc Cetina Mancilla²; Mikhail G. Zolotukhin²

¹ *Centro de Investigaciones en Optica*

² *Instituto de Investigaciones en Materiales, UNAM*

Autor responsable de la comunicación: garamoso@cio.mx

The physical process of energy transfer (ET) from a molecular donor (D) to a molecular acceptor (A) upon optical excitation finds applications in optoelectronics and biophotonics[1,2]. For example, at short distance, a dipole-dipole interaction can lead to a Förster Resonant Energy Transfer (FRET) from D to A. FRET is a radiation less process, but one condition for efficient FRET is that D exhibit high luminescence in the absence of A. At long interaction distance, radiative TE can also occurs when A absorbs the fluorescence emitted by D[2]. Both radiative and non-radiative TE occurs when there is a spectral overlap between the emission of D and the absorption of A.

For the present study, a nonlinear organic polymer (PMC 300), with a high fluorescence quantum yield (95%) and large two-photon absorption cross sections (on the order of 10,000 GM in the IR spectral range[3]), is used to transfer energy to the photosensitizer Rose Bengal (RB). The latter is a well-known photosensitizer for use in photodynamic therapy of cancer tissue. As a photosensitizer, RB offers efficient generation of reactive oxygen species which is the mechanism on which photodynamic therapy is based[4], however, it suffers from the limitation of being photoactive outside the biomedical range of interest, 700-900 nm. To circumvent this limitation, here we demonstrate that PMC300 can be excited at IR wavelengths by two-photon absorption to subsequently excite RB by efficient FRET.

A detailed spectroscopic analysis of the radiative and non-radiative interaction of PMC300-RB is presented in both the linear (using a continuous wave laser) and nonlinear (using a femtosecond laser) excitation regimes, and for the interaction occurring both in solution and in the solid phase. The results show ET efficiencies of up to 74.06% and 89.83% for linear and nonlinear excitation, respectively. Therefore, PMC300-RB is conceived as an organic molecular system capable of performing photodynamic therapy in the window of biomedical interest.

Keywords:

FRET, photodynamic therapy, two-photon absorption

Reference:

1. Macromol. Rapid Commun. 2009, 30, 1203-1231
2. Nat Commun. 2014, 5, 5722
3. Nanoscale, 2012, 4, 7751-7759
4. Prog React Kinet Mech. 2001, 26, 159-177

Ris work was supported by:

CIO



LUMINESCENCE PHENOMENA / 457

LANTHANIDE-DOPED NaMgF_3 PEROVSKITES FOR OPTICAL THERMAL SENSING; A COMPARATIVE STUDY OF HYDROTHERMAL AND AACVD METHODS.

Autores: Ciro Falcony Guajardo¹; Jessica de Anda Gil¹; José Iván Olivera Ruiz¹; Raúl Isaac López Esquivel¹

¹ Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional (CINVESTAV)

Autores responsables de la comunicación: jose.olivera@cinvestav.mx, raul.lopez@cinvestav.mx

Since their discovery in 1839, perovskites have attracted significant scientific interest due to their remarkable structural versatility and exceptional physicochemical properties. These crystalline materials, with the general formula ABX_3 , can accommodate a wide range of elements at the A and B cation-sites while the most common anions are O²⁻ and halide ions, enabling the design of functional materials for diverse applications in solar energy, sensing, optoelectronics, data storage, catalysis, and more.

Among them, fluoride-based perovskites such as NaMgF_3 , represent relatively novel materials with promising potential for integration into emerging technologies. However, reports on their synthesis and properties remain limited, due to the complexity of obtaining phase-pure structures since the appearance of additional phases is easily stimulated, due to the electronegativity of F.

In this work, new insights into the synthesis and characterization of NaMgF_3 perovskites are uncovered by employing two different routes: hydrothermal synthesis for nanoparticles and aerosol-assisted chemical vapor deposition (AACVD) for thin film growth. A direct comparison is made based on elemental composition (energy-dispersive X-ray spectroscopy, EDS), morphology (scanning electron microscopy, SEM), and structural features (X-ray diffraction, XRD). Furthermore, the temperature-dependent luminescence behavior of lanthanide-doped perovskites is evaluated within the physiological range (25 °C to 45 °C) using photoluminescence (PL) spectroscopy, highlighting their potential application in submicrometric thermal sensing, with Er^{3+} and Eu^{3+} as sensors.

Keywords:

Fluoride-based perovskites, temperature sensing, luminescence, NaMgF_3 , lanthanides

Reference:

[1] X.D. Wang, O.S. Wolfbeis, R.J. Meier, Luminescent probes and sensors for temperature, Chem. Soc. Rev. 42 (2013) 7834–7869, <https://doi.org/10.1039/c3cs60102a>.

Ris work was supported by:

Consejo Nacional de Humanidades, Ciencias y Tecnologías (CONAHCYT) y Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional (CINVESTAV)



MICROELECTRONICS AND MEMS

CHAIRMEN

Dr. Norberto Hernández Como, (Centro de Nanociencias y Micro y Nanotecnologías, IPN) nohernandezc@ipn.mx

Dr. Isai Salvador Hernández Luna (Centro de Nanociencias y Micro y Nanotecnologías, IPN) ishernandez@ipn.mx

The Internet of Things (IoT) exemplifies how silicon-based technologies are transforming the world for human benefit. Through remote monitoring and control via internet-connected sensors, these advancements underscore the growing influence of microelectronics and microsystems in our daily lives. At the heart of this technological shift are semiconductors and microelectromechanical systems (MEMS), which serve as critical enablers across sectors such as health, automotive, and consumer electronics. In this context, the mission of the Microelectronics and MEMS Symposium is to bring together scientists, technologists, and industry stakeholders interested in the design, simulation, modeling, fabrication, assembly, testing and packaging of micro- and nano-scale devices and circuits. The symposium will highlight advances in integrated circuits (ICs), Microelectronics Technology, Materials Science for Micro and Nanoelectromechanical Systems (MEMS/NEMS), and strategies for MEMS/NEMS packaging and integration. These developments are essential to support innovation in critical application areas, including flexible electronics, sensors, and IoT devices.

The Microelectronics and MEMS Symposium is focused on the integration of materials, processes, and design methodologies for the development of MEMS/NEMS devices and microelectronic systems. The symposium aims to promote innovation, interdisciplinary collaboration, and the creation of accessible technology platforms to support research, education, and technological sovereignty in emerging semiconductor regions.

Invited Talks, Oral and Poster Sessions will cover the following topics:

- Internet of Things (IoT) and Smart Systems Integration
- Design, Characterization, and Modeling of Integrated Circuits (ICs)
- CMOS and Thin-Film Technologies for Prototyping and Flexible Electronics
- Amorphous Materials and Compound Semiconductors
- Circuit-Sensor/Actuator Co-Design and Integration
- Microsystems Design: MEMS and NEMS
- Bulk and Surface Micromachining Techniques
- RF CMOS-MEMS and Wireless Microsystems
- Integrated Photonics and Optical Microsystems
- BioMEMS, Lab-on-a-Chip, and Point-of-Care Devices
- Aerospace and Defense Applications
- Chemical and Environmental Sensing
- Automotive and Industrial Applications
- Semiconductor Ecosystems: MPW Access, Prototyping, and Technology Transfer
- Education and Workforce Development for IC and MEMS Design



FABRICATION AND CHARACTERIZATION OF NANOSCALE VACUUM ELECTRONIC DEVICES.

Autor: Yuliana Elvira Saucillo¹

Coautores: Guillermo Santana Rodríguez²; Iouri Koudriavtsev³; José Miguel Zárate Reyes¹; René Asomoza Palacio¹

¹ *Departamento de Ingeniería Eléctrica. Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional. Unidad Zacatenco*

² *Departamento de Materiales de Baja Dimensionalidad, Instituto de Investigaciones en Materiales Universidad Nacional Autónoma de México, 04510 CDMX*

³ *Departamento de Ingeniería Eléctrica. Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional. Unidad Zacatenco.*

Autor responsable de la comunicación: yuliana.elvira.s@cinvestav.mx

In the last two decades, many papers have been published on nanoscale vacuum electronic devices [1]. In these devices, a vacuum nano gap with a width ranging from ~11 nm to ~100 nm is formed between metal or semiconductor electrodes, which, together with the special shape of the electrodes, allows such devices to operate at a voltage difference between them ranging from 0.3 volts to tens of volts (depending on the width of the vacuum gap) and at atmospheric pressure. Such devices are interesting because they can operate at high temperatures and under radiation. To the best of the authors' knowledge, such devices have not yet been produced in Mexico, either in laboratories or commercially. The report presents the results of the design and manufacture of vacuum diodes and triodes (transistors) in Cinvestav (Zacatenco). Optical and ion lithography were used to manufacture the devices. The latter was carried out using a focused ion beam system (FIB). "Vertical" vacuum nano diodes were manufactured using standard planar technology with a silicon substrate, 30-60 nm thick thermal silicon oxide, and molybdenum (cathode) and gold (back contact) contacts. "Planar" vacuum nano diodes-transistors were manufactured as metal-dielectric-metal structures. Molybdenum and gold contacts were used, with a silicon oxide dielectric layer. The upper contacts, functioning as cathodes and anodes, were manufactured using optical lithography. The vacuum gap between the cathode and anode (or between the source and drain in transistor), made using FIB, ranged from 30 to 80 nm for different structures. This gap made it possible, among other things, to measure the volt-ampere characteristics (VAC) of these devices in air. The obtained VACs were compared with VACs obtained in a vacuum chamber specially designed for studying such devices.

Keywords:

nanoscale vacuum devices, vacuum nano gap, FIB, lithography, MDM structure

Reference:

[1] X. Li, J. Feng, Review of Nanoscale Vacuum Devices, Electronics, 12, (2023) 802. <https://doi.org/10.3390/electronics12040802>

Ris work was supported by:

This work was partly supported by SECIHTI, grant CF-2023-I-1621



FLEXIBLE UV PHOTODETECTOR BASED ON ZnO THIN FILM ON POLYIMIDE SUBSTRATE

Autor: Nicol Alejandra Munguía Fernández¹

Coautores: Norberto Hernandez Como ²; Abraham Arias León ¹; Oscar Manuel Perez Landeros ³

¹ *Universidad Autónoma de Baja California*

² *Instituto Politecnico Nacional*

³ *Instituto de Ingeniería, Universidad Autónoma de Baja California*

Autor responsable de la comunicación: nicol.munguia@uabc.edu.mx

There is a growing interest in flexible and portable technologies, leading into attempts to convert current rigid electronics, such as transistors, diodes, and sensors, into flexible ones. Zinc oxide (ZnO) is a semiconductor with a wide band gap of ~ 3.4 eV, an ideal material for optoelectronic applications. This work presents the fabrication of an ultraviolet (UV) radiation photodetector device on a flexible substrate (polyimide) by depositing a ZnO and Aluminum (Al) thin films via magnetron sputtering. Photolithography technique was employed to create the interdigitated Al contacts and delimit the active semiconductor area ($520 \times 520 \mu\text{m}$). I-V curves were obtained by voltage sweep from 0 to ± 2 V under illumination at different wavelengths, the distance between the sample and the illumination source was fixed at 30 mm and directed perpendicularly to the sample. Additionally, current-time dependencies (I-t) were obtained using a 2 V bias at different frequencies of on/off illumination. Finally, a micrometric device capable of detecting UV radiation was fabricated over a flexible substrate with ohmic contacts and an on/off illumination response at low frequencies (less than 1 Hz).

Keywords:

Zinc Oxide, Flexible electronics, Photodetectors, Microelectronics, Thin Films

Reference:

K. Ozel, M. B. Faheem, and A. Yildiz, Fabrication of ZnO/polyimide based flexible UV photodetectors: Effect of film thickness on the detection performance, *Sens. Actuators A Phys.* 379 (2024) 116006. <https://doi.org/10.1016/j.sna.2024.116006>.

Ris work was supported by:

SECIHTI and Centro de Nanociencias y Micro y Nanotecnologías



DESIGN OF A CURRENT ACQUISITION CIRCUIT IN 28 nm CMOS TECHNOLOGY FOR RESPONSE MEASUREMENT OF ELECTROCHEMICAL SENSORS

Autores: Bradlee Castro¹; José Herrera-Celis¹; Juan Morales¹

Coautores: Jaime Barrero Pérez ¹; Javier Ardila ¹

¹ *Universidad Industrial de Santander*

Autor responsable de la comunicación: juanjosemoralesh@gmail.com

Electrochemical amperometric sensors are essential devices for monitoring biochemical compounds and microorganisms, such as glucose and viruses. The main challenge to achieve it consists in measuring the current generated from the direct or indirect interactions between the compounds or microorganisms and the sensor. Accurately measuring these currents while ensuring high precision and low noise performance is essential for implantable or portable sensing systems [1]. Conventional approaches often suffer from issues such as noise injection and limited linearity, particularly at low current levels. This project develops a compact current acquisition circuit in 28nm CMOS technology, specifically optimized for bidirectional measurement of minimal currents ranging from nanoamperes to microamperes.

The methodology included a theoretical study followed by an iterative design process. Performance validation was carried out using extensive simulations in Synopsys Custom Compiler, which included DC operating point analysis, frequency response, transient analysis, and robustness evaluation under process, voltage, and temperature (PVT) variations, as well as Monte Carlo simulations. It was possible to reduce noise by modifying both the current and the geometric parameters of the transistors with the most significant noise contribution. The results demonstrate that this analog circuit could be part of a potentiostat integrated on a chip, allowing the measurement of low electrochemical currents.

Keywords:

Current acquisition, CMOS technology, electrochemical sensor, circuit design, simulation.

Reference:

[1] H. M. Jafari and R. Genov, Chopper-Stabilized Bidirectional Current Acquisition Circuits for Electrochemical Amperometric Biosensors, IEEE Trans. Circuits Syst. I: Regul. Pap. 60 (2013) 1149–1157. <https://doi.org/10.1109/TCSI.2013.2248771>

Ris work was supported by:

The Universidad Industrial de Santander under the research project No. 4274, titled “Diseño de una topología transportadora en tecnología CMOS para la medición de corriente de sensores electroquímicos”.



EFFECT OF METAL CONTACT POSITION ON IGZO-BASED INTERDIGITATED STRUCTURES FOR SENSOR APPLICATION

Autores: Isai Salvador Hernandez Luna¹; Norberto Hernandez Como¹

Coautores: Arturo Torres-Sanchez ¹; Cuauhtemoc Leon-Puertos ¹; Francisco Hernandez-Cuevas ¹

¹ *Centro de Nanociencias, Micro y Nanotecnologías, IPN*

Autor responsable de la comunicación: ishernandezl@ipn.mx

Amorphous indium-gallium-zinc oxide (a-IGZO) continues to be studied and utilized in electronic devices due to its remarkable electrical and optical properties. IGZO has been integrated into various devices such as thin-film transistors, flexible and transparent electronics, photodetectors, and sensors. In this work, the electrical characteristics of resistive devices based on IGZO as the active layer and aluminum (Al) as the contact metal were analyzed, considering two configurations: with the active layer placed either on the top or bottom the metal contact. Special attention was given to contact resistance and the sensitivity of devices with interdigitated geometries. For both configurations, the active layer was simultaneously deposited using the room temperature sputtering technique and patterned via lift-off on a rigid transparent substrate. The thickness of the active layer was 40 nm and the contact metal was 200 nm. Interdigitated resistors with varying dimensions and configurations were fabricated to investigate how the contact area influences electrical parameters, which is crucial for optimizing sensor applications. The results reveal significant differences in contact resistance values and notable variations in sensitivity to environmental changes. Characterizing the resistance of the active layer is essential for sensor designers, as it provides guidelines for optimizing sensitivity, stability, response time, and achieving performance through simple fabrication processes.

Keywords:

IGZO, resistors, bottom contact, top contact, sensor

Reference:

Micromachines 2025, 16(2), 118; <https://doi.org/10.3390/mi16020118>

Ris work was supported by:

SIP-IPN under grant 20250680, "Estancias Posdoctorales Académicas" by SECIHTI.



EVALUATION OF THE PERFORMANCE OF MIS STRUCTURES BASED ON AMORPHOUS MoS₂ FOR 2D TFTS

Autor: Abril Abilene Garcia Soriano¹

Coautores: Isai Salvador Hernandez Luna ²; Norberto Hernandez Como ³

¹ *Instituto Politécnico Nacional*

² *CNMN-IPN*

³ *Instituto Politecnico Nacional*

Autor responsable de la comunicación: abril.garcia.soriano@cinvestav.mx

For the last years, Thin Film Transistors (TFTs) based on dichalcogenides materials have raised special interest since they are expected to passivate and even eliminate the Short Channel Effects (SCEs) that arise in silicon-based transistors. Currently, 2D MoS₂ is the most studied semiconductor material due to it possess peculiar electrical characteristics which make it one of the best alternatives to be part of the next generation of electronics. In this work, Metal-Insulator-Semiconductor (MIS) of Cr- Au/MoS₂/HfO₂/Mo and Metal-Semiconductor (MS) of (MoS₂/Cr/Au) structures were fabricated. The MIS structures employed HfO₂ as the dielectric layer and molybdenum as the top electrode, while gold was used as the bottom contact metal in both structures. The MoS₂ semiconductor layers were deposited using a one-step RF magnetron sputtering process, with three different thicknesses: 10 nm, 20 nm, and 30 nm, to evaluate the influence of thickness on electrical behavior. Electrical characterization was performed using capacitance-voltage (C-V) and current-voltage (I-V) techniques on the MIS structures. Additionally, the MS structures were used to analyze contact resistance.

Keywords:

2D materials, CV and IV characterization, MoS₂ by RF Sputtering

Reference:

A. A. García-Soriano, I. S. Hernández-Luna, M. Estrada, Y. Kudriavtsev and A. Cerdeira, "Physical And Electrical Characterization of MoS₂ Layers Deposited by RF Magnetron Sputtering for 2D FETs," 2024 IEEE Latin American Electron Devices Conference (LAEDC)

Ris work was supported by:

SIP-IPN under grant 20250680, and Isai S Hernandez-Luna would like to thank the program "Estancias Posdoctorales Académicas" by SECIHTI



SEMICONDUCTOR-ASSISTED CHEMICAL ETCHING.

Autores: Aimee Juárez García¹; Enrique Quiroga González²; Grecia Guadalupe Montes Duarte³

¹ *Facultad de Electrónica, Benemérita Universidad Autónoma de Puebla*

² *Institute of Physics, Benemérita Universidad Autónoma de Puebla.*

³ *Semiconductor Device Research Center, Benemérita Universidad Autónoma de Puebla*

Autor responsable de la comunicación: equiroga@ieee.org

Considering the role played by metal in metal-assisted chemical etching, this new etching technique proposes replacing this material with a semiconductor and a hole-generating source. In this process, TiO₂ particles were deposited via solvothermal synthesis on pre-textured silicon wafers, using titanium butoxide as a precursor and ethyleneglycol as a solvent. Etching was performed immersing these substrates in etching solutions consisting of deionized water, hydrofluoric acid, and vanadium oxide in different proportions for 1 h. Etching tests were performed with and without UV illumination to compare results. A high-power LED with a wavelength of 397 nm was used as the light source. Applying this etching technique, deep pits with diameters ranging from 300 nm to 2.5 μ m were obtained. This result not only confirms the feasibility of using a sacrificial semiconductor to assist the etching process but also demonstrates the development of a new etching technique that would allow the use of a wider variety of materials.

Keywords:

Si etching, semiconductor-assisted chemical etching, TiO₂ deposition.

Reference:

A. Garzon-Roman, C. Zúñiga-Islas and E. Quiroga-González, Modulation of morphology and optical characteristics of TiO₂ grown into porous silicon by an easy approach. *J Mater Sci: Mater Electron* 30 (2019) 21503–21513. <https://doi.org/10.1007/s10854-019-02540-1>

Ris work was supported by:

SECIHTI through the Frontiers of Science project CF-2023-G-28 and VIEP through the project 00462-PV/2024



DEVELOPMENT OF A FLEXIBLE MICROCOIL FOR WIRELESS POWER TRANSFER IN IMPLANTABLE DEVICES

Autores: Isai Salvador Hernandez Luna¹; Natiely Hernández Sebastián²; Victor Manuel Carpio Verdin²

¹ Centro de Nanociencias y Micro y Nanotecnologías, Instituto Politécnico Nacional

² Centro de Investigaciones en Óptica, A. C.

Autor responsable de la comunicación: victorcv@cio.mx

Due to the growing interest in the development of microdevices aimed at continuous and non-invasive monitoring of vital signs, efficient communication between sensors and data acquisition systems has become a critical component for prevention, early diagnosis, and follow-up of various medical conditions. In this context, the design of passive elements such as coils, capable of enabling wireless and reliable energy or information transfer, is essential. This work presents the design, simulation, fabrication, and electrical characterization of coils made of gold (Au) as the conductive material, deposited onto a flexible substrate. Various coil geometries and sizes were explored to evaluate their electrical performance in signal transmission and reception applications within biomedical sensor systems. The electrical characterization of the coils includes both direct current (DC) and alternating current (AC) measurements, focusing on parameters such as resistance, inductance, impedance, and quality factor (Q) as a function of frequency. These measurements help determine the suitability of the coils for operation within specific frequency ranges typical of short-range communication in wearable and portable devices. The approach adopted in this study supports the advancement toward the integration of coil inductors as key components in wireless communication systems for vital sign monitoring sensors, both invasive and non-invasive on the skin. This contributes to the development of more accessible, portable, and efficient medical technologies.

Keywords:

MEMS, BioMEMS, WPT, Coil, Design

Reference:

Tianjua, S., Xiang, X. & Zhihua, W. Wireless Power Transfer for Medical Microsystems. Springer. (2013).

Ris work was supported by:

"Estancias Posdoctorales Académicas" by CONAHCYT



STUDY OF MoO₃ THIN FILMS BY THERMAL OXIDATION

Autor: Leonardo Sebastian Sanchez-Fernandez¹

Coautores: Ariel Guzmán-Vargas ¹; Francisco Javier Hernández Cuevas ²; Jose Ortiz Landeros ³; María de Luz Olvera Amador ⁴; Norberto Hernandez Como ⁵

¹ *Instituto Politécnico Nacional, ESIQIE*

² *Centro de Nanociencias y Micro y Nanotecnología*

³ *ESIQIE*

⁴ *Centro de Investigación y Estudios Avanzados*

⁵ *Instituto Politecnico Nacional*

Autor responsable de la comunicación: lsanchezf1501@alumno.ipn.mx

Thin films of MoO₃ were deposited for evaluation in gas sensor applications. Initially, metallic molybdenum (Mo) films were deposited with durations of 60, 30, and 15 minutes at a pressure of 15x10⁻⁶ Torr, to obtain different thicknesses. The samples were then thermally oxidized in a furnace at 600 °C for 60 minutes under a controlled oxygen atmosphere with a constant flow rate of 100 mL/min. This treatment resulted in the formation of polycrystalline MoO₃ thin films. The presence of the MoO₃ phase was confirmed by X-ray photoelectron spectroscopy (XPS) and X-ray diffraction (XRD) to identify the crystalline phase. Electrical properties were evaluated using the four-point probe method to determine the resistivity films. In addition, scanning electron microscopy (SEM) images were taken from both the surface and cross-section to analyze the morphology and oxidation profile of the material. Finally, the results were compared with MoO₃ films obtained by reactive oxygen sputtering.

Keywords:

Sputtering, Thermal oxidation, MoO₃

Reference:

L. Zhang et al., "Self-assembly gridding α-MoO₃ nanobelts for highly toxic H₂S gas sensors," *Sens Actuators B Chem*, vol. 237, pp. 350–357, Dec. 2016, doi: 10.1016/J.SNB.2016.06.104.

Ris work was supported by:

SECIHTI and CNMN



A MULTIPROJECT WAFER INITIATIVE TO FABRICATE FLEXIBLE SENSORS IN MEXICO

Autores: Arturo Torres-Sanchez¹; Carlos Felipe Mendoza²; Isai Salvador Hernandez Luna³; Luis Reséndiz Mendoza²; Macaria Hernández Chávez²; Norberto Hernandez Como⁴; Pablo Toledo Guizar

¹ *Centro de Nanociencias, Micro y Nanotecnologías*

² *INSTITUTO POLITECNICO NACIONAL*

³ *CNMN IPN*

⁴ *Instituto Politecnico Nacional*

Autor responsable de la comunicación: nohernandezc@ipn.mx

Nowadays in Mexico, there is a growing number of undergraduate and graduate programs related to semiconductors. However, there is still limited availability of laboratories equipped to develop the practical skills and technical knowledge required by the semiconductor industry. Among the few existing facilities, the Laboratorio Nacional de Micro y Nanotecnologías (LNuynT), located at Instituto Politécnico Nacional (IPN Zacatenco), and the Centro de Ingeniería y Desarrollo Industrial (CIDESI Querétaro) have implemented a multi-project wafer (MPW) approach for the development of sensors and other semiconductor devices such as transistors. Focusing on sensor applications, a 10-micron technology is currently under development with the following characteristics: a 50- micron DuPont Kapton HN polyimide flexible substrate, a 10 nm/50 nm Cr/Au Metal-1 layer, and a 30 nm indium-gallium-zinc oxide (IGZO) active layer. This technology is capable of withstanding temperatures up to 300 °C and a bending radius as small as 2 mm. Fabrication is performed in an ISO 5 cleanroom and can be completed within three days after tape-out. This work presents results in several potential applications of the technology, including ultraviolet (UV) sensors, temperature sensors, and gas sensors.

Keywords:

semiconductor, technology, multi-project wafer, flexible electronics

Reference:

P. G. Olguín-Leija, N. Hernandez-Como, "Basic Logic Gates and Digital Circuits Based on Flexible IGZO Enhancement-Mode nMOS TFTs," IEEE Journal on Flexible Electronics, 3 (2024), doi: 10.1109/JFLEX.2024.3408135

Ris work was supported by:

SIP-IPN 20250680



FLEXIBLE MICROELECTRODE ARRAY FOR SELECTIVE TRANSCORNEAL ELECTRICAL STIMULATION

Autores: Natiely Hernández Sebastián¹; Victor Manuel Carpio Verdin¹

Coautores: Bernardino Barrientos García ¹; Erik Rene Borjes Valdez ²; Mario Humberto Buenrostro Jáuregui ²

¹ Centro de Investigaciones en Óptica, A. C.

² Universidad Iberoamericana Ciudad de México

Autor responsable de la comunicación: victorcv@cio.mx

Transcorneal electrical stimulation (TES) is a promising treatment for several retinal degenerative diseases (RDDs). TES involves the application of a controlled electrical current to the anterior surface of the cornea, aimed at activating the retina and posterior ocular structures. Dawson-Trick-Litzkow (DTL) and ERG-JET electrodes are among the most widely used for TES. However, their continuous metallic surface design limits spatial resolution and the ability to perform selective ES. In this work, we present the development of a flexible TES electrode for selective electrical stimulation of the cornea. The proposed design consists of 20 independent microelectrodes, strategically distributed across the central and paracentral corneal regions. The fabrication process combines surface micro-machining and flexible electronics technologies, employing only three materials: aluminum (Al), titanium (Ti) and polyimide (PI). This material selection is key to achieving a simplified, ergonomic, and reproducible manufacturing process. The fabricated electrode was validated at the laboratory level through electrical and electrochemical tests, showing relatively high electrical conductivity and low impedance, ranging from 791 k Ω to 1.75 M Ω within the clinically relevant frequency range (11 Hz to 30 Hz). Finally, biocompatibility was demonstrated by performing in-vitro and in-vivo test.

Keywords:

MEMS, BioMEMS, Corneal Electrical Stimulation, Microelectrodes

Reference:

N. Hernández-Sebastián et al., "Fabrication and Characterization of a Flexible Thin-Film- Based Array of Microelectrodes for Corneal Electrical Stimulation", *Micromachines*, vol. 14, n.o 11, p. 1999, oct. 2023, doi: 10.3390/mi14111999.

Ris work was supported by:

Proyecto: LNC-2023-121 denominado "Desarrollo de dispositivos oftálmicos de última generación en el Laboratorio Nacional de Óptica de la Visión, LANOV"



FABRICATION OF AN OPERATIONAL AMPLIFIER (OPAMP) WITH THIN-FILM TRANSISTORS (TFT) USING INDIUM GALLIUM ZINC OXIDE (IGZO)

Autor: Arturo Torres-Sánchez¹

Coautores: Isai S. Hernández-Luna ¹; Leonel S. Sánchez-Fernández ²; Norberto Hernández-Como ¹

¹ *Centro de Nanociencias, Micro y Nanotecnologías*

² *Escuela Superior de Ingeniería Química e Industrias Extractivas*

Autor responsable de la comunicación: atorressa@ipn.mx

Metal oxide thin-film transistors (TFTs) have been widely used as control elements in large-area electronics, such as displays. Recently, TFTs based on materials like indium-gallium-zinc oxide (IGZO) have gained interest for more complex circuits due to their high carrier mobility, high on/off current ratio, low off-state current, and low subthreshold slope. These circuits include digital systems, radio frequency identification (RFID) tags, biosensor monitoring systems, and mixed-signal systems, the latter of which rely on analog components such as operational amplifiers (opamps). This work presents the simulation, fabrication, and characterization of an opamp built with n-type a-IGZO TFTs, featuring minimum channel lengths down to 5 μm and processed at a maximum deposition temperature of 150 °C on glass substrates. The fabricated opamp achieved a voltage gain of 29 dB, a gain-bandwidth (GBW) of 60 Hz, a gain-bandwidth product (GBWP) of 1.7 kHz, and a unity-gain frequency (UGF) of 1 kHz. The results demonstrate the device is suitable for amplifying low-frequency signals in the millivolt range.

Keywords:

TFT, IGZO, OPAMP

Reference:

None

Ris work was supported by:

SIP-IPN under grant 20250680



MICROELECTRONICS AND MEMS / 386

SCANNING TUNNELING MICROSCOPY OF Au, Ag AND Au/Ag NANOPARTICLES SYNTHESIZED BY PHYSICAL METHODS.

Autor: Alejandra Guadalupe López Hernández¹

Coautores: Arantxa Villasana García ²; Francisco Aguirre Tostado ³; Margarita Sánchez Domínguez ⁴; Oscar Manuel Perez Landeros ²; Abraham Arias León ⁵

¹ UABC

² Instituto de Ingeniería, Universidad Autónoma de Baja California

³ Cimav, Unidad Monterrey

⁴ Centro de Investigación en Materiales Avanzados

⁵ Universidad Autónoma de Baja California

Autor responsable de la comunicación: lopez.alejandra50@uabc.edu.mx

Gold, Silver, and Gold/Silver thin films were deposited on Ni/Fe substrates by thermal evaporation. Then, metallic Au and Ag; and bimetallic Au/Ag nanoparticles were synthesized from the thin films using Rapid Thermal Annealing or Laser ablation method. For RTA, three different times of annealing were used to form nanoparticles. For the laser ablation method, power and laser speed were varied to optimize the nanometallic nanoparticle synthesis. A study of the relation between nanoparticles morphology and the annealing time, laser power and laser speed; is performed using Scanning Tunneling Microscopy (STM). The STM analysis was performed using three different tip current (1, 2 and 3 nA), two different data acquisition time (0.2 and 0.3 s) and two different number of lines per image (128 and 256). The results obtained are compared with Scanning Electron Microscopy images to establish the optimal STM parameters.

Keywords:

Metallic NPs, STM, RTA, Laser Ablation

Reference:

Landeros, O. P., Nedev, N., Alvarez, M. C., Salas, B. V., Barajas, A., Anzaldo, D. M., ... Leon, A. A. Vacuum, 157, 166-172. (2018).

Ris work was supported by:

The authors thanks to SECIHTI for graduate fellowships. And the SSP-Program U124-0232.



ELECTRICAL CHARACTERIZATION OF IGZO RIN-FILM TRANSISTORS USING CONTINUOUS AND PULSED MEASUREMENT TECHNIQUES

Autor: Isai Salvador Hernandez-Luna¹

Coautores: Arturo Torres-Sánchez ¹; Francisco Hernandez-Cuevas ¹; Norberto Hernandez-Como ¹

¹ Centro de Nanociencias, Micro y Nanotecnologías, IPN

Autor responsable de la comunicación: ishernandezl@ipn.mx

Thin-film transistors (TFTs) based on metal oxides such as IGZO (Indium-Gallium-Zinc Oxide) continue to gain prominence in electronic applications due to their high carrier mobility, optical transparency, and potential for integration into monitoring systems. For accurate electrical evaluation, it is essential to compare measurement techniques that can reliably characterize device behavior. This study investigates the differences between continuous (DC) and pulsed measurement methods in IGZO TFTs, aiming to understand how each approach impacts the accuracy of extracted electrical parameters, particularly in devices that are sensitive to thermal stress. The transistor materials were defined using direct lithography processes, with the semiconducting IGZO layer deposited by room-temperature sputtering and the gate dielectric (HfO₂) deposited using Atomic Layer Deposition (ALD). This material combination enables relevant analysis for display technologies and flexible electronics. Two measurement methodologies were applied to the fabricated TFTs: in the continuous measurement, gate and drain voltages were applied steadily over time; in the pulsed measurement, short voltage pulses with off-times were used, thereby reducing both electrical and thermal stress during characterization. The results provide a comparison of the extracted electrical parameters, such as threshold voltage (V_{th}) shift and field-effect mobility. This type of study is conducted to better understand how the choice of characterization method influences the reliability and fidelity of the measured data, particularly in materials that are prone to hysteresis effects or bias-induced degradation.

Keywords:

TFTs, IGZO, RT sputtering, ALD, measurement methods

Reference:

P. G. Olguín-Leija, N. Hernandez-Como, "Basic Logic Gates and Digital Circuits Based on Flexible IGZO Enhancement-Mode nMOS TFTs," IEEE Journal on Flexible Electronics, 3 (2024), doi: 10.1109/JFLEX.2024.3408135

Ris work was supported by:

SIP-IPN under grant 20250680, "Estancias Posdoctorales Académicas" by SECIHTI.



NANOESTRUCTURES

CHAIRMEN

Dra. Reyna Méndez Camacho (CINVESTAV-IPN), reyna.mendez@cinvestav.mx

Dr. Victor Cabrera Arenas (UPIITA-IPN), vcabreraa@ipn.mx

Dear Friends and Colleagues,

We take pleasure to invite you to participate in the Nanostructures symposium of the XVIII International Conference on Surfaces, Materials and Vacuum. Participants interested in presenting an oral or poster contribution are invited to submit an abstract.

The symposium scientific program will cover a wide spectrum of topics including physical phenomena, materials sciences, and applications of nanostructures. The diversity of topics provides an opportunity to broaden the knowledge on latest developments and future perspectives in nanostructures research. Current development in the nanostructured materials includes:

- Synthesis, functionalization, processing and self-assembly of nanoparticles
- Nanotubes, nanowires, quantum dots and other low dimensional structures
- Bio-active nanomaterials and nanostructured materials for bio-medical applications
- Carbon nanostructured materials, Nano-structured membranes, nano-porous materials, functional coatings
- Nanomaterials for photo-catalysis, solar hydrogen and thermoelectric
- Nano-fabrication, characterization and manipulation techniques for nanostructures
- Magnetic and nano-semiconductor materials
- Industrial development and application of nanomaterials
- Theoretical studies of nanostructured materials.

We look forward to welcoming you.



STUDY OF WATER CONDENSATION ON COPPER MICRO- AND NANO-STRUCTURED SURFACES AND MULTI-WALLED CARBON NANOTUBES

Autores: Julio Cesar Cruz Cardenas ¹

Coautores: Veronica Cristel Vázquez de la Cruz ²; Luis Fernando Benítez Rodríguez²; Ivan Camps³, Marco Martínez¹; Stephen Muhl ¹

¹ Departamento de Materiales de Baja Dimensionalidad. Instituto de Investigaciones en Materiales. Universidad Nacional Autónoma de México

² Facultad de Ciencias, Universidad Nacional Autónoma de México

³ Departamento de Ciencias. Instituto Tecnológico de Estudios Superiores de Monterrey. Campus Santa Fe.

Autor responsable de la comunicación: juliocruz@ens.cnyn.unam.mx

Water scarcity is a serious problem because drinking water is running out. The problem is further aggravated by climate change. However, a helpful alternative is to harvest water from the atmosphere, which has approximately 1.9×10^{19} cubic meters of water. In this work, we focused on studying the condensation process of atmospheric water on copper surfaces, micro- and nanostructured, and on multi-walled carbon nanotubes (MWCNTs). We reached the dew point by passing a voltage through a Peltier cell. It was possible to harvest water from the atmosphere along with parameters such as temperature and relative humidity. Our results show that surface structure strongly influences water harvesting, while hydrophobicity and hydrophilicity are secondary. Droplet-wise condensation, DWC, allowed for a better harvest, with the amount of water on a polished copper surface equal to 2.63 liters per hour.

Keywords:

Water harvesting, Peltier cell, copper, MWCNTs, water

Reference:

A: Goswami et al. 2021. Surface modifications to enhance dropwise condensation. Surfaces and Interfaces 25 (2021) 101143

Ris work was supported by:

DGAPA-UNAM under contract IG101123



BAND GAP DETERMINATION IN PAMBE-GROWN ALN BY THERMO-OPTICAL EFFECT

Autores: Edgar Agustin Contreras ¹

Coautores: Yenny Lucero Casallas Moreno²; Jesús Roberto Millan Almaraz ³; Luis Vargas Hernández ¹; Cristo Manuel Yee Rendon ³; Mario Alberto Zambrano Serrano ¹

¹ *Departamento de Física, Centro de Investigaciones y Estudios Avanzados de IPN*

² *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas (UPIITA-IPN)*

³ *Universidad Autónoma de Sinaloa*

Autor responsable de la comunicación: alejandroisais@uaz.edu.mx

The band gap energy is an important parameter in semiconductor materials, as it defines the type of applications they can be used, for example, in optoelectronic devices or high-power devices which require materials with large band gap energies, such as AlN. However, as the band gap increases, the characterization of these materials becomes more challenging due to the high-energy excitation required. In optical setups, this means that lasers with energy are required. In this work, in the pursuit of characterizing wide-band-gap materials, we have investigated AlN/Si(111) thin films grown by plasma-assisted molecular beam epitaxy (PA-MBE). The substrate temperature varied between 790 °C and 850 °C, while the aluminum cell flux was adjusted between 1.4×10^{-7} and 2.4×10^{-7} Torr. Structural analysis by X-ray diffraction confirmed the formation of the wurtzite phase, with a lattice parameter of approximately 4.974 Å, in excellent agreement with literature values. For optical characterization, we employed a thermo-optical effect to determine the band gap value. By using a temperature controller, the sample temperature was varied to perform spectroscopic measurements on AlN thin films. The same technique was also applied to GaAs substrates, where results consistent with those obtained by photoreflectance were observed. The change in temperature modifies the refractive index of AlN and leads to changes in the reflectance spectrum that allow the band gap to be identified. For AlN samples, we found a band gap value close to 6 eV, in good agreement with values reported in the literature.

Keywords:

MBE, AlN, Thermo-optical

Ris work was supported by:

This work was partially supported by CONAHCYT under project CF-2023-G-426.



DEGRADATION OF MALAQUITE GREEN BY ADSORPTION AND PHOTOCATALYSIS WITH DIFFERENT COMPOUNDS

Autores: Carlos Rafael Michel Uribe¹; Edgar Eduardo Reyna Ortega¹

¹ *Departamento de Física - Centro Universitario de Ciencias Exactas e Ingenierías - Universidad de Guadalajara*

Autor responsable de la comunicación: edgar.ore25@gmail.com

Malaquite Green (VM) is a dye which has generated controversy because its possible cancerigen risks. This work has studied MG degradation with different natural and synthetic compounds by adsorption and heterogeneous photocatalysis (fh). To measure its degradation, UV-Vis spectroscopy has been employed. The compounds involved was Zinc formate (FZ), 7 wt% Ag-doped Zinc formate (FZ- Ag) and their correspondent oxides calcined at 600°C: ZnO and ZnO-Ag. Also a comercial organoa- lminoslicate: Carbura Zea T in its natural form (CTS) and calcined at 400°C (CTC). These com- pounds were characterized by XRD. SEM was employed to ZnO and ZnO-Ag. An optical bandgap estimation of materials was obtained by tauc plot technique in order to predict their photocatalytic efficiency.

Keywords:

Malaquite green, Heterogeneous photocatalysis, Adsorption, Degradation, ZnO

Reference:

Y. Sun, W. Zhang, Q. Li, H. Liu, y X. Wang. (2023). Preparations and applications of zinc oxide based photocatalytic materials. Advanced Sensor and Energy Materials, Volumen(2), 100069. <https://doi.org/10.1016/j.asems.2023.100069>

Ris work was supported by:

Universidad de Guadalajara



CUBIC $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{GaN}$ QUANTUM WELLS BY MBE

Autores: Erik Antonio Arroyo Sosa¹; Luis Martin Reséndiz Mendoza²; Marlene Camacho Reynoso³; Máximo López López⁴; Yenny Lucero Casallas Moreno⁵; Yuriy Kudriavtsev⁶

¹ *Estudiante de Maestría en Tecnología Avanzada, Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional, Avenida Instituto Politécnico Nacional No. 2580, Colonia Barrio la Laguna Ticomán, Alcaldía Gustavo A. Madero, Ciudad de México, C.P. 07340, México*

² *Departamento de Investigación, Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional, Av. Instituto Politécnico Nacional No. 2580, Colonia Barrio la Laguna Ticomán, Alcaldía Gustavo A. Madero, Ciudad de México, 07340, México*

³ *Departamento de Física, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Apartado Postal 14-740, C.P. 07360, Ciudad de México, México*

⁴ *Departamento de Física, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Apartado Postal 14-740, C.P. 07000, Ciudad de México, México*

⁵ *Sección de Estudios de Ciencia e Ingeniería en Tecnología de la Información (SECIHTI), Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional, Avenida Instituto Politécnico Nacional No. 2580, Colonia Barrio la Laguna Ticomán, Alcaldía Gustavo A. Madero, Ciudad de México, 07340, México*

⁶ *Departamento de Ingeniería Eléctrica – Sección de Electrónica del Estado Sólido, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Unidad Zacatenco, Avenida Instituto Politécnico Nacional No. 2508, Colonia San Pedro Zacatenco, Alcaldía Gustavo A. Madero, Ciudad de México, C.P. 07360, México*

Autor responsable de la comunicación: erikantonioarroyososa@gmail.com

The cubic-phase $\text{In}_x\text{Ga}_{1-x}\text{N}$ alloy is a promising and viable alternative for solid-state lighting applications, particularly in light-emitting diodes (LEDs) [1]. The potential of this ternary material arises from its direct bandgap, which spans a broad range of the solar spectrum, from the InN bandgap (0.56 eV) to that of GaN (3.23 eV) at room temperature [1]. This study reports the growth of cubic (metastable) $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{GaN}$ quantum wells (QWs) using molecular beam epitaxy (MBE) on GaAs (001) substrates. Three QWs were deposited per sample, each with a thickness of 10 nm and GaN barriers of 30 nm. Secondary ion mass spectrometry (SIMS) was employed to assess chemical abruptness and determine the In (x) content in the QWs. Additionally, X-ray photoelectron spectroscopy (XPS) provided insights into the binding energies within the cubic $\text{In}_x\text{Ga}_{1-x}\text{N}$ QWs. Photoluminescence measurements revealed energy transitions within the visible spectrum, particularly in the green region, in agreement with theoretical calculations. These findings contribute to the development of high-performance active regions for LEDs.

Keywords:

c- $\text{In}_x\text{Ga}_{1-x}\text{N}$, quantum wells, cubic phase, metastable phase

Reference:

M. Camacho-Reynoso, C.A. Hernández-Gutiérrez, C. M. Yee-Rendón, C. Rivera-Rodríguez, D. Bahena-Uribe, S. Gallardo-Hernández, Y. Kudriavtsev, M. López-López, Y. L. Casallas-Moreno, Cubic $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{GaN}$ quantum wells grown by Migration Enhanced Epitaxy (MEE) and conventional Molecular Beam Epitaxy (MBE), 921 (2022)

Ris work was supported by:

Thanks to the IPN projects



INDIUM CONCENTRATION IN $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{GaN}$ QUANTUM WELLS BY X- RAY PHOTOELECTRON SPECTROSCOPY (XPS)

Autor: Marlene Camacho Reynoso¹

Coautores: Cristo Manuel Yee Rendón²; Erik Antonio Arroyo Sosa³; Máximo López López¹; Yenny Lucero Casallas Moreno³; Yuriy Kudriavtsev¹

¹ Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional (CINVESTAV-IPN)

² Universidad Autónoma de Sinaloa (UAS)

³ Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas (UPIITA-IPN)

Autor responsable de la comunicación: marlene.camacho@cinvestav.mx

The nitride family has a promising future due to its properties with an important position within materials science and nanotechnology. These materials have been used to grow low-dimensional structures that are key elements for the creation of new nanotechnological devices like light-emitting diodes (LEDs) [1]. This study focuses on $\text{In}_x\text{Ga}_{1-x}\text{N}$ quantum wells with GaN barriers on GaAs in a metastable phase using the Molecular Beam Epitaxy (MBE) technique. These nanostructures exhibit emission in the visible green spectral range, principal motivation for our work since the literature reports four times less efficient in comparison with the blue emission [1]. Each sample contains three quantum wells with a thickness of 10 nm and barriers of 30 nm. The formation of the wells was observed using Transmission Electron Microscopy (TEM), X-ray Photoelectron Spectroscopy (XPS), and Secondary Ion Mass Spectroscopy (SIMS), the indium content in these quantum wells was determined using XPS. These analyses provide important contributions to the development and advancement of optoelectronic devices.

Keywords:

Quantum wells, Indium concentration

Reference:

Y. -C. Tsai, J. -P. Leburton and C. Bayram, "Quenching of the Efficiency Droop in Cubic Phase InGaAlN Light-Emitting Diodes," in IEEE Transactions on Electron Devices, vol. 69, no. 6, pp. 3240-3245, June 2022, doi: 10.1109/TED.2022.3167645.

Ris work was supported by:

Y.L. Casallas-Moreno thanks to the project CONAHCYT-Frontier Science 2023 CF-2023-I-1117



GREEN SYNTHESIS OF NANOPARTICLES WO₃ DECORATED WITH GOQDs

Autor: Fernando Díaz Monge¹

Coautores: Aldo Hernández Díaz ²; Alejandro Rodríguez Juárez ¹; Alejandro Sánchez Guzman ¹; Hilario López Xelo ¹; Orlando Zaca Moran ³; Placido Zaca Moran ⁴

¹ Tecnológico Nacional de México, ITS - Tlaxco, Predio Cristo Rey Ex-Hacienda de Xalostoc, Carretera Apizaco-Tlaxco, Km. 16.8, Tlaxco, Tlaxcala, 90271, México

² Instituto Politécnico Nacional, Unidad Profesional Interdisciplinaria de Ingeniería Campus Tlaxcala. Guillermo Valle 11, Centro, Tlaxcala de Xicohténcatl, 90000, México.

³ Instituto Politécnico Nacional, Centro de Investigación en Biotecnología Aplicada, Ex-Hacienda de San Juan Molino, Km 1.5 de la Carretera Estatal Santa Inés, Tecuexcomac-Tepetitla, Tepetitla, Tlaxcala, 90700, México

⁴ Instituto de Ciencias, Benemérita Universidad Autónoma de Puebla, 72050, Puebla, México

Autor responsable de la comunicación: fernando.dm@tlaxco.tecnm.mx

In this study, the effect of redshift on the absorption spectrum of tungsten oxide nanoparticles (WO₃ NPs) decorated with graphene oxide quantum dots (GOQDs) was analyzed. The synthesis was via green synthesis, using *Justicia secunda* Vahl extract and sodium tungstate dihydrate as a metal precursor; the GOQDs were obtained from carbonized coffee grounds. The red shift of the absorption spectrum of WO₃ NPs/GOQDs was monitored by ultraviolet-visible (UV-vis) spectroscopy. The results showed synergy in the absorption band shift compared to the individual absorption bands of WO₃ NPs and GOQDs, in addition to confirming a significant dependence on the mixing order of the extract-precursor-GOQDs and a close relationship between the volumetric proportions used for the formation of the decorated in the WO₃ NPs/GOQDs. Transmission electron microscopy (TEM) and energy-dispersive spectroscopy (EDS) analysis confirmed the formation of spherical WO₃ NPs with GOQDs adsorbed on their surface, as well as their chemical composition. Fourier transform in- frared spectroscopy (FTIR) confirmed the presence of functional groups of antioxidant compounds such as flavonoids, anthocyanins, and isoflavones that cause the bio-reduction process. This low- temperature green synthesis method is novel compared to existing chemical synthesis methods. Furthermore, the presence of organic functional groups on the surface reduces toxicity, making them promising candidates for biomedical applications.

Keywords:

Green synthesis, nanoparticles, GOQDs

Reference:

U. O. Aigbe and O. A. Osibote, "Green synthesis of metal oxide nanoparticles, and their various applications," Journal of Hazardous Materials Advances, vol. 13, p. 100401, Feb. 2024, doi: 10.1016/J.HAZADV.2024.100401

Ris work was supported by:

Tecnológico Nacional de México under grant no. 23127.25-PD, SECIHTI (before CONAHCYT) CF-2023- G-1080 and the IPN - SIP projects no. 20241938 and no. 20250124.



1DZnO BIOFUNCTIONALIZATION WITH DNA PROBES TARGETING A LOW- MUTATION REGION OF SARS-CoV-2

Autor: Shirley Elizabeth Martinez Tolibia¹

Coautores: Ateet Dutt ²; César Millán Pacheco ³; Edgar O. Castrejón González ⁴; Erik Vázquez Montelongo ⁴; Guillermo Santana Rodríguez ⁵; Josue Esau Romero ⁶; Rafael A. Salinas ⁶

¹ Instituto de Investigaciones en Materiales (IIM-UNAM), México City 04510, México.

² Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México, Materiales de Baja dimensionalidad, México City 04510, México.

³ Facultad de Farmacia, Universidad Autónoma del Estado de Morelos, Cuernavaca, Morelos 62209, México.

⁴ Departamento de Ingeniería Química, Tecnológico Nacional de México en Celaya. Celaya, Guanajuato 38010, México.

⁵ Departamento de Materiales de Baja Dimensionalidad, Instituto de Investigaciones en Materiales Universidad Nacional Autónoma de México, México City 04510, México.

⁶ Instituto de Investigaciones en Materiales IIM-UNAM, México City 04510, México.

Autor responsable de la comunicación: smartinezt@materiales.unam.mx

The genome of SARS-CoV-2 includes 4 structural proteins, 16 nonstructural proteins, and 6 accessory proteins. Among these, the structural proteins spike (S), envelope (E), membrane (M), and nucleocapsid (N), are crucial targets for viral identification. Nevertheless, the accurate detection of SARS-CoV-2 among mutated strains presents a significant challenge, making DNA-based biosensors a viable alternative for targeting specific genomic regions. In this work, we established a one-step immobilization strategy for DNA probes targeting a low-mutation region from the envelope protein of SARS-CoV-2 onto one-dimensional ZnO nanostructures (1DZnO) to achieve high detection efficiency. First, DNA probes were designed to focus on a highly conserved region (L28-A36) prevalent among SARS-CoV-2 subvariants, identified through bioinformatics analysis. Subsequently, we conducted dynamic simulations to assess the binding affinity of DNA to the 1DZnO, revealing that phosphate groups exhibited the greatest affinity to the ZnO surface, followed by sugar rings and base pairs. In addition, calculations of linear interaction energies and average contributions for the ssDNA/ZnO interfaces were included. Computational simulations were correlated to experimental techniques, where suitable DNA immobilization and target detection were confirmed by FTIR, Atomic Force Microscopy (AFM), photoluminescence (PL), transmission electron microscopy (TEM), and elemental mapping, corroborating the adsorption of DNA across the entire 1DZnO surface. The optical signal response by PL showed a distinctive shift in deep level emission band between 520–530 nm, with a partial quenching of the near band emission signal, obtaining variations as well in the calculated bandgap. Computational and experimental findings suggest that structural oxygen vacancies in 1DZnO nanoplateforms present a significant proportion of available active sites for effective and strong interactions with the phosphate backbone of DNA, thus enhancing physical adsorption. Lastly, molecular validation was performed using Polymerase Chain Reaction (PCR) to confirm the detection, integrity, and stability of the target.

Keywords:

ZnO nanowires, DNA, adsorption, optical detection, photoluminescence

Reference:

Shirley Martínez Tolibia et al. Efficient one-step immobilization of DNA probes on 1DZnO nanoplateforms targeting a low-mutation region of SARS-CoV-2. 2025 Biofabrication IOP Science. 17, 025029.

Ris work was supported by:

This work was supported by the UNAM Postdoctoral Program (POSDOC). A. D. thanks the Project PAPIIT-DGAPA-UNAM IN100125, and G. S. thanks the Project PAPIIT-DGAPA-UNAM IG100123.



OPTIMIZATION OF PHOTOCATALYTIC APPLICATIONS THROUGH- OUT THE SYNTHESIS OF SODIUM AND STRONTIUM TITANATE NANOSTRUCTURES DECORATED WITH NANOPARTICLES

Autores: Sergio Corte González¹; Hiram Joazet Ojeda Galván²; Socorro Oros Ruíz³

Coautores: Hugo Ricardo Navarro Contreras ²; Mildred Quintana Ruiz ⁴

¹ *Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología, Universidad Autónoma de San Luis Potosí. Av. Sierra Leona #550-2ª, Lomas de San Luis, 78210 San Luis Potosí, S.L.P., México.*

² *Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología, Universidad Autónoma de San Luis Potosí. Av. Sierra Leona #550-2ª, Lomas de San Luis, 78210, San Luis Potosí, S.L.P., México.*

³ *Instituto de Física, Universidad Autónoma de San Luis Potosí. Av. Parque Chapultepec 1570, Privadas del Pedregal, 78295 San Luis Potosí, S.L.P., México.*

⁴ *Centro de Investigación en Ciencias de la Salud y Biomedicina, Universidad Autónoma de San Luis Potosí. Av. Sierra Leona 550, Lomas de San Luis, 78210 San Luis Potosí, S.L.P., México.*

Autor responsable de la comunicación: serchie504@gmail.com

The analysis of photocatalytic properties of the nanomaterials -NaTNT, NC-STO and the formation of CdS composites, was accomplished throughout photocatalytic activity tests in order to evaluate these materials' capacity to induce chemical reactions under light radiation. These tests included hydrogen generation from water splitting, adsorption, and degradation of the organic dye Methylene Blue, a pollutant commonly present in textile effluents via photocatalytic decomposition. The synthesized nanomaterials presented an improvement in the photocatalytic activity while being superficially modified via the photodeposition of metallic nanoparticles, in comparison to the non- decorated materials. A better efficiency in hydrogen generation was observed along with more capacity to degrade dyes. These improvements were attributed to the high superficial area, the presence of active sites in the material-nanoparticle interface and to the enhanced optical properties of nanomaterials. Characterization techniques were employed in order to obtain a detailed understanding of the structure, composition and properties of the nanomaterials, which contributed to the optimization of its photocatalytic applications; X-ray Diffraction (XRD) techniques were employed to determine the crystalline structure of the titanate nanostructures; Raman Spectroscopy was used in order to investigate molecular vibrations and composition of the materials; the Transmission Electron Microscope (TEM) technique allowed us to examine morphology and the size of the nanostructures at nanometric scale. Finally, diffuse reflectance UV-Vis spectroscopy was used to evaluate optical properties of the materials and their response to visible light.

Keywords:

Photocatalysis, Hydrogen Generation, Na₂Ti₃O₇, CdS, SrTiO₃, Methylene Blue

Reference:

H. J. Ojeda-Galván, A. G. Rodríguez, I. A. Santos-López, R. Mendoza-Cruz, M. J. Yacamán, B. E. Handy; "Deformation behavior of titanate nanotubes subjected to high pressure." J. Appl. Phys. 14 January 2017; 121 (2): 025902.

Ris work was supported by:

Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos-UASLP. Acknowledges SECIHTI



Mn_xFe_{3-x}O₄ NANOPARTICLES FUNCTIONALIZED IN SITU WITH CLOVE POLYPHENOLS BY CO-PRECIIPITATION ROUTE.

Autor: Blanca Estela Zendejas Leal¹

Coautores: Brayan Javier Lorenzano Hernández¹; Jaime Santoyo Salazar¹

¹ *Departamento de Física del Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional. Avenida Instituto Politécnico Nacional No. 2508, Colonia San Pedro Zacatenco, Código Postal: 07360, Alcaldía de Gustavo A. Madero, Ciudad de México, México.*

Autor responsable de la comunicación: bzendejas@cinvestav.mx

Superparamagnetic nanoparticles (SPIONs) have a wide range of applications in biomedical, technological, and industrial fields due to their controllable magnetic properties as function of size, shape, composition, and surface nature. Their processing control and properties are essential to understanding their behavior, performance, and risks to the environment and human health.

In this work, (SPIONs) were synthesized in manganese ferrite (MnFe₂O₄) configuration by the coprecipitation method from iron and manganese chloride salts. Starting with solutions of 30% hydrochloric acid (HCl) diluted with distilled water, degassing the solvent by constant injection of compressed argon gas. Potash (-KOH) dissolved in degassed water was used as a salt precipitation agent and then added to the chloride solution found at a molar ratio of (Fe³⁺ + Mn²⁺): (2Fe²⁺). Finally, the functionalization of the nanoparticles was carried out by adding a clove extract solution, to provide biological affinity to the nanoparticles.

Physical properties of (MnFe₂O₄) nanoparticles were analyzed in size distribution and composition by SEM with EDS. Structure was defined by XRD and SAED. The size, shape, and polyphenol coating were observed by TEM. The composition and main bonds in the nanoparticles were obtained using FTIR.

Keywords:

Superparamagnetic nanoparticles (SPIONs), manganese ferrite (MnFe₂O₄), Co-precipitation, polyphenols.

Reference:

Y. Shen, et al, "Facile solvothermal synthesis of mnfe₂o₄ hollow nanospheres and their photocatalytic degradation of benzene investigated by in situ ftir,"Catalysis Communications, vol. 68, pp. 11–14, 2015.

Ris work was supported by:

Cinvestav



DESIGN AND CONSTRUCTION OF MS₂@TiO₂ HETEROJUNCTIONS (WHERE M IS MO₂⁺ AND W₄⁺) FOR PHOTOCATALYTIC APPLICATIONS USING VISIBLE LIGHT.

Autores: Diana Sofia Michell Flores Saldaña¹; Hiram Joazet Ojeda Galván¹; Hugo Ricardo Navarro Contreras¹

Coautores: Aida Catalina Hernandez Arteaga²; Edgar Giovanni Villabona Leal³; Mildred Quintana Ruiz⁴; Selene Acosta⁵; Socorro Oros Ruíz⁶

¹ *Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología, Universidad Autónoma de San Luis Potosí. Av. Sierra Leona #550-2ª, Lomas de San Luis, 78210 San Luis Potosí, S.L.P., México*

² *Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología, Universidad Autónoma de San Luis Potosí. Av. Sierra Leona #550-2ª, Lomas de San Luis, 78210 San Luis Potosí, S.L.P., México*

³ *Departamento de Biotecnológicas Y Ambientales Química, Universidad Autónoma de Guadalajara. Av. Patria 1201 45129 Zapopan, Jalisco, México*

⁴ *Centro de Investigación en Ciencias de la Salud y Biomedicina CICSaB. Universidad Autónoma de San Luis Potosí. Av. Sierra Leona #550-2ª, Lomas de San Luis, 78210 San Luis Potosí, S.L.P., México*

⁵ *Centro de Investigación en Ciencias de la Salud y Biomedicina, Universidad Autónoma de San Luis Potosí, Av. Sierra Leona 550, Lomas de San Luis, 78210, San Luis Potosí, México.*

⁶ *Instituto de Física, Universidad Autónoma de San Luis Potosí. Av. Parque Chapultepec 1570, Privadas del Pedregal, 78295 San Luis Potosí, S.L.P., México.*

Autor responsable de la comunicación: dianasofiamichell@gmail.com

One of the recent problems is water pollution, which has begun to have repercussions on the lives of certain populations. Heterogeneous photocatalysis can help with this problem. One material that has a great photocatalytic performance is titanium dioxide (TiO₂); however, this material requires ultraviolet light. Two materials that are especially used in this problem are 2D materials that are based on dichalcogenides such as molybdenum disulfide MoS₂ and tungsten disulfide WS₂. These materials have a considerably lower band gap, which makes them ideal for visible light absorption. It is for this reason that the heterojunction between these materials offers an avenue in applications where the main phenomenon is oxidation and reduction, such as heterogeneous photocatalysis and hydrogen generation. The main objective is to study the effect of MS₂ on TiO₂ in photocatalytic activity and hydrogen generation with different concentrations 0.25%, 0.5%, 1.5%, 2.5% by weight. The samples were characterized by Raman spectroscopy, X-ray diffraction (XRD), UV-vis-NIR spectroscopy and TEM microscopy. The results of the X-ray diffraction were analyzed by the Rietveld method, and the data from the UV-vis diffuse reflectance spectroscopy were analyzed using the Tauc graphic method to obtain the concentration correlation with the band gap in each sample. Photocatalytic activity was measured under visible light irradiation.

Keywords:

Dichalcogenides, MoS₂, WS₂, TiO₂, Photocatalysis, Hydrogen generation

Reference:

1. Akira Fujishima. (2000). Titanium dioxide photocatalysis. Journal of Photochemistry and Photo-biology C: Photochemistry Reviews.1-21. [https://doi.org/10.1016/S1389-5567\(00\)00002-2](https://doi.org/10.1016/S1389-5567(00)00002-2)

Ris work was supported by:

Scholarship by Secretaría de Ciencia, Humanidades, Tecnología e Innovación Secihti



ELECTROMAGNETIC MODEL OF ORGANIC NANOSTRUCTURES APPLIED TO ORGANIC SOLAR CELLS USING EXPERIMENTAL OPTICAL DATA

Autor: Adriana Razo De León¹

Coautores: Luis Reséndiz Mendoza ¹; Víctor Cabrera-Arenas ¹

¹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas Instituto Politécnico Nacional*

Autor responsable de la comunicación: adrianarazo.leon@gmail.com

Inorganic nanostructures play an important role in the development of next-generation organic solar cells because they allow precise control of light at the nanometer scale. Their integration improves optical confinement, increases effective light absorption, and reduces recombination losses, all without affecting the flexibility or scalability of the devices.

This work presents a method of electromagnetic simulation using the **FDTD (Finite-Difference Time-Domain)** method with the open-source software **MEEP**, focused on the optical behavior of nanostructures inside organic architectures. Based on experimental data obtained from **ellipsometry**, the optical properties of the materials are adjusted using **Lorentzian models**, which helps to create realistic materials in the spectral range of interest.

The process of converting extinction coefficients and refractive indices into the parameters required by the simulator is explained, emphasizing the importance of having strong experimental data to ensure accurate results. Finally, the electromagnetic response of configurations with and without nanostructures is compared, showing their direct impact on the electric field distribution and the absorption coefficient.

This approach offers a useful platform for designing photovoltaic devices and helps to explore the potential of inorganic nanostructures as key elements in the transition to more efficient and adaptable solar energy technologies.

Keywords:

Organic solar cells, inorganic nanostructures, FDTD simulation, ellipsometry, nanophotonics.

Reference:

1. N. M. Ali and N. H. Rafat, Modeling and simulation of nanorods photovoltaic solar cells: A review, *Renew. Sustain. Energy Rev.* 68 (2017) 212–220. <https://doi.org/10.1016/j.rser.2016.09.114>

Work was supported by:

Instituto Politécnico Nacional, Maestría en Tecnología Avanzada.



SPIRAL GROWTH AND MECHANICAL RESPONSE OF MOLYBDENUM DISULFIDE STRUCTURES SYNTHESIZED BY CVD

Autor: Daniela Lucio Rosales¹

Coautores: Alejandra Garcia-Garcia ¹; David Torres Torres ¹

¹ Centro de Investigación en Materiales Avanzados, Subsede Monterrey. Av. Alianza Norte #202, Parque de Investigación e Innovación Tecnológica, 66628. Apodaca, Nuevo León, México.

Autor responsable de la comunicación: daniela.lucio@cimav.edu.mx

Two-dimensional transition metal dichalcogenides (TMDs) such as molybdenum disulfide (MoS_2) have attracted considerable attention due to their unique structural, electronic, and mechanical properties. Understanding the relationship between growth mechanisms and resulting material properties is critical for advancing their application in nanotechnology. This study explores the growth and mechanical response of MoS_2 structures synthesized via Chemical Vapor Deposition (CVD) on Si/SiO_2 substrates. The synthesized MoS_2 structures exhibit triangular domains characterized by prominent spiral growth, a phenomenon attributed to the continuous step flow generated by screw dislocations. These dislocations are strongly influenced by the substrate's surface features, which act as nucleation centers and significantly impact the resulting morphology. Raman spectroscopy revealed vibrational modes at 176 cm^{-1} ($A_{1g}(M) + LA(M)$) and 228 cm^{-1} ($LA(M)$), indicating the structural stability of the MoS_2 layers. The main vibrational modes, E^1 at 383 cm^{-1} and A_{1g} at 408 cm^{-1} , correspond to in-plane and out-of-plane atomic dynamics. Shifts in these modes, along with variations in their relative intensities, provide valuable information regarding the thickness of the MoS_2 , enabling differentiation between few-layer and multilayer regions. Moreover, the observation of additional peaks at 418 cm^{-1} , 454 cm^{-1} ($2LA$), and 465 cm^{-1} (A_{2u}) reflects complex vibrational coupling associated with multilayer stacking and interlayer interactions. AFM characterization validated the spiral growth patterns and allowed precise assessment of topography and layer stacking. Nanoindentation measurements revealed that the MoS_2 structures exhibit a combination of elastic and elastoplastic behavior, influenced by the presence of dislocations which contribute to enhanced toughness and strain accommodation. The interplay between structural defects and mechanical performance highlights the critical role of nanoscale growth mechanisms in tailoring the functional properties of MoS_2 films. These findings provide insights into the design of 2D materials with engineered mechanical responses for use in flexible electronics, energy dissipation systems, and strain-sensitive devices.

Keywords:

MoS_2 nanostructures, spiral growth, nanoindentation, screw dislocations, flexible electronics

Reference:

D. Lucio-Rosales, D. Torres-Torres, and A. Garcia-Garcia, A focused study of the out-plane mechanical properties and the spiral growth of MoS_2 structures, Surf. Coatings Technol. 504 (2025) 132034.

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación



GOLD NANOPARTICLES: INVESTIGATING THEIR OPTICAL PROPERTIES, MORPHOLOGY, AND POTENTIAL FOR INNOVATIVE APPLICATIONS

Autor: Mou Pal¹

¹ *Instituto de Física BUAP*

Autor responsable de la comunicación: mou@ifuap.buap.mx

In this study, gold nanoparticles (AuNPs) of various sizes and shapes were synthesized using mild chemical reduction methods with both biological waste (e.g., *Sargassum* spp.) and mild chemical reducing agents. Spherical AuNPs with an average diameter of 8 nm were obtained using *Sargassum* extract (SE), which acted as both the reducing and stabilizing agent. The SE-stabilized gold nanoparticles manifested strong catalytic activity towards the reduction of 4-nitrophenol and degradation of Rhodamine B dye. Additionally, anisotropic gold nanoparticles were synthesized using mild reducing agents such as ascorbic acid. Star-shaped AuNPs were produced by co-reduction of HAuCl₄ with ascorbic acid in the presence of AgNO₃, while the omission of AgNO₃ yielded predominantly spherical particles. Gold nanorods were synthesized via a seed-assisted growth method, employing ascorbic acid as the reducing agent and CTAB as a surfactant. The shape-dependent surface-enhanced Raman scattering (SERS) activity of the synthesized AuNPs was evaluated using Rhodamine B in aqueous solution. Among the tested morphologies, star-shaped AuNPs exhibited the highest SERS enhancement, followed by nanorods and spherical particles.

Keywords:

Gold nanoparticles, Variable morphology, Green synthesis, catalysis, SERS effect

Reference:

F. Tian, F. Bonnier, A. Casey, A. E. Shanahan and H. J. Byrne, Surface enhanced Raman scattering with gold nanoparticles: effect of particle shape, *Anal. Methods*, 2014, 6, 9116.

Ris work was supported by:

VIEP-BUAP 2025 project with grant no. 00336-PV/2025.



AEROGELS: CHARACTERISATION AND CONTROL OF NANOPOROUS STRUCTURE

Autor: Guadalupe Izamar Delgado Angeles¹

¹ *Laboratorio de síntesis y modificación de nanoestructuras y materiales 2D, Centro de Investigación en Materiales Avanzados, Alianza Norte 202, Parque de Investigación e Innovación Tecnológica, Apodaca, Nuevo León, México.*

Autor responsable de la comunicación: guadalupe.delgado@cimav.edu.mx

An aerogel is an extremely light solid material, consisting of a porous three-dimensional structure [1]. Because of this, aerogels maintain a high specific surface area as well as extremely low density [2], [3]. Biopolymer aerogels are highly relevant in the field of nanomaterials due to their porous nanostructured structure (1-100 nm), which combines high specific surface area (500-1000 m²/g), low density (0.01-0.3 g/cm³) and exceptional thermal properties (~0.02-0.05 W/m-K), with materials such as chitosan (CS) of sustainable origin due to their biocompatibility and biodegradability [4], [5] that make them ideal for advanced applications such as nanomedicine, nanoelectronics and nano- environmental remediation, positioning them as key materials for future environmentally friendly technologies [3]. The procedure used in this work to obtain the chitosan (CS)-based aerogel focused on the freeze-drying technique, as it is a recommended method for biopolymeric aerogels [4], since it allows adapting the secondary pore structure and preserving the pores and structural networks of the material [6]. This method consists of freezing the pore liquid and then sublimating it under vacuum to preserve the pore structure. Once the chitosan solution (CS) is prepared in acetic acid, bubbles are introduced through agitation, and then quickly submerged in a container with nitrogen. Once the chitosan solution (CS) was prepared in acetic acid, bubbles were introduced through agitation, and then quickly immersed in a container with liquid nitrogen to freeze the sample and finally subject it to freeze-drying. They were then characterised by SEM to analyse the morphology of the porous network, the size and shape of the pores, as well as the uniformity of the structure and the presence of defects, where it was possible to observe the presence of cavities distributed over the surface with sizes greater than 10 μ m.

Keywords:

porous material, nanostructure, chitosan, aerogel, ultralightweight

Reference:

1. Kistler. (1928).
2. Gesser, H. D. (1989).
3. Fricke, J. (1997).
4. Zhao, S et al. (2018).
5. Sonu, S. S. (2023).
6. Smirnova, I. (2018).

Ris work was supported by:

Centro de Investigación en Materiales Avanzados



MECHANICAL EXFOLIATION OF GRAPHITE USING ULTRASONIC CAVITATION

Autores: Hugo Alejandro Hinojosa Novales¹; Stephen Muhl Saunders²; Julio César Cruz Cárdenas²; Marco Antonio Martínez Fuentes²; Ivan Camps³

¹ Física, Facultad de Ciencias, Universidad Nacional Autónoma de México, Ciudad Universitaria, Apartado Postal 70-399, CDMX, 04510, México.

² Departamento de Baja Dimensionalidad, Instituto de Investigaciones en Materiales - Universidad Nacional Autónoma de México, Ciudad Universitaria, Apartado Postal 70-399, CDMX, 04510, México.

³ Escuela de Ingeniería y Ciencias, Tecnológico de Monterrey, Campus Santa Fe, La Loma, Álvaro Obregón, 01389 CDMX, México.

Autor responsable de la comunicación: hugocho14@ciencias.unam.mx

Carbon is one of the most studied materials due to its ability to form different bonds, which allows it to have allotropes with different properties among them. The most common of these is graphite, which forms a hexagonal lattice and bonds in parallel with other lattices. The bonds between the lattices are weak, so they can be separated and form a single hexagonal lattice, which is another allotrope of carbon called graphene. Graphene promises to be a material with the ability to improve electronics and nanotechnology, therefore, its production is desirable. This is why it is of great interest to study the mechanical exfoliation of graphite, using ultrasound to break the weak bonds of graphite to obtain graphene. For this reason, in the following work we sought to vibrate graphite rods and characterize the resulting samples to check the proportion of graphene obtained. The objective of the work was to make a variation of the amplitude of the wave to see how its change improves the percentage of graphene obtained and to see how it changes structure, morphology and size distribution throughout the sample. It was performed with an ultrasonic processor of 20 kHz frequency, increasing by 10% the amplitude from 40% to 80% (100% amplitude was 120 μm), a temperature of 20 °C was maintained throughout the process, as well as a synthesis time of 8 hours in total, with a 50/50 cycle of 10 seconds of operation and 10 seconds of rest. Characterizations were performed by scanning electron microscopy (SEM) to know its morphology and size, as well as Raman spectroscopy to analyze the type of carbon present in the sample, to determine the amount of graphene obtained.

Keywords:

Nanostructure, ultrasonic cavitation, SEM, Raman, graphene, graphite.

Reference:

A. V. Tyurnina, I. Tzanakis, J. Morton, et al., Ultrasonic Exfoliation of Graphene in Water: A Key Parameter Study, Elsevier Ltd. Carbon.168 (2021) 737–747. <https://doi.org/10.1016/j.carbon.2020.06.029>.

Ris work was supported by:

Julio Cruz and Marco Martinez would like to thank CONAHCYT (SECIHTI) for their postdoctoral fellowship. One of the authors acknowledges support of DGAPA-UNAM under contract IG101123.



SELF-ASSEMBLED FACETED NANOWIRE ARRAYS ON SI(331) FOR STRAIN-ENGINEERED III-V INTEGRATION

Autor: Elihu Hazel Sánchez Martínez¹

Coautores: Máximo López López ²; Reyna Méndez Camacho ²; Javier Alanis ¹; Mario Alberto Zambrano Serrano ²; Edgar Armando Cerda Méndez ³; Miguel Ángel Vidal Borbolla ¹; Esteban Cruz Hernández ¹

¹ *Coordinación para la Innovación y Aplicación de la Ciencia y Tecnología, Universidad Autónoma de San Luis Potosí*

² *Departamento de Física, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional*

³ *Instituto de Investigación en Comunicación Óptica, Universidad Autónoma de San Luis Potosí*

Autor responsable de la comunicación: elihuhazels@yahoo.com.mx

Achieving monolithic integration of III-V semiconductors on silicon remains a critical challenge due to interfacial defects and strain accumulation. In this work, we present a lithography-free approach for the growth of aligned GaAs nanowire arrays on Si(331) substrates via strain-driven faceted Molecular Beam Epitaxy. By initiating growth with a single Ga monolayer followed by low-rate GaAs deposition, we induce the spontaneous formation of a nanocorrugated surface composed of alternating (111) and (110) facets aligned along the [110] direction. This self-organized faceting process yields quasi-one-dimensional nanostructures with hierarchical periodicity in the 16–48 nm range, as revealed by atomic force microscopy and reflection high-energy electron diffraction. High-resolution X-ray diffraction confirms the presence of anisotropic strain relaxation, while low-temperature micro-photoluminescence measurements demonstrate excellent optical quality and strong in-plane polarization anisotropy, consistent with the nanowire-like geometry. Notably, this growth mode bypasses conventional lithographic or etching steps, offering a scalable and CMOS-compatible route to integrate functional III-V nanostructures directly on silicon. These findings highlight the potential of surface energy-driven self-assembly as a pathway for strain management and nanoscale ordering in III-V/Si systems, paving the way for advanced applications in photonic integration and polarized light emission.

Keywords:

Silicon, MBE, Nanowire, GaAs, monolithic-integration

Reference:

Wang WI, Phys Lett A. Molecular beam epitaxial growth and material properties of GaAs and Al- GaAs on Si (100). Appl Phys Lett 1984;44:1149{51.
<https://doi.org/10.1063/1.94673>.

Ris work was supported by:

CONAHCYT



PRISMA-COUPLED OPTICAL BIOSENSOR BASED ON 2D MATERIALS

Autor: Ireri Aydée Sustaita Torres¹

Coautores: Jefté Ceballos Zumaya ²; Jesús Madrigal Melchor ²

¹ *Unidad Académica de Ingeniería Eléctrica, Universidad Autónoma de Zacatecas*

² *Unidad Académica de Ciencia y Tecnología de la Luz y la Materia, Universidad Autónoma de Zacatecas*

Autor responsable de la comunicación: ireri.sustaita@uaz.edu.mx

Optical biosensors have evolved significantly, standing out for their high sensitivity, specificity and capacity for real-time detection. From plasmonic-based configurations to interferometry and optical resonators, their application in biomedical diagnostics and environmental monitoring has grown exponentially. However, many of these devices rely on metallic components that have disadvantages such as limited biocompatibility, optical losses and complexity in their integration at the nanometer scale [1]. In this context, two-dimensional (2D) materials, such as graphene and tungsten diselenide (WSe₂), offer a promising alternative. Their high surface-to-volume ratio, tunable optical properties and compatibility with miniaturized systems enable the design of all-optical, metal-free biosensors that are more efficient, sustainable and adaptable to biological environments. The development of these devices marks a key step towards the next generation of biosensors that are more integrable, cost-effective and environmentally friendly. In this work, a biosensor formed only with 2D materials whose structure is SF10 prism - N repeats of three graphene sheets and a monolayer of WSe₂ - biological medium for different values of N and chemical potential values of graphene is analyzed and proposed. The analysis starts by studying the angular reflection spectra. In addition, the dispersion relation was calculated and the excitation mode was found to correspond to a surface polaritonic excitation. Performance parameters were also adapted for this biosensor and their values were calculated, and it is deduced that it is possible to use this system as a biosensor having considerably high performance parameters.

Keywords:

Optical biosensors, 2D materials, performance parameters

Reference:

[1] J. Ceballos-Zumaya, I.A. Sustaita-Torres, J.S. Pérez-Huerta, D. Ariza-Flores, J. Madrigal-Melchor, Performance parameters as a function of graphene's chemical potential for SPR biosensor based on 2D materials, *Optik* 314 (2024) 172013. <https://doi.org/10.1016/j.ijleo.2024.172013>.

Ris work was supported by:

SECIHTI



STRUCTURE AND MAGNETIC PROPERTIES OF $\text{Ni}_{0.7}\text{Cr}_{0.1}\text{Mn}_{0.1}\text{Fe}_{1.1}\text{O}_{(3+x)}$ MEDIUM-ENTROPY OXIDE NANOSTRUCTURES

Autores: Raul Arotaipe Ala¹; Umapada Pal¹; Felipe Pérez Rodríguez¹

¹ *Institute of Physics, Autonomous University of Puebla, Av. San Claudio y Blvd. 18 sur, Col. San Manuel, Puebla 72570, Mexico.*

Autor responsable de la comunicación: arotaipe@ifuap.buap.mx

Magnetic cooling, a solid-state refrigeration technology based on the magnetocaloric effect (MCE), has attracted significant attention due to its high energy efficiency and environmental friendliness. This study investigates the magnetocaloric potential of $\text{Ni}_{0.7}\text{Cr}_{0.1}\text{Mn}_{0.1}\text{Fe}_{1.1}\text{O}_{(3+x)}$ oxide nanostructures prepared by the sol-gel method. Comprehensive characterization was performed using X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), and Raman spectroscopy. The magnetic properties of the nanostructures were analyzed using a Physical Property Measurement System (PPMS). A model for temperature-dependent magnetization dynamics of the nanoparticles is proposed, based on the Landau-Lifshitz-Gilbert approach.

Structural analysis using SEM and TEM revealed the formation of nanoparticles with a quasi-spheroidal morphology. XRD and Raman spectroscopy indicated that the nanostructures are a single-phase compound with a maghemite-like crystal structure. According to Banerjee's criteria and the Arrott plot, the multimetallic oxide revealed a second-order phase transition. The value of the magnetic entropy change ($-\Delta S_M$) of the compound was estimated using Maxwell relations and relative cooling power (RPC).

Keywords:

medium entropy oxides, sol-gel method, magnetocaloric effect, physical properties.

Reference:

Law, J.Y., Franco, V., Moreno-Ramírez, L.M. et al. A quantitative criterion for determining the order of magnetic phase transitions using the magnetocaloric effect. *Nat Commun* 9, 2680 (2018). <https://doi.org/10.1038/s41467-018-05111-w>

Ris work was supported by:

NATIONAL COUNCIL FOR HUMANITIES, SCIENCES AND TECHNOLOGY AND VIEP-BUAP FOR EXTENDING DOCTORAL FELLOWSHIP AND RESEARCH GRAND # 00262, RESPECTIVELY.



FABRICATION OF CARBON-COATED Fe₃O₄ NANOPARTICLES (Fe₃O₄@C) FOR MICROWAVE ABSORBER APPLICATIONS

Autores: LISBETH JHOSELY YAURI CONDORI¹; Umapada Pal¹

¹ *Institute of Physics, Autonomous University of Puebla, Av. San Claudio y Blvd. 18 sur, Col. San Manuel, Puebla 72570, Mexico.*

Autor responsable de la comunicación: lyauri@ifuap.buap.mx

The rapid advancement of science and technology, particularly in developing electronic and communication devices operating in the microwave frequency range, has intensified issues related to electromagnetic interference, leading to adverse effects on both human health and the environment. Therefore, developing novel materials capable of absorbing unwanted electromagnetic waves by converting them into heat or other forms of energy is crucial to minimizing their reflection and transmission. In this study, the synthesis of magnetite (Fe₃O₄) nanoparticles is reported using two different methods: the polyol method, which yielded particles ranging from 10 to 30 nm in size, and the hydrothermal method, which produced particles between 100 and 400 nm. The crystallographic phase, morphology, internal structure, and elemental composition were characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), and energy dispersive spectroscopy (EDS). The magnetic properties of the nanostructures were evaluated using a Physical Property Measurement System (PPMS). The results show that the Fe₃O₄ nanoparticles are uniformly coated with a thin carbon layer approximately 6–8 nm thick.

Keywords:

Microwave absorption, Fe₃O₄, Core-shell structures.

Reference:

Sharma, S., Parne, S. R., Panda, S. S. S., & Gandhi, S. (2024). Progress in microwave absorbing materials: A critical review. *Advances in Colloid and Interface Science*, 103143. <https://doi.org/10.1016/j.cis.2024.103143>

Ris work was supported by:

NATIONAL COUNCIL FOR HUMANITIES, SCIENCES AND TECHNOLOGY AND VIEP-BUAP FOR EXTENDING DOCTORAL FELLOWSHIP AND RESEARCH GRAND # 00262, RESPECTIVELY



IN-SITU PLD GROWTH OF Au-MEDIATED ZnO STRUCTURES: INFLUENCE OF SUBSTRATE TEMPERATURE AND AMBIENT PRESSURE

Autores: Mónica Martínez¹; Rosalba Castañeda Guzmán¹

Coautores: Citlali Sánchez Aké¹; Francisco Javier Altamirano García¹

¹ *Micro and nanotechnologies, Instituto de Ciencias Aplicadas y Tecnología*

Autor responsable de la comunicación: mony.estephany@gmail.com

ZnO micro and nano structures display a wide range of morphologies, and tailoring them for specific applications requires a clear understanding of how synthesis parameters affect their formation. Pulsed Laser Deposition (PLD) has demonstrated effectiveness in synthesizing a wide variety of ZnO micro and nano structures on some substrates. In this study, we investigate the formation of ZnO micro and nano structures using an in-situ PLD technique that incorporates gold nanoparticles during the deposition process, without breaking the vacuum. This configuration enables us to investigate how gold-mediated growth affects ZnO morphology. Specifically, we examine the impact of varying substrate temperatures (400–800 °C) and ambient pressures (250–450 mTorr) on the aspect ratio and morphology of the resulting ZnO structures. The synthesized materials were characterized using Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), and UV-Vis spectroscopy. SEM analysis revealed a clear dependence of ZnO morphology on growth conditions: pyramid-like and porous structures were observed as the substrate temperature increased. Additionally, variations in ambient pressure during deposition led to notable changes in the aspect ratio of the microstructures. These results provide insight into the controlled fabrication of ZnO microstructures through in-situ PLD, with potential applications in photocatalysis and optoelectronic devices.

Keywords:

ZnO, Gold nanoparticles, PLD.

Reference:

R. S. Rai and V. Bajpai, Recent advances in ZnO nanostructures and their future perspective, *Advances in nano research*. 11(2021) 37-54. <http://doi.org/10.12989/anr.2021.11.1.037>.

Ris work was supported by:

The PAPIIT INI08024 project and by CONAHCYT for the economic doctorate scholarship.



NANOSTRUCTURES / 144

LiNCM AEROGEL OBTAINED BY SOL-GEL

Autor: María del Rosario González García¹

Coautores: Alan Daniel Alcantar Mendoza ¹; Antonieta García Murillo ²; Felipe de Jesús Carrillo Romo ¹

¹ *Instituto Politécnico Nacional-Centro de Investigación e Innovación Tecnológica*

Autor responsable de la comunicación: rosgg79@outlook.com

LiNCM is a material that has been gaining popularity due to its application as a cathode in lithium-ion batteries, thanks to its favorable electrochemical properties and the potential to reduce cobalt content. It is composed of lithium, nickel, cobalt, and manganese, and has commonly been used in the form of ceramic powder due to its physical characteristics. However, the search for novel materials with innovative properties presents an opportunity to enhance the electrochemical performance of lithium-ion batteries. In this study, a LiNCM aerogel was synthesized using the sol-gel process, assisted by epoxide and supercritical CO₂ drying. Various characterizations were performed to investigate its structural, chemical, morphological, and elemental properties, using techniques such as X-ray diffraction (XRD), Fourier-transform infrared (FTIR) spectroscopy, scanning electron microscopy (SEM), and energy-dispersive spectroscopy (EDS). Selected area electron diffraction (SAED) was also carried out to determine the interplanar spacing. XRD patterns corresponding to LiNCM were identified, although they exhibited a mixture of phases. M-O bonds were observed in the IR spectra at 625 and 530 cm⁻¹, along with C-O bonds attributed to the amorphous aerogel structure. SEM micrographs of aerogels without thermal treatment revealed particles of varying sizes and irregular shapes, primarily consisting of interconnected large and small particles. In contrast, thermal treatment resulted in particles with hexagonal geometric patterns. EDS analysis provided the weight and atomic percentages of elements in the aerogel, including cobalt, nickel, and manganese. TEM images also revealed hexagonal particles, consistent with the morphology observed in SEM. Furthermore, the measured interplanar spacings were used to index the XRD patterns. With the characterization of the aerogel both before and after thermal treatment, this material shows strong potential as a candidate for various research applications, particularly in energy storage devices such as lithium-ion battery cathodes.

Keywords:

aerogel, metals, supercritical-drying, lithium-ion.

Reference:

L. de Biasi, B. Schwarz, T. Brezesinski, P. Hartmann, "Chemical, Structural, and Electronic Aspects of Formation and Degradation Behavior on Different Length Scales of Ni-Rich NCM and Li-Rich HE-NCM Cathode Materials in Li-Ion Batteries," *Advanced Materials*, (2019) 31-26. doi: 10.1002/adma.201900985.

Ris work was supported by:

By SECIHTI for the financial support for the doctorate. By the support laboratories in materials characterization CNMN-IPN and CREA CIITEC.



INACTIVATION OF HEAT-RESISTANT PSEUDOMONAS AERUGINOSA VIA MAGNETIC HYPERTHERMIA

Autor: Flavio Cesar Franyutti Villegas¹

Coautores: Jorge Antonio Salinas Hernández²; René Pablo Manzano Villanueva²; María Guadalupe López Merino³; Miguel Ángel Méndez Rojas³; Ulises Salazar Kuri¹

¹ Instituto de Física “Ing. Luis Rivera Terrazas”, Benemérita Universidad Autónoma de Puebla

² Facultad de Biología, Benemérita Universidad Autónoma de Puebla

³ Departamento de Ciencias Químico-Biológicas, Universidad de las Américas

Autor responsable de la comunicación: flaviofv@ifuap.buap.mx

Heat-resistant *Pseudomonas aeruginosa* poses significant challenges in antimicrobial treatments due to its inherent thermotolerance, prompting exploration of advanced techniques like magnetic hyperthermia (MH) for effective inactivation. This study aimed to evaluate the antibacterial efficacy of two nanoparticle systems: bare Zn-doped magnetite (ZnFe_2O_4) and core-shell $\text{ZnFe}_2\text{O}_4@\text{MEO}_2\text{MA-Ag}$ nanocomposites (thermo-responsive polymer with embedded silver nanoparticles)—against this resilient pathogen. Bacteria were cultured in *Pseudomonas*-specific King A and King B media to induce characteristic pigments (pyocyanin/fluorescein), then exposed to MH for 6 minutes using a Nanotherics Magnetherm system (160 Oe, 166 kHz AMF); bacterial inhibition was quantified via UV-Vis spectroscopy by correlating pigment depletion with metabolic inactivation. Results demonstrated that bare ZnFe_2O_4 nanoparticles achieved >90% inhibition, validating the critical role of magnetic core-mediated hyperthermia through Néel/Brownian relaxation heating. The core-shell $\text{ZnFe}_2\text{O}_4@\text{MEO}_2\text{MA-Ag}$ system exhibited superior efficacy (>99% inhibition), attributed to synergistic mechanisms: AMF-induced heating activated the thermo-responsive MEO_2MA polymer, triggering release of embedded silver nanoparticles that combined thermal ablation with Ag^+ biocidal action. UV-Vis data confirmed near-total pigment elimination in the composite system, underscoring enhanced metabolic disruption. These findings conclude that while bare nanoparticles are effective, the complete $\text{ZnFe}_2\text{O}_4@\text{MEO}_2\text{MA-Ag}$ nanocomposite delivers superior antibacterial action, leveraging dual thermal-chemical pathways to overcome thermotolerance and achieve rapid, near-complete inactivation of resilient *P. aeruginosa* under short-duration AMF exposure.

Keywords:

Magnetic Hyperthermia, Nanoparticles, Antimicrobial effect, *Pseudomonas*, Nanocomposite, Heat-resistant bacteria

Reference:

Wehbe, Mohamad, et al. “Synergistic Dual Antibacterial Activity of Magnetite Hydrogels Doped with Silver.” *Langmuir* 40.43 (2024): 22865-22874.

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación



PHOTOCATALYTIC DEGRADATION OF RHODAMINE B USING HETEROJUNCTIONS WITH MoS_2 , WS_2 AND $\text{Na}_2\text{Ti}_6\text{O}_{13}$ UNDER UV-VISIBLE LIGHT IRRADIATION

Autores: Gisela Karely Pérez Nájera¹; Diana Sofia Michell Flores Saldaña²; Hugo Ricardo Navarro Contreras³; Mildred Quintana Ruiz⁴; Edgar Giovanni Villabona Leal⁵; Aida Catalina Hernández Arteaga⁶; Hiram Joazet Ojeda Galván⁶

¹ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí, Avenida Parque Chapultepec 1570, Privadas del Pedregal, 78295 San Luis Potosí, S.L.P., México

² Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología, Universidad Autónoma de San Luis Potosí, Avenida Sierra Leona 550, Lomas de San Luis, 78210 San Luis Potosí, S.L.P., México.

³ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología, Universidad Autónoma de San Luis Potosí, Avenida Sierra Leona 550, Lomas de San Luis, 78210 San Luis Potosí, S.L.P., México.

⁴ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí

⁵ Coordinación para la Aplicación de la Ciencia y la Tecnología, Universidad Autónoma de San Luis Potosí, Avenida Sierra Leona 550, Lomas de San Luis, 78210 San Luis Potosí, S.L.P., México.

⁶ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí, Avenida Parque Chapultepec 1570, Privadas del Pedregal, 78295 San Luis Potosí, S.L.P., México.

Autor responsable de la comunicación: giselaperez070502@gmail.com

Photocatalysis is defined as the acceleration of a photochemical reaction by the action of a catalyst. Heterogeneous photocatalysis offers excellent advantages, being the relatively simple recovery and reuse of the catalyst one of the most promising. For this reason, it is one of the most studied and used processes in the treatment of water contaminated with organic compounds such as dyes [1], including Rhodamine B. In this work, we synthesized MoS_2 , WS_2 and $\text{Na}_2\text{Ti}_6\text{O}_{13}$ nanomaterials to form $\text{MoS}_2@ \text{Na}_2\text{Ti}_6\text{O}_{13}$, $\text{WS}_2@ \text{Na}_2\text{Ti}_6\text{O}_{13}$, $\text{MoS}_2@ \text{WS}_2$ and $(\text{MoS}_2\text{-WS}_2\ 1:1)@ \text{Na}_2\text{Ti}_6\text{O}_{13}$ hetero-junctions through a hydrothermal synthesis route. Their use as photocatalysts in the degradation process of Rhodamine B by heterogeneous photocatalysis was evaluated using ultraviolet-visible energy as a stimulation source, presenting different responses compared to the use of pristine materials. Different characterization techniques were used to confirm the formation, morphology, optical properties and vibrational modes of the heterojunction by X-ray diffraction, Transmission Electron Microscopy, Diffuse Reflectance Spectroscopy and Raman Spectroscopy.

Keywords:

Photocatalysis, Heterojunctions, Degradation

Reference:

Rodríguez Peña Mayra y Barrera Díaz Carlos Eduardo, Procesos de oxidación avanzada en el tratamiento del agua, Universidad Autónoma del Estado de México, Estado de México (2020)

Ris work was supported by:

Coordinación para la Aplicación de la Ciencia y la Tecnología and Centro de Investigación en Ciencias de la Salud y Biomedicina



NICKEL-BASED MOFS FOR THE DEVELOPMENT OF SENSORS FOR THE DETECTION OF VOLATILE ORGANIC COMPOUNDS

Autor: Manuel Pérez Villegas¹

Coautores: Enrique Rosendo Andrés ¹; José Manuel Bravo Arredondo ¹; María Josefina Robles Águila ¹

¹ Posgrado en Dispositivos Semiconductores, Benemérita Universidad Autónoma de Puebla, Av. San Claudio y 14 Sur, Edif. IC 5, Col. San Manuel, C.P. 72520, Puebla, México. Tel.:222295500.

Autor responsable de la comunicación: pv224570098@alm.buap.mx

Air pollution caused by volatile organic compounds (VOCs) such as acetone, methanol, and toluene, along with gases like SO₂, NH₃, CO, and CO₂, poses a serious threat to human health and ecological balance. Industrial and natural pollutants are highly volatile, accumulating in the environment easily, and causing chronic diseases such as cancer and organ damage. This problem requires the development of reliable, fast, and cost-effective detection technologies, which is essential. A nickel metal-organic framework (Ni-MOF) with the organic ligands terephthalic acid (BDC) and amino terephthalic acid (NH₂BDC) was proposed and evaluated in this study, taking advantage of their structural, optical, and adsorption properties. The Ni-MOFs were synthesized using the sonochemical method, which has advantages including short reaction time, green conditions, and morphology control at low cost. X-ray diffraction (XRD), diffuse reflectance spectroscopy (DRS), attenuated total reflectance infrared spectroscopy (ATR-IR), and Raman spectroscopy were used to characterize the obtained Ni-MOFs and validate the formation of the highly pure materials. SEM was then used to evaluate morphology. Ni-MOFs were deposited as films on glass substrates using the Dr. Blade technique, and initial tests against specific VOCs were conducted. The sensitivity, selectivity, response time, and reproducibility of the sensors are being evaluated, and due to the functionalization of the ligands and porous framework structure, integration of Ni-MOFs into VOC sensing platforms is expected to improve detection capabilities. The developed sensors are expected to show superior performance thanks to the high surface area, porosity, and optoelectronic properties of MOFs. This approach contributes to the advancement of environmental detection technologies and promotes sustainable solutions to the challenges of air pollution.

Keywords:

MOFs, gas sensor, VOCs, sonochemistry, air pollution

Reference:

H. Sohrabi et al., "Metal-organic frameworks (MOF)-based sensors for detection of toxic gases: A review of current status and future prospects," Mater. Chem. Phys., vol. 299, p. 127512, Apr. 2023, doi: 10.1016/J.MATCHEMPHYS.2023.127512.

Ris work was supported by:

Posgrado en Dispositivos Semiconductores, Benemérita Universidad Autónoma de Puebla, Av. San Claudio y 14 Sur, Edif. IC 5, Col. San Manuel, C.P. 72520, Puebla, México. Tel.:222295500. Secretaría de Ciencia, Humanidades, Tecnología e Innovación (CVU 818732)



NANOSTRUCTURES / 232

SUSTAINABLE SYNTHESIS OF LUMINESCENT NANOGRAFITE BY COFFEE PULP CARBONIZATION

Autor: Diana Laura Díaz Santiago¹

Coautores: Oscar G. Rojas Valencia ²; José Luis Casas Espínola ¹; Miriam Estrada Flores ²; Carmen M. Reza San German ²

¹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional. Av. Instituto Politécnico Nacional No. 2580, Col Barrio la Laguna Ticomán, Gustavo A. Madero, CDMX, México.*

² *Escuela Superior de Ingeniería Química e Industrias Extractivas, Instituto Politécnico Nacional. Av. Luis Enrique Erro S/N, Unidad Profesional Adolfo López Mateos, Zacatenco, Gustavo A. Madero, CDMX, México.*

Autor responsable de la comunicación: ddiazs1700@alumno.ipn.mx

The mismanagement of agro-industrial waste, particularly coffee pulp, poses a significant environmental risk due to its high organic content. In response, this study proposes an eco-friendly synthesis method for producing luminescent nanographite using coffee pulp as a carbon-rich source. The synthesis was carried out by muffie-assisted carbonization in air atmosphere, without the use of toxic reagents, catalysts, or oxidizing agents, and employing only water as a dispersing medium.

Four samples were obtained under different temperature and time conditions. The resulting nanoparticles were characterized by Ultraviolet-Visible (UV-Vis), Photoluminescence (PL), and Fourier-Transform Infrared (FT-IR) spectroscopy. Optical characterization showed emission peaks around 440 nm under 325 nm excitation, with a red-shift relative to the absorption band at 271 nm. FT-IR spectra confirmed the presence of esters, carboxylates, and aromatic groups, which are associated with the luminescent behavior of the nanoparticles and their surface composition.

The results indicate that synthesis conditions have a high influence on the optical properties of nanographite. Compared to conventional methods using fruit peels or plant waste, this approach stands out for its simplicity, lower environmental impact, and elimination of chemical additives. This work demonstrates the potential of coffee pulp as a sustainable carbon source for the production of functional nanomaterials with applications in photocatalysis and pollutants detection, while promoting green chemistry and circular economy principles.

Keywords:

Luminescence, carbon nanoparticles, coffee waste

Reference:

S. Thakur, A. Bains, K. Sridhar, R. Kaushik, P. Chawla, and M. Sharma, Valorization of food industrial waste: Green synthesis of carbon quantum dots and novel applications, *Chemosphere*, 347(2024). <https://doi.org/10.1016/j.chemosphere.2023.140656>

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECIHTI)



GRAPHENE OXIDE QUANTUM DOTS: SYNTHESIS AND EVALUATION OF THEIR ANTIBACTERIAL ACTIVITY AGAINST PSEUDOMONAS AERUGINOSA

Autor: Jesús Tadeo Pérez Cardona¹

Coautores: Orlando Zaca Moran¹; Fernando Díaz Monge²; Valentín López Gayou¹; Plácido Zaca Moran³; Celia Lizeth Gómez Muñoz³; Alejandro Rodríguez Juárez²

¹ Departamento de Nanobioteología y Biosensores, Centro de Investigación en Biotecnología Aplicada, Instituto Politécnico Nacional

² Tecnológico Nacional de México, Instituto Tecnológico Superior de Tlaxco

³ Instituto de Ciencias, Benemérita Universidad Autónoma de Puebla

Autores responsables de la comunicación: ozacam@ipn.mx, jperezc2300@alumno.ipn.mx

The development of nanostructured materials with biotechnological and biomedical applications is of great relevance today. Graphene oxide quantum dots (**GOQDs**) are zero-dimensional carbon-based nanomaterials that, due to their size ranging from 1 to 10 nm, exhibit unique properties such as quantum confinement, high fluorescence, photobleaching resistance, and low toxicity, among others, making them ideal candidates for biotechnological and biomedical applications (Carrillo et al., 2025). This work describes the green synthesis of GOQDs from orange peel and their evaluation as antibacterial agents in conjugation with acetylsalicylic acid (ASA). X-ray diffraction (XRD) analysis confirmed the presence of the (2 0 0), (1 0 0), and (1 1 0) planes, while Raman spectroscopy showed the D and G bands, confirming the presence of graphite oxide. The UV-Vis spectrum revealed $\pi \rightarrow \pi$ and $n \rightarrow \pi$ electronic transitions, and FTIR spectroscopy displayed bands corresponding to C=C, C-OH, C-O, and C-H bonds, indicating the presence of functional groups on the GOQDs' surface. Fluorescence spectroscopy showed an emission at 436 nm, corresponding to an emission energy of 3.87 eV. TEM micrographs revealed particles of approximately 3 nm with an interplanar spacing of 2.45 Å. The GOQDs-ASA conjugate was evaluated through minimum inhibitory concentration (MIC) assays against *Pseudomonas aeruginosa*, obtaining a value of 37.5 µg/mL, which demonstrates significant antibacterial activity. These results suggest that the GOQDs-ASA conjugate may be used as an alternative antimicrobial treatment or as a drug delivery system for biomedical applications.

Keywords:

GOQDs, Antibacterial Activity, ASA, *Pseudomonas aeruginosa*, MIC.

Reference:

Carrillo, F. S., Díaz, A. O. & Moran, O. Z. (2025). Study of properties of graphene oxide nanoparticles obtained by laser ablation from banana, mango, and tangerine peels. Nano Trends, 9. <https://doi.org/10.1016/j.nwnano.2025.10009>

Ris work was supported by:

Instituto Politecnico Nacional por el proyector SIP 20250124 y al SECIHTI (antes CONAHCYT) Proyecto CF-2023-G-1080.



CHEAP SEPARATION PROCESS FOR BIOCHAR-DERIVED CARBON QUANTUM DOTS

Autor: Jose Luis Luna Sánchez

Coautores: Genaro López Gamboa ; Jose Luis Jiménez Pérez ; Rubén Gutiérrez Fuentes ; Usiel Omar García Vidal ; Verónica Hernández Rosas ; Zormy Nacary Correa Pacheco

Autor responsable de la comunicación: jluislunas@gmail.com

Biochar derived Carbon Quantum Dots (BCQDs) are being investigated intensively due to their semi-conducting properties, and the expected applications that are implied (Lo Bello et al., 2022). Multiple biomass sources have been used but all of them find the purification of such nanomaterials as a barrier that must be overpassed or avoided. In this research, a differential centrifugation process, based on centrifugation speed and solvent selection is proposed as a cheap method to separate y purify BCQDs. Banana peel flour was used as a biomass source to synthesize BCQDs with a conventional microwave. The optical UV-Vis spectroscopy (UV-vis), thermal lens (TL), and structural transmission electron microscopy (TEM) and X-ray diffraction (XRD) properties were characterized. Preliminary essays showed that the synthesized CQDs' diameter was 3.9 ± 0.9 nm on average. The UV-vis absorption spectra present absorption bands ranging from 290 to 298 nm. The XRD analysis powders present an amorphous structure with broad bands centered in $2\theta = 24.5^\circ$ assigned to [002] and in $2\theta = 44.5^\circ$ assigned to [101] reflection plane of graphite. The implications found in the separation process and how the thermal diffusivity of BCQDs dispersion varies versus the centrifugation speed is shown.

Keywords:

Semiconductor CQDs, Diffusivity, Biochar, Thermal Lens.

Reference:

G. Lo Bello, M. Bartoli, M. Giorcelli, M. Rovere, and A. Tagliaferro, A Review on the Use of Biochar Derived Carbon Quantum Dots Production for Sensing Applications. Chemosensors 10 (2022) 117. <https://doi.org/10.3390/chemosensors10030117>.

Ris work was supported by:

SIP project 20250885.



OPTIMIZING EXPERIMENTAL CONDITIONS FOR ENHANCED SULFURIZATION OF ZNO NANOWIRES AND ZNO-ZNS CORE-SHELL FORMATION

Autores: Patricia Patricia Gutierrez Zayas Bazán¹; Karla Gutierrez Zayas Bazán²; Guillermo Santana¹; Ateet Dutt¹; Gerardo Contreras-Puente³; OSVALDO de Melo PEREIRA³

¹ Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México, Materiales de Baja dimensionalidad, México

² Unidad Profesional Interdisciplinaria de Energía y Movilidad (UPIEM) IPN, Formación Profesional, Instituto Politécnico Nacional

³ Escuela Superior de Física y Matemáticas, Escuela Superior de Ingeniería Mecánica y Eléctrica, Instituto Politécnico Nacional

Autor responsable de la comunicación: odemelo@gmail.com

ZnO nanostructures are among the most promising materials for biosensors and gas sensing applications due to their high surface area, which facilitates rapid electron transport, enhances sensor response time and sensitivity, and provides excellent chemical stability and tunable electrical properties. The formation of a ZnS film coating the nanowires—creating a core-shell structure—could modify their optoelectronic properties and introduce additional active sites for gas and antibody adsorption, thereby improving sensitivity and selectivity. In this study, we report the successful synthesis of one-dimensional ZnO nanostructures via the Vapor-Liquid-Solid (VLS) mechanism, followed by sulfur incorporation at oxygen sites through vapor-phase treatments. Initially, three different vapor-phase configurations were explored using H₂ as a reducing carrier gas, along with sulfur or ZnS precursors, at a temperature of 800 °C. SEM analysis revealed morphological changes in the nanowires. For two of the configurations, a complete transformation from ZnO to ZnS was observed, as confirmed by Energy Dispersive Spectroscopy (EDS) and X-ray Diffraction (XRD) analysis. Photoluminescence (PL) measurements of these samples showed a shift in the defect peak toward lower energies, suggesting the presence of new defects associated with sulfur incorporation. The three experimental configurations were repeated at a lower reactor temperature (~600 °C) to slow down the ZnO reduction process and minimize nanowire sublimation. This adjustment is expected to promote sulfur incorporation on the nanostructure surfaces, facilitating core-shell formation.

Keywords:

Nanowires, core-shell, ZnO, sulfurization

Reference:

Ming-Yen Lu, Jinhui Song, Ming-Pei Lu, Chung-Yang Lee, Lih-Juann Chen, Zhong Lin Wang, ACS Nano 2009, 3, 2, 357–362, <https://doi.org/10.1021/nn800804r>

Ris work was supported by:

PGZB thankfully acknowledges SECIHTI post-doctorate funding (CVU: 787342). This work was partially supported by IPN projects 20250142, 20250087 and the PAPIIT A100123, IG100123 and IN100125 projects



SYNTHESIS AND CHARACTERIZATION OF Fe_2O_3 NANOSTRUCTURE VIA PULSED LASER ABLATION IN LIQUID

Autor: Hugo Ernesto Acevedo Juárez¹

Coautores: Armando Pérez-Centeno²; Elder Alejandro Meza Ramírez³; Javier Daniel Acosta Mendoza⁴; José Guadalupe Quiñones Galván⁵; Monica Sareli Barajas Alvarez¹

¹ Departamento de Matemáticas y Física, Instituto Tecnológico y de Estudios Superiores de Occidente

² Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara

³ Departamento de Física, Universidad de Guadalajara

⁴ Instituto Tecnológico y de Estudios Superiores de Occidente

⁵ Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara

Autor responsable de la comunicación: hugo.acevedo@iteso.mx

Iron oxide nanoparticles (IONP) exhibit unique magnetic properties that have attracted interest in various fields. In medicine, for instance, they are used as contrast agents in tomography analysis for cancer diagnosis [1]. In this study, IONPs were synthesized using laser ablation in liquid (LAL) method, varying the laser energy and the solvent medium. The nanoparticles were characterized using X-ray diffraction (XRD), Atomic Force Microscope (AFM), Raman spectroscopy, Ultraviolet- visible spectroscopy (UV-vis), Transmission Electron Microscope (TEM), and X-ray Photoelectron Spectroscopy (XPS). The result from multiple experiments shows that when a laser energy with 450 mJ is applied over a target immersed in water, the synthesized nanoparticle exhibits two crystalline phases corresponding to hematite and maghemite, with a size ranging from 3 to 9 nm and a band gap of 2.6 eV, indicating semiconductor behavior. Additionally, a toxicity test using brine shrimp showed that the IONPs exhibited low toxicity after one hour of exposure.

Keywords:

Iron Oxide Nanoparticles, Maghemite, Hematite, Laser, Magnetic Properties, Materials

Reference:

[1] F. G. CSIC, «Nanopartículas como agentes de contraste positivo en imagen por resonancia magnética», [En línea]. Available: <https://www.csic.es/es/innovaci%C3%B3n-y-transferencia/oferta-tecnol%C3%B3gica/salud-diagnostico-imagen/nanoparticulos-como-agentes-de-contraste-positivo-en-imagen-por-resonancia-magnetica#:~:te>

Ris work was supported by:

ITESO & UDG



SYNTHESIS AND CHARACTERIZATION OF Y ZEOLITE EXCHANGED WITH Ni^{2+} AND REDUCED Ni^0 BY DRS, XRF AND TGA

Autores: Andrés Josué Reyes Solís¹; Victor Manuel Soto García¹

¹ *Laboratorio de Estado Sólido, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara, Blvd. M. García Barragán #1451, C.P. 44430, Guadalajara, Jalisco, México*

Autor responsable de la comunicación: andres.reyes0203@alumnos.udg.mx

Zeolite Y belongs to a very broad group of zeolites whose main characteristic is their high thermal and structural stability. As in all zeolites, this one has ionic exchange zones that can be occupied by metal cations, thus stabilizing the total charge of the system. It has been reported that the exchange zone, as well as the size of the metal ion, can affect some physical properties of the zeolite, such as its optical properties. In this work, the relationship between exchange time and the Si/Al ratios of the zeolite and its absorption bands was investigated. For this purpose, a HY zeolite with Si/Al ratios of 15 and 40 were used. These zeolites were ion-exchanged in $\text{Ni}(\text{NO}_3)_2$ solutions to obtain NiY zeolites. The exchange times were 1, 5, 15 and 30 days. Subsequently, these zeolites were reduced by hydrogen gas for the growth of nickel nanoparticles at 100, 200 and 300 °C. The characterizations resulted in the appearance of 3 absorption bands around 391, 640 and 740 nm in the exchanged zeolites and a greater thermal stability of the zeolite from 200 °C for Si/Al ratios = 40 according to TGA and DRS. From these results it was obtained that for the NiY zeolite (Si/Al = 40) the exchanged Ni^{2+} originally present octahedral coordination and after the heat treatment they are mobilized for the formation of Ni^0 evidenced by an increase in the absorption band around 202 nm.

Keywords:

nanoparticles, nickel, zeolite, exchange, drs

Reference:

Mekki, A., Mokhtar, A., Hachemaoui, M., Beldjilali, M., Meliani, M. fethia, Zahmani, H. H., Hacini, S., & Boukoussa, B. Fe and Ni nanoparticles-loaded zeolites as effective catalysts for catalytic reduction of organic pollutants. *Microporous and Mesoporous Materials*, 310 (2021), 110597

Ris work was supported by:

Centro Universitario de Ciencias Exactas e Ingenierías - Universidad de Guadalajara, Guadalajara - Jalisco. Centro de Investigación Científica y de Educación Superior de Ensenada, Ensenada - Baja California. Secretaría de Ciencia, Humanidades, Tecnología e Innovación (Secihti)



DESIGN AND IMPLEMENTATION OF AN SPR OPTICAL SENSOR FOR THE DETECTION OF HEAVY METALS IN WATER

Autor: Dania Estefania Moreira Del Rio¹

Coautores: Augusto David Ariza Flores ²; Ireri Aydée Sustaita Torres ²; Jesús Madrigal Melchor ¹

¹ *Unidad Académica de Ciencia y Tecnología de la Luz y la Materia, Universidad Autónoma de Zacatecas*

² *Unidad Académica de Ingeniería Eléctrica, Universidad Autónoma de Zacatecas*

Autor responsable de la comunicación: daniamoreira@hotmail.com

Water contamination by heavy metals such as mercury, lead, and arsenic, among others, represents a grave environmental and public health problem. These metals are toxic, persistent, and bioaccumulative, and they can cause adverse effects on human health even in minimal concentrations, affecting vital organs and biological systems. In light of this challenge, the development of rapid, sensitive, and accessible detection technologies is imperative for environmental monitoring and the preservation of aquatic ecosystems. In this context, surface plasmon resonance (SPR) emerges as a promising optical technique for real-time detection of pollutants, thanks to its high sensitivity and markerless measurement capability [1]. The objective of this project is to develop a low-cost SPR optical sensor designed to detect heavy metals in contaminated waters. This sensor will be characterized by its high sensitivity, selectivity, and capacity for real-time measurements. The objective of this proposal is to encourage the advancement of monitoring technologies that are characterized by enhanced efficiency, accessibility, and applicability in real-world scenarios. The sensor was implemented in Kretschmann configuration with different components, and the response was measured for different refractive indices. The theoretical and experimental Attenuated Total Reflectance (ATR) spectra were calculated. Furthermore, to enhance the selectivity of the sensor, a deposition of carbon dots of green precursors was conducted for the specific detection of heavy metals.

Keywords:

surface plasmon resonance sensor, heavy metals, carbon dots

Reference:

M.G. Daher, M.M. Halim, N.M. Ahmed, S.A. Taya, M.M.A. Eid, B. Karki, An Optical Surface Plasmon Resonance Device (OSPRD) for the Accurate Detection of Injurious Heavy Metals, Plasmonics. (2025). <https://doi.org/10.1007/s11468-025-02839-2>

Ris work was supported by:

SECIHTI



COMPARATIVE STUDY OF the InAs QDs SELF-ASSEMBLY ON $\text{Al}_x\text{Ga}_{1-x}\text{As}$ AT DIFFERENT AL CONCENTRATION.

Autores: Guadalupe del Carmen Yepez Barradas¹; Victor Hugo Mendez Garcia²

Coautores: Leticia Ithsmel Espinosa Vega ³; Jaime Ruíz García ⁴; Jose Luis Cuellar Camacho ⁵; Irving Eduardo Cortes Mestizo ; Maria Fernanda Mora Herrera ⁶; Daniel López Vilchis ⁶; Alexis Fernández Fernández ¹; Jesús Samuel Sámano González ⁶; Ángel Iván Méndez García ³; David Vazquez Cortes ⁷

¹ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí

² Universidad Autonoma de San Luis Potosi

³ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí

⁴ Instituto de Física, Universidad Autónoma de San Luis Potosí

⁵ Universidad Autónoma de Zacatecas

⁶ Facultad de Ciencias, Universidad Autonoma de San Luis Potosi.

⁷ Mechanics and Materials Unit, Okinawa Institute of Science and Technology Graduate University (OIST)

Autor responsable de la comunicación: a335612@alumnos.uaslp.mx

In recent years, semiconductor quantum dots (QDs) have received significant attention due to their unique size-dependent electronic and optical properties, which make them promising candidates for applications in quantum photonics, quantum information processing and infrared optoelectronic devices. Among various materials, InAs QDs are particularly attractive for their strong quantum confinement and advantageous light emission/conversion. However, their optical and physical properties are highly sensitive to the growth environment and the composition of the underlying substrate. In this study, we report a comprehensive comparative analysis of InAs QDs grown by molecular beam epitaxy (MBE) on $\text{Al}_x\text{Ga}_{1-x}\text{As}$ buffer layers, where the aluminum concentration (x) was systematically varied from 0 to 1 in the ternary alloy. The primary objective is to compare how the increasing Al content affects their self-assembly morphological, and structural characteristics of the QDs. In situ reflection high energy electron diffraction (RHEED) analyses revealed that one of the primary and reproducible effects on self assembly of incorporating Al in the layer beneath the QDs is an increase in the diffusion parameter of InAs. Previous studies have linked the surface adatom diffusion length to the QD density. In general, when surface adatoms diffuse less, the QD density increases. However, in contrast to this common trend, we have observed a similar dependence during the self-assembly of QDs. Atomic force microscopy (AFM) images showed that the increasing density can be large enough to provoke the coalescence of QDs. Raman Spectroscopy (RS) was employed to assess changes in residual strain. These findings demonstrate that substrate composition plays a critical role in tailoring the physical and optical properties of InAs QDs, offering a viable route for optimizing their performance in next-generation optoelectronic and quantum devices.

Keywords:

Quantum Dots, Alluminum Alloy, Nanostructures

Ris work was supported by:

This work was supported by: The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, and financial support from COPOCyT Fideicomiso 23871, SECIHTI CF-2023-I-1300, and Investigadoras e Investigadores por México.



HIGH-CAPACITY OXAMYL PHOTODEGRADATION VIA SCHOTTKY-ENHANCED $\text{Fe}_3\text{O}_4/\text{Au}$ NANORODS: SYNTHESIS AND CATALYTIC PERFORMANCE

Autor: Javier Emiliano Benítez Zamudio¹

Coautores: Rutilo Silva González ¹; Ulises Salazar Kuri ¹; Umapada Pal ¹

¹ *Instituto de Física "Ing. Luis Rivera Terrazas", Benémerita Universidad Autónoma de Puebla, México*

Autor responsable de la comunicación: tichebenitez@gmail.com

Oxamyl, a highly toxic carbamate insecticide (WHO Class Ia neurotoxicant), poses significant environmental risks due to its high water solubility (280 g/L at 25°C), which facilitates groundwater contamination and bioaccumulation. Its acetylcholinesterase inhibition threatens non-target species, pollinators, and human health, even at trace levels. To address this, $\text{Fe}_3\text{O}_4/\text{Au}$ magnetometallic nanocomposites (MMNCs) are designed, combining the magnetic properties of Fe_3O_4 with the plasmonic activity of Au. This design enhances visible-light photoabsorption and creates Schottky heterocontacts at the $\text{Fe}_3\text{O}_4/\text{Au}$ interface, narrowing the effective bandgap that drives ROS ($\cdot\text{OH}$, $\text{O}_2^{\cdot-}$) generation. These radicals rapidly degrade oxamyl into harmless products (CO_2 , H_2O). The nanocomposite exhibits exceptional photocatalytic performance under sunlight, achieving over 95% degradation of 1000 ppm oxamyl in 10 minutes at 0.5 mg/mL. Its magnetic recyclability enables over 10 reuse cycles without loss of efficiency, thus surpassing conventional methods (e.g., TiO_2/UV , ozonation) that are energy-intensive or produce recalcitrant byproducts. The synthesis involves controlled evaporation of the Au precursor over oleylamine-functionalized Fe_3O_4 , enabling directed nanoparticle growth. Studies on the effects of Au concentration reveal optimized photocatalytic activity and luminescence quenching, highlighting its potential for sustainable pollutant remediation.

Keywords:

Oxamyl, Magnetic nanoparticles, Plasmon, Photodegradation, Schottky union.

Reference:

Tatsuma, T., Nishi, H., & Ishida, T. (2017). Plasmon-induced charge separation: chemistry and wide applications. *Chemical science*, 8(5), 3325-3337.

Ris work was supported by:

Financial support of the project A1-S-10011 SECIHTI



NANOSTRUCTURES / 466

FROM CONVENTIONAL TO HIGH-TEMPERATURE SUPERCONDUCTING NANOSTRUCTURED METAMATERIALS

Autor: Felipe Pérez Rodríguez¹

¹ *Institute of Physics 'Ing. Luis Rivera Terrazas'*

Autor responsable de la comunicación: fperez@ifuap.buap.mx

A general nonlocal homogenization theory for calculating effective electromagnetic and mechanical properties of nanostructured metamaterials based on conventional and/or high-temperature superconductors is revisited. The theory provides explicit expressions for the effective permittivity and permeability tensors, as well as for the effective mass-density and stiffness tensors even beyond the long wavelength limit. As a result, the effective metamaterial parameters depend on both the wave vector and frequency. In particular, it will be discussed how the linear dielectric response function of a superconducting nanostructure, treated as an effective medium, alters the electron pairing interaction and, consequently, the effective coupling constant and the critical temperature for the metamaterial. The calculated effective parameters for metal-superconductor and dielectric-superconductor nanostructures will be presented and analyzed. Specific designs for increasing the critical temperature of superconducting nanostructures are also proposed.

Keywords:

Nanostructure, metamaterial, superconductor

Reference:

Ris work was supported by:

VIEP-BUAP



EFFECT OF LIQUID MEDIUM AND LASER FLUENCE ON GOLD NANOPARTICLES SYNTHESIZED VIA PULSED LASER ABLATION IN LIQUIDS: A DESIGN OF EXPERIMENTS (DOE) APPROACH

Autor: Elder Alejandro Meza Ramírez¹

Coautores: Armando Pérez-Centeno ¹; José Guadalupe Quiñones Galván ¹

¹ *Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara, Blvd. Gral. Marcelino García Barragán 1421, Olímpica, 44430 Guadalajara, Jal, México.*

Autor responsable de la comunicación: elder.meza3439@alumnos.udg.mx

Gold nanoparticles (AuNPs) exhibit size-dependent optical properties that make them attractive for applications in sensing, catalysis, and biomedicine. Pulsed laser ablation in liquids (PLAL) is a surfactant-free synthesis technique that enables the production of colloidal AuNPs with high purity and tunable characteristics [1,2]. In this study, we employ a factorial design of experiments (DoE) to investigate the influence of two key factors liquid medium and laser fluence on the optical properties of AuNPs synthesized via PLAL. Eight experimental conditions were evaluated, varying the solvent (water and alcohol-based media) and fluence. UV-Vis spectroscopy was used as the primary characterization technique, revealing that alcohol-based media tend to yield broader or dual-peak plasmon resonance bands, suggesting increased size dispersion or particle aggregation effects [3,4]. Transmission electron microscopy (TEM) provided complementary insights into particle morphology and distribution. The design of experiments framework facilitates a systematic exploration of how synthesis parameters affect nanoparticle features. Preliminary trends are being analyzed to identify the most significant factors influencing the optical response. Further characterization with atomic force microscopy (AFM) is underway to correlate structural and optical observations. This approach aims to inform more reproducible and controlled AuNP synthesis via PLAL.

Keywords:

laser ablation, gold, nanoparticles, DOE, absorption

Reference:

Amendola, V., & Meneghetti, M. (2009), Sylvestre, J.-P., et al. (2004). , Link, S., & El-Sayed, M. A. (1999). , Zhang, D., et al. (2010).

Ris work was supported by:

Universidad de Guadalajara



OPTIMIZATION OF UV-ASSISTED GRAPHENE TRANSFER USING PARAFFIN AS SUPPORT LAYER

Autor: Fernando Anaya Simon¹

Coautores: Nayeli Colín Becerril²; Carlos Ernesto Ávila Crisóstomo²; Jessica Surisadai Rodríguez Aguilar²; Uriel Alcides Torices Saucedo²; Yenny Lucero Casallas Moreno²; Diego Giovanni González Vallejo¹

¹ *Escuela Superior de Ingeniería Mecánica y Eléctrica, Unidad Zacatenco, Instituto Politécnico Nacional. Av. Luis Enrique Erro, Adolfo López Mateos S/N, Zacatenco, Gustavo A. Madero, 07700, Ciudad de México, México.*

² *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzada, Instituto Politécnico Nacional. Av. Instituto Politécnico Nacional 2580, La Laguna Ticoman, Gustavo A. Madero, 07340 Ciudad de México, México.*

Autor responsable de la comunicación: fersimon26@gmail.com

Graphene holds remarkable potential for next-generation electronic and photonic applications, yet its transfer from growth substrates to target surfaces often degrades its quality due to structural defects and polymer residues. This study investigates the effectiveness of ultraviolet (UV) irradiation in improving the quality of graphene transferred to silicon (Si) substrates using polymethylmethacrylate (PMMA) and paraffin as polymer support layers. We optimized key parameters including the UV source distance and exposure time. Two experimental series were conducted using Raman spectroscopy and atomic force microscopy (AFM) to evaluate structural quality. Raman measurements showed four signal in all spectra: G signal at 1582 cm^{-1} , 2D signal at 2700 cm^{-1} , X signal at 1300 cm^{-1} and Y signal at 1450 cm^{-1} . Results indicate that increasing the distance between the UV source and the graphene surface improves the 2D/G Raman intensity ratio (I2D/IG), indicating fewer defects and monolayer characteristics. Notably, Series 2, which used paraffin as the support layer, showed the highest I2D/IG value (8.6) and the lowest FWHM2D (30.6 cm^{-1}), demonstrating superior quality over PMMA-based methods. Additionally, Raman spectra revealed lower intensity of defect-related signs for paraffin-transferred samples. AFM analysis confirmed reduced surface roughness (RMS = 1.73 nm) in UV-treated paraffin samples. These results support the use of UV-assisted paraffin as a cleaner and more effective alternative to PMMA, enabling high-quality graphene transfer with minimal contamination and processing times between 10–40 seconds. This work introduces an efficient and novel protocol for graphene integration in scientific and industrial applications.

Keywords:

Graphene, UV treatment, transfer process, paraffin support, Raman spectroscopy.

Reference:

Y. Ren, C. Zhu, W. Cai, H. Li, Y. Hao, Y. Wu, S. Chen, Q. Wu, R. D. Piner, and R. S. Ruoff, An improved method for transferring graphene grown by chemical vapor deposition, *Nano* 7 (2012) 01. <https://doi.org/10.1021/nl203177p>

Ris work was supported by:

The authors sincerely thank the IPN and SECIHTI for their financial support in this work. We particularly thank SIP 20253723, SIP 20254808, PRORED 20254785, and the Frontier Science projects SECIHTI CF-2023-I-1117 and SECIHTI CBF-2025-I-3719. would like to thank Norma González García, Edmundo Rodríguez, and Miguel Avendaño from the Solid-State Electronics Department at CINVESTAV-Zacatenco for their technical support.



BACTERIAL CELLULOSE WITH ANTIBACTERIAL PROPERTIES

Autores: Alma Cristina Arellano García¹; Josefina Aguila López; José Alfredo Pescador Rojas; José Francisco Sánchez Ramírez; Maribel Flores González

¹ *Estudiante de posgrado*

Autor responsable de la comunicación: aarellanog2401@alumno.ipn.mx

Bacterial cellulose is a linear homopolysaccharide composed of β -D-glucopyranose units that are held together by β -1,4-glycosidic bonds. The microorganisms synthesize a random nanofibrillar network of cellulose chains of 10 to 50 nm in diameter and 100 to 1000 nm in length, which generates a porous matrix. The arrangement of the fibers and -OH groups in the structure allows the incorporation of molecules that confer antimicrobial properties. This attribute enables the reduction of infection transmission in sanitary environments, wound treatment and improvement of performance in consumer products. This research reports the obtaining of bacterial cellulose from a consortium of bacteria and yeasts for 14 days at $28 \pm 2^\circ\text{C}$ and functionalized with the incorporation of silver nanoparticles synthesized by the in situ method in the membrane. The formation and properties of the bacterial cellulose membrane and silver nanoparticles were evaluated using electron microscopy (SEM) and infrared spectroscopy (FT-IR). The antimicrobial activity of cellulose was evaluated against *Staphylococcus epidermidis* through a qualitative test.

Keywords:

Bacterial cellulose, Silver nanoparticles, Antibacterial

Reference:

S. Pal, R. Nisi, M. Stoppa, and A. Licciulli, Silver-Functionalized Bacterial Cellulose as Antibacterial Membrane for Wound-Healing Applications, *ACS Omega*. 2 (2017) 3632-3639. <https://doi.org/10.1021/acsomega.7b00442>

Ris work was supported by:

Centro de Investigación en Biotecnología Aplicada CIBA-IPN



EFFECT OF ELECTRODEPOSITION PARAMETERS ON ZnO MORPHOLOGY

Autores: VICTOR HUGO CASTREJON SANCHEZ¹; ÁNDRES ACOSTA HERNÁNDEZ¹

Coautores: MA. DE LOS ÁNGELES ENRÍQUEZ PÉREZ ¹; NIDIA GARCÍA GONZÁLEZ ¹

¹ *TecNM/Tecnológico de Estudios Superiores de Jocotitlán*

Autor responsable de la comunicación: vic110579@hotmail.com

ZnO is a material that has been widely used and continues to hold great interest in the scientific community due to its general properties, which allow it to be manipulated for experimentation in a highly versatile manner. This versatility enables researchers to obtain new and diverse results that improve efficiency in its applications, making it an extremely useful material. One of the most important properties of ZnO is the ability to alter its morphology, as this makes it possible to obtain different microstructures [1].

In this work, ZnO was deposited onto copper substrates via an electrochemical cell using electrodes of metallic copper and zinc. Different currents, temperatures and times were used to determinate its effect on ZnO morphology. Several characterization were used to study morphology, present phases and crystalline lattices.

Keywords:

ZnO, electroposition, crystalline phases

Reference:

[1] M. E. F. Alessandro Di Mauroa, ZnO for application in photocatalysis: From thin films to nanostructures, Italia: Materials Science in Semiconductor Processing, 2017.

Ris work was supported by:

TecNM Convocatoria 2024: PROYECTOS DE INVESTIGACIÓN CIENTÍFICA, DESARROLLO TECNOLÓGICO E INNOVACIÓN



ONE-STEP SYNTHESIS OF MOS₂/TiO₂ USED FOR DEGRADATION OF METHYLENE BLUE

Autores: Efrén González-Aguiñaga¹; Ma. Concepción Arenas-Arrocena¹; Sarahí García-Carvajal¹; Victor Ruíz-Santoyo¹

¹ *Nanoestructuras y Biomateriales, Escuela Nacional de Estudios Superiores Unidad León, Universidad Nacional Autónoma de México, León, Guanajuato, México*

Autor responsable de la comunicación: ibiefren@gmail.com

One of the most important challenges today is ensuring access to clean and safe water. However, in recent years, the quality of this resource has been seriously affected by various human activities, mainly industry, agriculture and the public sector. Among the pollutants are organic dyes, widely used in the textile industry. The waste generated by this industry is often disposed of without proper treatment, which directly affects water quality. Various methodologies have been developed to remove these contaminants, heterogeneous photocatalysis has proven to be an effective technique. It uses a semiconductor that is active by a light source to degrade contaminants in aqueous medium. One of the most widely used materials is titanium oxide (TiO₂), due to its high chemical stability, low cost, non-toxicity and excellent optical properties. However, due to its band gap (3.2 eV), its practical use is limited, as it can only be activated by ultraviolet (UV) radiation, which represents less than 5% of the solar spectrum. To overcome this limitation, various techniques for structural and electronic modification of TiO₂ have been proposed, such as doping with metals and non-metals, formation of semiconductor heterostructures, and incorporation of noble metal nanoparticles. In this research study, TiO₂ nanocomposites surface-modified with MoS₂ were synthesized using different synthesis routes, with the aim of using them in the removal of organic dyes, specifically methylene blue. The nanocomposites were synthesized using hydrothermal, precipitation, and chemical impregnation methods. They were then characterized using powder UV-Vis spectroscopy, X-ray diffraction (XRD), and scanning electron microscopy (SEM). Finally, their efficiency in degrading methylene blue was evaluated.

Keywords:

Methylene blue, nanocomposites, metal sulfides, photodegradation, waste water

Reference:

S. García-Carvajal et al., "In Situ Synthesis and Characterization of Conductive Hybrid Composites Using Functionalized 3D Molybdenum Disulfide Nanoflowers," *J Electron Mater*, vol. 53, no. 8, pp. 4584– 4600, Aug. 2024, doi: 10.1007/s11664-024-11085-x.

Ris work was supported by:

This work was supported by UNAM Posdoctoral Program (POSDOC) and PAPIIT-DGAPA IN114124



EFFECT OF BEP VARIATION ON THE STRUCTURAL PROPERTIES OF InAs NANOWIRES GROWN BY MBE ON GRAPHENE/Si

Autores: Jessica Surisadai Rodríguez Aguilar¹; Nayeli Colin Becerril²; Mario Alberto Zambrano Serrano³; Uriel Alcides Torices Saucedo¹; Miguel Ángel González Morales²; José Angel Guillen-Cervantes³; Máximo López López³; José Luis Herrera Pérez⁴; Yenny Lucero Casallas Moreno⁵

¹ *Maestría en Tecnología Avanzada, Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Av Instituto Politécnico Nacional 2580, La Laguna Ticoman, Gustavo A. Madero, 07340 Ciudad de México, México.*

² *Programa de Doctorado en Tecnología Avanzada, Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Av Instituto Politécnico Nacional 2580, La Laguna Ticoman, Gustavo A. Madero, 07340 Ciudad de México, México.*

³ *Departamento de Física, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Av Instituto Politécnico Nacional 2508, San Pedro Zacatenco, Gustavo A. Madero, 07360 Ciudad de México, México*

⁴ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Av Instituto Politécnico Nacional 2580, La Laguna Ticoman, Gustavo A. Madero, 07340 Ciudad de México, México.*

⁵ *Secretaría de Ciencia, Humanidades, Tecnología e Innovación- Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Av Instituto Politécnico Nacional 2580, La Laguna Ticoman, Gustavo A. Madero, 07340 Ciudad de México, México.*

Autor responsable de la comunicación: jrodrigueza1701@alumno.ipn.mx

Controlling the growth of semiconductor nanowires is essential for their integration into optoelectronic devices. We grew InAs nanowires by molecular beam epitaxy (MBE), in order to study the influence of the beam equivalent pressure (BEP) of indium and arsenic on the dimensions of the resulting nanostructures. Scanning electron microscopy (SEM) allowed us to analyze the morphology, density, diameter, and length of the nanowires, revealing a clear dependence of both conditions, BEP_{In} and BEP_{As} on the growth conditions. Additionally, nanowires were grown on silicon substrates both with and without a graphene interlayer to investigate its effect on nanowire growth. We analyzed the crystalline structure, morphology and density of the nanowires under both conditions, showing that the presence of graphene influences the density, vertical alignment and spatial distribution of the nanowires. These observations suggest that graphene is useful for achieving controlled nanowire growth. To complement the structural characterization, micro-Raman spectroscopy measurements were carried out. We identified the transverse optical (TO) mode at 213 cm⁻¹ and the longitudinal optical (LO) mode at 236 cm⁻¹. The surface optical (SO) mode was also observed, which is of particular interest due to its direct relationship with the nanowire diameter. Based on the experimental SO mode and its theoretical dependence on diameter, dimensional estimations were made that showed good agreement with SEM measurements. These results help to understand the effect of growth parameters on the structural properties of InAs nanowires and support the design of semiconductor nanostructures for future device applications.

Keywords:

InAs nanowires, semiconductors, MBE, SO phonon mode

Ris work was supported by:

The authors sincerely thank the IPN and SECIHTI for their financial support in this work. We particularly thank SIP 20253723, SIP 20254808, PRORED 20254785, and the Frontier Science projects SECIHTI CF-2023-I-1117 and SECIHTI CBF-2025-I-3719. Thanks to Miguel Angel Avendano-Ibarra and Carlos Ernesto Ávila Crisóstomo for the Raman measurements.



Ga-Au AND Ga-In EUTECTIC ALLOYS ON Si AS CATALYTIC PRE-CURSOR FOR GaAs GROWTH BY CSVT

Autor: Marco Antonio Ramírez Orozco¹

Coautores: Yenny Lucero Casallas-Moreno ²; José de Jesús Cruz Bueno ¹; Uriel Alcides Torices Saucedo ¹; Jessica Surisadai Rodríguez Aguilar ¹

¹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional*

² *Secihti, Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional*

Autor responsable de la comunicación: marco.raor10@gmail.com

The use of liquid metallic alloys as catalysts has gained increasing attention in the study of self-assisted growth of III-V semiconductor nanostructures such as gallium arsenide (GaAs). In this work, we investigate the behavior of Ga-Au and Ga-In eutectic alloys deposited on substrates, on these types of substrates, crystalline silicon (Si), silicon dioxide on silicon (SiO₂/Si), and graphene transferred onto SiO₂/Si. We evaluate the formation of three-dimensional, spherical metallic droplets that can act as catalytic precursors for the growth of GaAs by Close-Spaced Vapor Transport (CSVt). The experimental configuration consists of a vertical two-substrate assembly, in which the eutectic alloy is deposited on a lower sample (1A), and a second sample (1B), with or without graphene, is positioned above it using a quartz spacer to maintain a controlled separation. The assembly is thermally treated in a rapid thermal annealing (RTA) furnace at temperatures above the eutectic points of the alloys (~15 °C for Ga-In and ~360 °C for Ga-Au), to promote partial evaporation and the transport and deposition of atoms onto the upper substrate. The samples are characterized using scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), and X-ray photoelectron spectroscopy (XPS) to analyze the morphology, distribution, and chemical composition of the metallic species formed. These results allow to determine optimal thermal and surface conditions for the formation of active sites for the growth of GaAs by CSVt.

Keywords:

Ga-In, Ga-Au, graphene, CSVt, eutectic alloys

Reference:

Vukajlovic-Plestina, J., Kim, W., Ghisalberti, L., Varnavides, G., Tütüncüoglu, G., Potts, H., ...Fontcu-berta i Morral, A. (2019). Fundamental aspects to localize self-catalyzed III V nanowires on silicon. *Nature Communications*, 10(1). doi:10.1038/s41467-019-08807-9

Ris work was supported by:

The authors sincerely thank the IPN and SECIHTI for their financial support in this work. We particularly thank SIP 20253723, SIP 20254808, PRORED 20254785, and the Frontier Science projects SECIHTI CF-2023-I-1117 and SECIHTI CBF-2025-I-3719.



DESIGN OF METAL-DOPED TiO₂ NANOTUBULAR ARRAY SURFACES AS FUNCTIONAL PLATFORMS FOR ADVANCED ELECTROCHEMICAL SENSING

Autores: ZAIRA MORA-MORA¹; MA. GUADALUPE GARNICA-ROMO²

Coautor: HÉCTOR EDUARDO MARTÍNEZ-FLORES ³

¹ Programa Institucional de Doctorado en Ciencias Biológicas, Facultad de Químico Farmacobiología, Universidad Michoacana de San Nicolás de Hidalgo

² Facultad de Ingeniería Civil, Universidad Michoacana de San Nicolás de Hidalgo

³ Facultad de Químico Farmacobiología, Universidad Michoacana de San Nicolás de Hidalgo

Autor responsable de la comunicación: 2026096g@umich.mx

Applied electrochemistry (AE) is currently a growing technology that offers sustainable and low environmental impact solutions to multiple needs of modern society. Electrodes are key components that determine the efficiency of devices such as sensors, batteries and solar cells, among others, making the design and engineering of functional materials for new electrodes at nanometric scale essential. It is well known that the electrode's composition, structure and surface morphology are related to critical parameters such as sensitivity, selectivity and stability of these systems. In this context, TiO₂ nanotubular array surfaces (TNAs) are an effective strategy for electrochemical sensing platforms, due to their high area/volume ratio, chemical stability and facility of surface modification, as well as the advantages of biocompatibility with low toxicity. TNAs offer direct channels to enhance the electron conductivity promoting redox processes. Moreover, the incorporation of transition metals such as silver (Ag) brings additional benefits by introducing active sites and enhancing analyte-surface interaction. The controlled introduction of dopants provides a better understanding of their role in sensing mechanisms, which contributes to the development of more efficient devices [1]. In view of this, in this work we report the synthesis of titanium dioxide nanotubular arrays (TiO₂NTAs) doped with silver, obtained by anodization in organic media with 1 and 10 %wt metal precursor (AgNO₃) followed by heat treatment to stabilize the structure. Characterization analysis by SEM, EDS, XRD and XPS techniques confirmed the formation of the ordered nanotubular arrays, with homogeneous distribution of metallic and ionic silver species. Electrochemical proofs by cyclic voltammetry (CV) and electrochemical impedance (EIS) with an antioxidant (Gallic acid) as analyte showed the increasing in active surface with silver dopant and by consequence the surface capacitance, conductivity and sensitivity. Results evidence better sensitivity at low dopant precursor concentrations, meanwhile for high concentrations the stability is enhanced.

Keywords:

Electrochemistry, Nanomaterials-based sensors, Electrochemical sensors, Antioxidant electrosensing, Surface modification.

Reference:

S. Sharma, S. K. Ganeshan, S. Kundu, and K. N. Chappanda, K. N, Effect of doping on TiO₂ nanotubes based electrochemical sensors: Glucose sensing as a case study. IEEE Transactions on nanotechnology, 20. (2021) doi:10.1109/TNANO.2021.3060786

Ris work was supported by:

Continuidad de Proyectos de Investigación Científica de Impacto Regional, ICTI (PICIR-059) y Coordinación de Investigación Científica, UMSNH.



SYNTHESIS AND CHARACTERIZATION OF AU- Fe_2O_3 HYBRID NANOSTRUCTURES VIA LASER ABLATION IN LIQUID FOR BIOMEDICAL APPLICATIONS

Autor: Monica Sareli Barajas Alvarez¹

Coautores: Armando Pérez-Centeno ²; Elder Alejandro Meza Ramírez ²; Enrique Campos González ³; Enrique Camps ⁴; Hugo Ernesto Acevedo Juárez ¹; José Guadalupe Quiñones Galván ²

¹ Departamento de Física y Matemáticas, Instituto Tecnológico y de Estudios Superiores de Occidente

² Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara

³ Conahcyt - National Institute for Nuclear Research, Mex-Tol Highway s/n, La Marquesa, Ocoyoacac, State of Mexico, ZIP Code 52750, Mexico

⁴ Department of Physics, National Institute for Nuclear Research, Mex-Tol Highway s/n, La Marquesa, Ocoyoacac, State of Mexico, ZIP Code 52750, Mexico

Autor responsable de la comunicación: monica.barajas@iteso.mx

The objective of this research is the synthesis of gold (Au) and iron oxide (Fe_2O_3) hybrid nanostructures via the laser ablation in liquid (LAL) technique. This approach aims to integrate the electrical and chemical properties of both materials for potential applications in the biomedical field. A laser source with a wavelength of 532 nm, a energy pulse of 400 mJ, and a 9 mm spot size was employed. In this case, four types of colloidal media were used: an aqueous-based Fe_2O_3 colloidal solution, an acetone-based Fe_2O_3 colloidal solution, an aqueous-based Au colloidal solution and an acetone-based Au colloidal solution. The resulting nanostructures were characterized using ultraviolet-visible (UV- Vis) spectroscopy to assess their absorbance spectra and electronic properties; atomic force microscopy (AFM) and scanning electron microscopy (SEM) to evaluate morphology; and X-ray photo-electron spectroscopy (XPS) to determine elemental composition and chemical states. The synthesis yielded hybrid Au- Fe_2O_3 nanostructures contained into colloidal solutions. Furthermore, the study revealed insights into the influence of iron oxide on the electronic properties of gold, specifically regarding modifications in the band gap and shifts in the characteristic surface plasmon resonance of Au. These results suggest that the Au- Fe_2O_3 hybrid nanoparticles have potential for biomedical applications, including use as sensor, tracking and drug delivery systems, and contrast agents in imaging.

Keywords:

Laser ablation, Aurum, Iron oxide, Nanoparticles, Biomedical

Reference:

Larsen, G. K., Farr, W., & Hunyadi Murph, S. E. (2016). Multifunctional Fe_2O_3 -Au Nanoparticles with Different Shapes: Enhanced Catalysis, Photothermal Effects, and Magnetic Recyclability. *The Journal of Physical Chemistry C*, 120(28), 15162–15172. doi:10.1021/acs.jpcc.6b03733

Ris work was supported by:

Instituto Tecnológico y de Estudios Superiores de Occidente, Universidad de Guadalajara



STUDY AND REORETICAL ANALYSIS OF THE OPTICAL PROPERTIES OF CARBON NANOTUBES WITH CYLINDRICAL AND OVAL GEOMETRIES

Autor: Emmanuel Medina Aragon¹

¹ *Instituto Tecnológico de Puebla*

Autor responsable de la comunicación: angelj3236p@hotmail.com

In this work, we present a detailed analysis of Photoluminescence and Raman spectra on carbon nanotubes with different geometries, in order to observe the different behaviors of the designed and calculated structures. The studied structures are CNTs with longitudinally deformed geometry. Since the discovery of the interesting optical and electronic properties of carbon nanotubes, their behavior as a metallic or semiconducting material, or both, strongly depends on the diameter dimensions of the carbon nanotube determined by the chirality indices (n,m) with respect to the emitted wavelength (λ). The low dimensionality of carbon nanotubes results in the quantum confinement of electrons, which has important implications for both optical and electronic properties. This electronic confinement gives rise to the formation of van Hove singularities (VHS), which are energy ranges with a high density of associated states (DOS). The general characteristics of the radial breathing mode, the tangential mode (G band), the disorder-induced mode (D band), and other Raman features are presented, with the focus directed towards their use for the characterization of carbon nanotubes.

Keywords:

nanotubes, semiconductor, Photoluminescence, states

Reference:

Victoria, A. R., de la Luz, A. H., Juárez, J. M., Espinosa-Torres, N. D., Robles-Águila, M. J., López, J. L., & Juárez-Díaz, G. (2019). Photoluminescence spectrum using DFT for double-walled carbon nanotubes with metallic constituents.

Ris work was supported by:

Instituto Tecnológico de Puebla



REMOVAL OF RECALCITRANT HERBICIDE PARAQUAT DICHLORIDE VIA PHOTOCATALYSIS BY ANATASE PHASE TiO₂ NANOFIBERS

Autor: Harold Yesid Bermon Bayona¹

Coautores: Joel Diaz-Reyes²; Josefina Aguila López³; José Francisco Sánchez Ramírez⁴; Oscar Secundino Sánchez⁵

¹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional.*

² *Centro de Investigación en Biotecnología Aplicada, Instituto Politécnico Nacional*

³ *UPIITA-Instituto Politécnico Nacional.*

⁴ *Centro de Investigación en Biotecnología Aplicada, Instituto Politécnico Nacional.*

⁵ *CINVESTAV-Instituto Politécnico Nacional. Departamento de Física.*

Autor responsable de la comunicación: yessbermon@gmail.com

The intensive use of agrochemicals in traditional farming practices has significantly impacted various ecological components. This study presents the photocatalytic degradation of the herbicide paraquat dichloride using titanium dioxide (TiO₂) nanofibers. The nanofibers were synthesized via electrospinning, employing polyvinylpyrrolidone (PVP) and titanium tetrabutoxide as molecular precursors. The nanofibers underwent thermal treatment at 450 °C for 4 hours, resulting in the formation of a tetragonal crystalline structure corresponding to the anatase phase, as confirmed by UV/Vis spectroscopy and X-ray photoelectron spectroscopy (XPS). The composition and structural characteristics were further analyzed using X-ray diffraction (XRD) and Raman spectroscopy. Three different concentrations of TiO₂ catalyst (25 mg/L, 50 mg/L, and 100 mg/L) were tested to evaluate the degradation efficiency of the herbicide. A paraquat concentration of 1000 ppm was used, and the photocatalytic process was conducted in a 50 mL batch reactor equipped with a UV lamp. The synthesized TiO₂ nanofibers exhibited an absorbance peak at 350 nm (UV/Vis) and a band gap energy of 3.16 eV. The XRD pattern and Raman scattering results revealed the characteristic peaks of the anatase phase of TiO₂. All tested catalyst concentrations achieved complete degradation (100%) of the herbicide under UV irradiation; notably the 25 mg/L concentration of TiO₂ accomplished total xenobiotic removal within 120 minutes. These findings demonstrate the potential of TiO₂ nanofibers as effective photocatalysts for degrading highly recalcitrant toxic compounds.

Keywords:

Electrospinning technique, nanofibers, Titanium dioxide, photocatalysis, paraquat dichloride.

Reference:

Aguila-López, J., Secundino-Sánchez, O., Sánchez-Ramírez, J.F. et al. Photocatalytic degradation of 2,4-dichlorophenoxyacetic acid by electrospun TiO₂ nanofibres synthesised from two different titanium molecular precursors. *Environ Sci Pollut Res* 31, 49413–49426 (2024). <https://doi.org/10.1007/s11356-024-34503-3>

Ris work was supported by:

Instituto Politécnico Nacional



STUDY OF THE THERMAL DIFFUSIVITY OF THE RGB BLUE TEXTILE DYE WITH TiO_2 NANOPARTICLES USING PHOTOTHERMAL TECHNIQUES

Autor: Rigoberto Carbajal Valdez

Coautores: Alfredo Cruz Orea; Oscar Secundino Sánchez

A photothermal study using thermal lens (TL) will be used for cotton dyeing in the textile industry by bleaching RGB blue textile dye with titanium dioxide nanoparticles (TiO_2 -NPs) in the presence of UV radiation. The change in thermal diffusivity of the nanofluid with irradiation time will be investigated by fitting the experimental TL data to a theoretical model. In this work, the main characterization of the thermal properties will be performed using thermal lens (TL) for the measurement of thermal diffusivity. Other techniques such as X-ray diffraction (XRD), Raman spectroscopy, UV-Vis spectroscopy, and transmission electron microscopy (TEM) were employed for complementary characterization. These studies are of great interest in applications of catalytic bleaching of RGB blue textile dye in the textile industry.

Keywords:

Bleaching, Nanoparticles, azul RGB, Thermal diffusivity, Thermal lens

Reference:

S. Salem, E. Hammad, A. Mohamed, W. El-Dougdoug, A comprehensive review of nanomaterials: types, synthesis, characterization, and applications. *Biointerface Res. Appl. Chem.* 13 (1) (2023) 41.
<https://doi.org/10.33263/BRIAC13>

His work was supported by:

SECIHTI



ENCAPSULATION OF A BIOHERBICIDE CONTAINING INORGANIC NANOPARTICLES WITH CONTROLLED-RELEASE PROPERTIES

Autores: Josefina Aguila López¹; José Francisco Sánchez Ramírez²

Coautores: Alma Cristina Arellano García ²; Joel Díaz Reyes ²; Maribel Flores González ²; Oscar Secundino Sánchez³

¹ Departamento de Nanotecnología. Instituto Politécnico Nacional, Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas.

² Departamento de Nanobiotecnología. Instituto Politécnico Nacional, Centro de Investigación en Biotecnología Aplicada.

³ Departamento de Física. Instituto Politécnico Nacional, Centro de Investigación y de Estudios Avanzados.

Autor responsable de la comunicación: joss2327_aguila@hotmail.com

The encapsulation of bioherbicides from *Streptomyces* sp. and *Phoma* sp. and nanoherbicides of inorganic nanoparticles with controlled release properties is considered an innovative and effective method for weed control without environmental effects. This research reports the preparation, characterization, and application of new release systems (core@shell) of bioherbicides and nanoherbicides surrounded by biodegradable polymers (alginate, chitosan, and gelatin) with controlled release properties and presowing and post-emergence phytotoxic activity in weed control. The yield and control of experimental parameters during preparation are key to the successful formation of controlled-release systems of bioherbicides and nanoherbicides containing Ag nanoparticles (Ag NPs) and TiO₂ nanofibers (TiO₂ NFs). The results of the biosynthesis of bioherbicides from *Streptomyces* sp. and *Phoma* sp. using the submerged fermentation method are presented, as well as the synthesis of Ag NPs with sizes on the nanometric scale through chemical reduction and TiO₂ NFs with diameters on the nanometric scale using the electrospinning technique. Using the dripping extrusion technique, controlled release systems of bioherbicides and nanoherbicides with a core@shell structure were successfully prepared with an encapsulation efficiency of > 94%. Well-defined and compact release systems with a spherical shape were obtained, with shell diameters and thicknesses on the millimeter and micrometer scales, respectively. The effect of the concentration of molecular precursors and gelling agents on the formation and properties of the release systems was studied using different characterization techniques: UV-Vis spectroscopy, TEM, SEM, EDS, XRD, and stereoscopic optical microscopy. The inhibition of germination in the weeds *Lolium perenne*, *Amaranthus retroflexus*, and *Bidens pilosa* is presented using controlled-release bioherbicide systems. Similarly, Ag NPs and TiO₂ NFs nanoherbicides reveal inhibition properties in germination and phytotoxic activity at the foliar level in *Amaranthus retroflexus*, respectively. These results demonstrate that controlled release systems of bioherbicides and nanoherbicides represent a potentially sustainable alternative for weed control.

Keywords:

Nanoherbicide, Control weed, Dripping extrusion, Nanoparticles, Nanofibers

Reference:

G. L. Zabot, F. Schaefer Rodrigues, L. Polano Ody, M. Vinícius Tres, E. Herrera, H. Palacin, J. S. Córdova-Ramos, I. Best y L. Olivera-Montenegro, Encapsulation of Bioactive Compounds for Food and Agricultural Applications, Polymers, 14 (2022), <https://doi.org/10.3390/polym14194194>

Ris work was supported by:

The authors are grateful for the financial support provided by SIP-IPN and SECIHTI for the realization of this research work.



DESIGN, SIMULATION AND FABRICATION OF METASURFACES FOR VISIBLE HOLOGRAPHY AND INFRARED ABSORPTION BY EBL

Autores: José Antonio Cuevas Lara¹; Aranza Cantú Puga²; Valeria Rodríguez Moreno²; Alan Elías Echevarría Flores²; Esteban Cruz Hernández¹; Miguel Ángel Vidal Borbolla¹

¹ CIACYT

² Facultad de ciencias, UASLP

Autor responsable de la comunicación: jose.antonio.cuevas@uaslp.mx

Metasurfaces offer unprecedented control over light-matter interactions at the nanoscale. This work presents the design, simulation, and fabrication of nanostructured metasurfaces using electron beam lithography (EBL) targeting distinct spectral applications. One line involves the development of holographic metasurfaces operating in the visible range, designed through simulations involving a variety of material and geometric combinations. These metasurfaces aim to overcome pixel saturation issues by incorporating meta-atom geometries inspired by designs typically used in the infrared or terahertz regimes, enabling multicolor holographic image reconstruction. The second focuses on infrared metasurfaces composed of gold nanoresonators on silicon substrates, simulated and fabricated to achieve high-efficiency resonant absorption at selected infrared wavelengths. Both implementations utilize EBL to realize nanostructures with high fidelity and precision, supporting their respective optical functionalities. The EBL process includes resist coating, exposure, development and etching or lift-off, enabling feature sizes down to tens of nanometers with control over line width and pattern reproducibility. The results demonstrate how a simulation-guided design workflow, combined with precise nanofabrication, yields metasurfaces with tailored optical responses in their designated spectral ranges, confirming the potential of metasurface engineering for advanced photonic applications such as holographic displays and infrared sensing.

Keywords:

Metasurfaces, Electron beam lithography, Visible holography, Infrared absorption, Nanofabrication

Ris work was supported by:

CONAHCYT



SYNTHESIS AND CHARACTERIZATION OF INSULIN-COATED Ag NANOPARTICLES CONTAINED IN PLA/PBAT NANOFIBERS APOSSITES FOR TRANSDERMAL INSULIN DELIVERY FOR THE TREATMENT OF DIABETES.

Autores: Genaro Lopez-Gamboa¹; José Luis Jiménez-Pérez¹

Coautores: José Luis Luna-Sánchez¹; Ruben Gutierrez-Fuentes¹; Usiel Omar García-Vidal; Verónica Hernández-Rosas¹; Zormy Nacary Correa-Pacheco²

¹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas del Instituto Politécnico Nacional*

² *Centro de Desarrollo de Productos Bióticos del Instituto Politécnico Nacional*

Autor responsable de la comunicación: veronicahdr@gmail.com

Currently, science is developing alternative methods to injections for administering insulin to diabetic patients. This is because the injection method presents problems for these patients, including bleeding from the injection, insulin dripping after the injection, pain, and insulin leakage from the injection site. Several alternative methods to injections have been reported in the literature, including insulin pens, insulin pumps, insulin inhalers, and transdermal apossites. The latter have been highly successful in other areas of medicine. A typical example is diclofenac-loaded apossites, which have been widely used as transdermal patches for the treatment of muscle pain, dislocations, and sprains. In this research project, the synthesis (using a green method) of Ag nanoparticles (NPs) coated with insulin. Once the Ag/insulin NPs are synthesized, they will be mixed in a solution composed of: poly-lactic acid (PLA), polybutylene adipate co-terephthalate (PBAT), chloroform and formic acid. This solution will be used to form apossites using the technique called electrospinning. These apossites will be used as adhesive, biocompatible and biodegradable patches for the prolonged release of insulin via transdermal route for glucose control in diabetic patients. The nanoparticles and apossites will be characterized with respect to their morphology, size and structure by scanning electron microscopy (SEM), the components and functional groups present in the apossites will also be studied by Fourier transform infrared spectroscopy (FTIR), the thermal properties of the apossites without insulin and loaded with insulin will be obtained with photothermal techniques as follows: thermal wave resonant cavity (TWRC), inverse pyroelectric photo spectroscopy (IPPE), ultraviolet visible spectroscopy (UVVIS) and photoacoustic spectroscopy (PA), obtaining the photothermal properties will help us identify if the addition of insulin generates alterations in the photothermal properties of the apossites components. The apossites will be studied to determine the percentage of insulin availability incorporated into the polymer solution and the degree of release under physiological conditions of osmolarity, pH, and temperature. This will allow us to determine whether the apossites created can efficiently contain insulin and can release it adequately to allow its glucose-control action in diabetic patients.

Keywords:

Ag-nanoparticles, polybutylene-adipate-coterephthalate, polylactic-acid, transdermal-apossites, insulin, diabetic-patients

Reference:

Andrea Lurahgi et al. Electrospinning for drug delivery applications: A review. *Journal of Controlled Release* 334(2021) 463-484.

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación



PREPARATION AND EVALUATION OF CHITOSAN NANOPARTICLE GELLAN GUM MEMBRANES FOR WASTEWATER REMEDIATION

Autores: Heriberto Hernandez Cocoltzi; Ivana Solis Vizcaino

Coautores: Efrain Rubio Rosas ; Eva Aguila Almanza ; Jena L Varela Caselis

Autor responsable de la comunicación: ivana.solis17@gmail.com

The removal of emerging contaminants from wastewater represents one of the main current environmental challenges. Although various technologies have been implemented for this purpose including nanometric adsorbents and nanocomposite membranes many face limitations such as high material costs and rapid membrane fouling. In this study, flat membranes based on nanoparticulated chitosan crosslinked with gellan gum were developed and characterized as a sustainable alternative for wastewater treatment. Chitosan nanoparticles were obtained through ultrasonic treatment and incorporated into the membranes using the solvent evaporation technique. The membranes were characterized by Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), thermogravimetric analysis (TGA), water contact angle, and mechanical testing based on ASTM D638-14. The results showed that membranes fabricated with nanoparticulated chitosan exhibited higher tensile strength compared to those made with macroscopic chitosan, indicating improved mechanical properties. Additionally, a higher concentration of gellan gum as a crosslinking agent enhanced membrane performance, resulting in a denser structure, increased hydrophobicity, and suitable thermal stability at elevated temperatures.

These findings demonstrate the potential of developing more resistant, stable, and efficient membranes for the removal of emerging contaminants. The proposed membranes represent a promising, low-cost, and environmentally friendly alternative to address current challenges in wastewater treatment.

Keywords:

Chitosan nanoparticles, gellan gum, nanocomposite membranes, membrane filtration.

Reference:

I. Solis Vizcaino, E. Rubio Rosas, E. Águila Almanza, M. Marín Castro, and H. Hernández Cocoltzi, Ultrasonic production of chitosan nanoparticles and their application against *Colletotrichum gloeosporioides* present in the Ataulfo mango, *Polymers* 16(21) (2024) 3058. <https://doi.org/10.3390/polym16213058>.

Ris work was supported by:

Vicerrectoria de Investigación y Estudios de Posgrado, BUAP.



CORE/SHELL NANOCOLUMNS ON GRAPHENE USING VAN DER WAALS EPITAXY

Autor: Nayeli Colin Becerril¹

Coautores: Carlos Ernesto Ávila Crisóstomo ¹; José Angel Guillen Cervantes ²; José Luis Herrera Pérez ¹; Mario Alberto Zambrano Serrano ²; Máximo López López ²; Yenny Lucero Casallas Moreno ³

¹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional*

² *Departamento de Física, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional*

³ *Secihti-Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional*

Autor responsable de la comunicación: nayeli.colin140596@hotmail.com

III-V semiconductor nanostructures, such as quantum dots and nanowires, have emerged as promising candidates for next-generation optoelectronic and nanotechnology applications due to their superior quantum confinement effects, strain relaxation, and high crystal quality. A key challenge is their integration with silicon-based technologies. In this study, we demonstrate the molecular beam epitaxy (MBE) growth of InAs/InGaAs core/shell nanocolumns on graphene/Si(111) substrates, leveraging van der Waals epitaxy to minimize lattice mismatch constraints. Prior to nanocolumn growth, a monolayer of graphene was deposited onto the Si(111) substrate, serving as a 2D buffer layer. The structural and chemical properties of the nanocolumns were characterized using scanning electron microscopy (SEM), transmission electron microscopy (TEM), energy-dispersive X-ray spectroscopy (EDS), and Raman spectroscopy. The results reveal nanocolumns with lengths reaching 1 μm and diameters of 160 nm, highlighting their potential for applications in lasers, photodetectors, high-mobility transistors, and advanced photovoltaic devices.

Keywords:

core/shell, graphene, III/V semiconductor, MBE, nanocolumns

Reference:

1. A. L. Martínez-López et al., Mater. Sci. Semicond. Process., vol. 181 (2024). <https://doi.org/10.1016/j.mssp.2024.108605>.
2. W. Wang et al., J. Appl. Phys., vol. 111, no. 9 (2012). <https://doi.org/10.1063/1.4709732>.
3. C. Zhao et al., Prog. Quantum Electron., vol. 76 (2021). <https://doi.org/10.1016/j.pquantelec.2020.100313>.

Ris work was supported by:

The authors sincerely thank the IPN and SECIHTI for their financial support in this work. We particularly thank SIP 20253723, SIP 20254808, PRORED 20254785, and the Frontier Science projects SECIHTI CF-2023-I-1117 and SECIHTI CBF-2025-I-3719.



NANOSTRUCTURES / 160

CHARACTERIZATION OF NITRIDED HIGH-DIELECTRIC CONSTANT OXIDE NANOFILMS GROWN ON III-V SEMICONDUCTOR SUBSTRATES

Autor: Carmen Lizet Estefani Seminario Panta¹

Coautores: Alberto Herrera-Gomez ¹; Carlos Alberto Ospina-Ocampo ¹; Dulce Maria Guzman Bucio ¹; Joaquin-Gerardo Cortazar-Martinez ¹; Kevin Daniel Vallejo ²; Merve Baksi ²; Orlando Cortazar-Martinez ¹

¹ Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional

² Idaho National Laboratory

Autor responsable de la comunicación: lizetseminario@gmail.com

Metal-oxide-semiconductor (MOS) structures have been crucial to the advancement of optoelectronics, enabling devices such as MOS capacitors and MOSFETs. As silicon transistors reach their scalability limits, high-k dielectrics, such as hafnium dioxide (HfO₂), combined with high-mobility III-V semiconductors (e.g., InGaAs), are emerging as promising alternatives for the next generation of devices.

A key challenge in InGaAs-based MOS devices is atomic diffusion (e.g., indium) through high-k dielectrics such as HfO₂. This can degrade performance by increasing leakage currents and affecting interface stability.

In this work, high-k HfO₂ with thicknesses <10 nm was deposited on InGaAs substrates using ALD (Savannah, Cambridge, 100). Tetrakis(dimethylamido)hafnium (TDMAH) and deionized water were used as precursors. The films were nitrided with a remote plasma source (LITMAS) integrated into a sputtering system, at various powers and 350°C.

Photoemission spectra were obtained with an XPS instrument (1487.6 eV monochromatic source and 7-channel spectrometer) at 6 takeoff angles. A peak-fitting analysis was performed by simultaneously fitting the peaks and modelling the background simultaneously for the six spectra using A Analyzer. The chemical composition was quantitatively evaluated using the Multilayer Model (MLM).

The results for chemical composition and film thickness were consistent with the expected values. In addition, the thickness and composition of the interface layer were characterized, confirming the applicability of the MLM.

Keywords:

high-k dielectric, Photoemission Spectra, Diffusion

Reference:

1. Mayorga-garay. Herrera-gomez, A. Applied Surface Science XPS study of the nitridation of hafnia on silicon. Applied Surface Science, 678(August), 161073. <https://doi.org/10.1016/j.apsusc.2024.161073>
3. Internal Report. Self consistent ARXPS analysis for multilayer conformal films with abrupt interfaces.

Ris work was supported by:

This work was partially financed by CONAHcyT Project Fronteras 58518, Mexico.



REAL-TIME CONTACT NANOBIOSENSOR AS SUITABLE STRATEGY FOR PATHOGEN DETECTION

Autor: Rafael A. Salinas¹

Coautores: Abdu Orduña Díaz ²; Andrés Galdámez Martínez ³; Ateet Dutt ⁴; Carlos Ramos Vilchis ¹; Guillermo Santana Rodríguez ¹; Josue Esau Romero ¹; Laura Jeanette García Barrera ²; Shirley Elizabeth Martínez Tolibia¹

¹ *Instituto de Investigaciones en Materiales IIM-UNAM*

² *Centro de Investigación en Biotecnología Aplicada del Instituto Politécnico Nacional*

³ *University of Oulu, Nano and Molecular Systems Research unit, Finland*

⁴ *Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México, Materiales de Baja dimensionalidad, México*

Autor responsable de la comunicación: rasd@iim.unam.mx

Accurate detection of pathogens presents a significant challenge for global health systems. The potential for rapid outbreaks emphasizes the critical need for swift detection, particularly in resource-constrained environments. One-dimensional zinc oxide nanomaterials (1DZnO) have emerged as promising, low-cost platforms with customizable properties suitable for electrochemical and optical biosensing applications. In this work, modifications in the fundamental photoluminescent response of 1DZnO to create a novel immunosensor specifically designed to detect enteropathogenic *Escherichia coli*. This nanobiosensor showcases a change in photoluminescence signals that effectively respond to analyte concentrations between 1×10^2 and 1×10^8 CFU/mL, enabling direct visualization of targeted bacterial cells on 1DZnO structures using scanning electron microscopy (SEM). The design of this nanobiosensor emphasizes a real-time contact approach, significantly shortening processing and response times for pathogen detection, which is particularly beneficial in emergency contexts. The detection process occurs in real time, requiring only a brief 5–10 seconds of interaction time, corroborated by the standard polymerase chain reaction method. This combined validation highlights the biosensor's reliability and accuracy. Moreover, the application of 1DZnO nanoplateforms is not limited to enteropathogenic *E. coli*, as the biosensing capabilities demonstrated here indicate potential for similar uses with other relevant pathogens. This research advances the wider application of 1DZnO-based biosensors in medical diagnostics, providing rapid, sensitive, and real-time detection capabilities.

Keywords:

Nanomaterials, Biosensors, Real-time, Detection, Pathogen

Reference:

<https://doi.org/10.1002/anbr.202400013>

Ris work was supported by:

Ateet Dutt Project PAPIIT-DGAPA-UNAM IN100125, and Guillermo Santana Project PAPIIT-DGAPA-UNAM IG100123.



COMPUTATIONAL STUDY OF THE SENSITIVITY OF OPTICAL SENSORS BASED ON SURFACE PLASMON RESONANCE WITH A HEXAGONAL ARRAY OF GOLD NANORODS

Autor: Víctor Manuel Morales Juárez¹

Coautor: Víctor Manuel Altuzar Aguilar ¹

¹ *Facultad de Ciencias Físico Matemáticas. Benemérita Universidad Autónoma de Puebla.*

Autor responsable de la comunicación: victor.moralesj@alumno.buap.mx

Optical biosensors based on surface plasmon resonance (SPR) in the Kretschmann configuration are widely used for label-free studies of molecular interactions. Nanoscience and nanotechnology enable the synthesis of metallic nanoparticles with different shapes, sizes, and compositions. In particular, it has been reported that using arrays of vertically self-assembled gold nanorods on a pre-functionalized SPR sensor can enhance its sensitivity, making it a powerful biosensing tool. This work presents a numerical study using the finite element method to investigate the sensitivity of SPR sensors with an optimized design of periodic hexagonal arrays of spherical nanoparticles (NPs) and gold nanorods covalently anchored on a thin gold film of an SPR sensor. Through COMSOL Multiphysics simulations, we characterize the system under p-polarized light incidence ($\lambda = 632.8$ nm), evaluating the resonance angle shift as a function of the geometric parameters of the nanoarray. The simulation domain includes a prism, a 47.5 nm gold film functionalized with dithiol poly(ethylene glycol) (PEG-D), a periodic nanostructured array of gold NPs, and a bulk medium of phosphate-buffered saline (PBS). The interparticle distances and nanoparticle sizes in the hexagonal array are systematically varied to optimize near-field coupling and far-field radiative properties. The results show that the lattice parameters significantly modulate the electric field intensity and sensor sensitivity. Configurations with nanoparticles achieving a 25% electric field enhancement factor and approximately 30% sensitivity improvement compared to the classical nanoparticle-free configuration are presented.

Keywords:

Surface plasmon resonance, gold nanorod arrays, biosensor, finite element modeling

Reference:

Maier, S. A. Plasmonics: Fundamentals and Applications. Springer (2007).

Ris work was supported by:

This work received no external funding



SPR BIOSENSORS TO MEASURE GLUCOSE LEVELS IN THE SKIN

Autor: Andrea Treto¹

Coautor: Jesús Madrigal Melchor¹

¹ *Unidad Académica de Ciencia y Tecnología de la Luz y la Materia*

Autor responsable de la comunicación: andy.treto27@gmail.com

Surface Plasmon Resonance (SPR) optical sensors are based on the excitation of surface plasmons. In this work, we propose the use of the SPR optical technique for the modelation of a biosensor capable of directly measuring glucose in the skin in a non-invasive manner, allowing for continuous monitoring. According to Homola [1], a large part of the SPR, wave's electromagnetic field is located in the dielectric medium, so the propagation constant is highly sensitive to changes in the refractive index. In this work, we employed the Kretschmann configuration, using metals such as Au and Ag in combination with TMDCs (Transition Metal Dichalcogenides), such as MoS₂, MoSe₂, WS₂, and WSe₂. We also sought to add graphene to each of these combinations, changing the number of layers and chemical potential. The SPR biosensor system consists of a prism, metal, TMDCs, and skin. We also analyzed bimetallic sensors using both Au and Ag, and all these configurations were analyzed with and without graphene. We evaluated performances parameters such as sensitivity, spectral full width at half maximum (FWHM), detection accuracy (DA), and quality factor (QF), using the reflectance calculated with the transfer matrix method. The skin's refractive index used was 1.445, based on the report by Anuj K. Sharma [3] of a refractive index of $1.445 + 0.01i$, where only the real part was used since skin absorption was not considered. Assuming that glucose levels are reflected in changes in the skin's refractive index, this study sought to examine the biosensor's behavior by varying the refractive index in the third decimal place, based on the increments reported in the studies of Mudgalc [4] and Mostufa [5], which measured glucose concentration in urine, as these increments showed changes in the observed concentrations. The biosensors that showed the best performance were those to which Au was added, such as the biosensor composed of Au and WS₂, which showed a sensitivity range of 140 to 162 °/RIU, FWHM of 14.2 to 17 °, QF of 8 to 9, and DA of 0 to 0.3. When incorporating graphene into the systems, the biosensor that presented the best behavior was composed of Au and MoSe₂, along with a single layer of graphene and a chemical potential of 0.25, achieving a sensitivity of 120 to 155 °/RIU, FWHM of 14.5 to 16 °, QF of 7.5 to 10, and DA of 0 to 0.21.

Keywords:

SPR biosensors, skin, glucose measurement

Reference:

[1] Jiří Homola. "Present and future of surface plasmon resonance biosensors". En: Analytical and bioanalytical chemistry 377 (2003), págs. 528-539.

Ris work was supported by:

Unidad Académica de Ciencia y Tecnología de la Luz y la Materia, Universidad Autónoma de Zacatecas. Circuito Marie Curie S/N, Parque de Ciencia y Tecnología QUANTUM Ciudad del Conocimiento, Zacatecas, México.



MICROWAVE-ENHANCED PHYSICAL PROPERTIES OF BATH-DEPOSITED ZnO NANOFILMS

Autores: Oscar Secundino-Sánchez¹; Joel Diaz-Reyes²; Josefina Aguila López³; José Francisco Sánchez-Ramírez⁴

¹ *Depto. de Física, CINVESTAV-IPN*

² *Centro de Investigación en Biotecnología Aplicada, Instituto Politécnico Nacional*

³ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional*

⁴ *Instituto Politécnico Nacional*

Autor responsable de la comunicación: oscar.secundino@cinvestav.mx

The enhanced physical properties of ZnO thin films are studied as a function of the urea concentration in the growth solution. ZnO is grown using the chemical bath deposition technique, enhancing its properties with microwaves (CBD-AW). It was carried out energy dispersive spectroscopy (EDS) measurements on the nanofilms to determine their stoichiometry. The X-ray diffraction (XRD) analysis and Raman scattering reveal that as-deposited ZnO films showed hexagonal polycrystalline wurtzite type structure. The average grain size of the ZnO Nanofilms was ranged from 16 to 28 nm that was determined by Debye-Scherrer equation from wurtzite (WZ), (100), (002) and (101) directions. The average grain size as function of the urea concentration shows a sinusoidal behaviour. Because the growth rate in the direction (002) is greater than that in the directions (100) and (101), in which the growth rate is almost equal, the geometric form of the grain is ellipsoidal. The Raman spectra present four main peaks at 444, 338, 104 and 78 cm⁻¹ associated to the modes E₂high, (E₂high - E₂low), E₂low and an unidentified band. The 300K photoluminescence presents visible/UV radiative bands that are associated to vacancies of zinc and oxygen.

Keywords:

ZnO, wide bandgap Semiconductor, Chemical bath technique

Reference:

S. Y. Lee, E. S. Shim, H S. Kang, S. S. Pang, and J S. Kang. Thin Solid Films 437(2005) 31-34.



CONTROLLED SYNTHESIS, OPTICAL AND STRUCTURAL CHARACTERIZATION OF ELECTROSPUN ZnO NANOFIBERS FOR PHOTOCATALYTIC APPLICATIONS

Autores: Oscar Secundino Sánchez¹; Josefina Aguila López²; Joel Diaz-Reyes³; José Francisco Sánchez-Ramírez³

¹ *Depto. de Física, CINVESTAV-IPN*

² *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional*

³ *Centro de Investigación en Biotecnología Aplicada, Instituto Politécnico Nacional*

Autor responsable de la comunicación: oscar.secundino@cinvestav.mx

In this work the controlled synthesis of ZnO nanofibers obtained by the electrospinning technique is presented. By varying the distance between the tip of the needle and the manifold, the diameter and formation of the fibres can be controlled to within the nanometer scale. By means of scanning electron microscopy (SEM) it was possible to corroborate the formation of nanofibers without the presence of defects called "rosaries". The nanofibers with the smallest diameter were obtained at a working distance of 20 cm. The functional groups of the ZnO nanofibers were obtained by infrared spectroscopy (FTIR) and by energy dispersive spectroscopy (EDS) and chemical stoichiometry. The structure and crystalline phase of the ZnO nanofibers were controlled through annealing in a range from 0 to 1000 °C in a laboratory atmosphere. The results of the characterization by X-ray diffraction and Raman scattering of the nanofibers obtained with different heat treatments are presented. The transformation of the crystalline phase varied as a function of the temperature of the heat treatment. By X-ray diffraction it was found that at annealing temperatures lower than 200 °C the nanofibers are amorphous, the hexagonal wurtzite phase occurs from 300 °C. Finally, at temperatures higher than 700 °C of annealing, nanofibers with better crystalline quality were obtained.

Keywords:

ZnO, Electrospun nanofibers, wide bandgap Semiconductor

Reference:

Ü. Özgür, Ya. I. Alivov, C. Liu, A. Teke, M. A. Reshchikov, S. Dogan, V. Avrutin, S.-J. Cho, and H Morküyd. J. Appl.Phys. 98 (2005) 041301.



SYNTHESIS, CHARACTERIZATION AND PHOTOCATALYTIC APPLICATIONS ELECTROSPINNING TiO₂/ZnO NANOFIBERS

Autores: Oscar Secundino-Sánchez¹; Julio Gregorio Mendoza Alvarez²; José Francisco Sánchez Ramírez³; Joel Díaz-Reyes³; José Luis Herrera Pérez⁴

¹ *Depto. de Física, CINVESTAV-IPN*

² *Departamento de Física, CINVESTAV-IPN*

³ *Centro de Investigación en Biotecnología Aplicada, Instituto Politécnico Nacional.*

⁴ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional*

Autor responsable de la comunicación: oscar.sekundino@cinvestav.mx

This work reports the controlled synthesis of zinc oxide (ZnO) and titanium dioxide (TiO₂) nanofibers using electrospinning. Scanning electron microscopy (SEM) was used to confirm the successful formation of nanofibers with a well-defined morphology and no defects in both materials. The crystalline structure of the nanofibers was controlled by an annealing process at 400 °C in an air atmosphere, which allowed precise control over the crystalline phases formed. Further characterization was carried out by X-ray diffraction (XRD) and Raman spectroscopy. The XRD results revealed that, for ZnO nanofibers, the predominant crystalline phase was the hexagonal wurtzite phase after annealing at 400 °C. In contrast, for TiO₂ nanofibers, the phase obtained at this temperature was the anatase phase. Raman spectroscopy corroborated the presence of the corresponding crystalline phases. Finally, the photocatalytic properties of the electrospun nanofibers were evaluated, and it was found that TiO₂ nanofibers exhibited superior performance compared to ZnO ones. This evaluation was carried out through specific tests that measured the decolourization efficiency of azo dyes under UV illumination, demonstrating that TiO₂ nanofibers have a greater capacity to generate free radicals and, therefore, greater photocatalytic activity. This study not only confirms the ability of the electrospinning technique to produce ZnO and TiO₂ nanofibers with specific crystalline structures, but also highlights the superiority of TiO₂ in photocatalytic applications, which may be of great interest for developments in the field of nanotechnology and wastewater treatment.

Keywords:

Electrospinning, semiconductor nanofibers, textile dyes

Reference:

Electrospinning, semiconductor nanofibers, textile dyes

Ris work was supported by:

Not applicable



SYNTHESIS, CHARACTERIZATION AND PHOTOCATALYTIC APPLICATION OF CEVO₄ AND TiO₂ BASED COMPOUNDS

Autor: Sergio Eduardo Negrete Durán¹

Coautores: Edgar Giovanni Villabona Leal²; Hiram Joazet Ojeda Galván¹; Hugo Ricardo Navarro Contreras¹; Javier Alanís Pérez¹; Mildred Quintana Ruiz³

¹ *Coordinación para la Innovación de la Ciencia y la Tecnología, Universidad Autónoma de San Luis Potosí, Av. Sierra Leona #550-2ª, Lomas de San Luis, 78210 San Luis Potosí, S.L.P., México.*

² *Departamento de Biotecnológicas y Ambientales Química, Universidad Autónoma de Guadalajara. Av. Patria 1201, 45129, Zapopan, México*

³ *Centro de Investigación en Ciencias de La Salud y Biomedicina, Universidad Autónoma de San Luis Potosí, Av. Sierra Leona 550, San Luis Potosí, S.L.P. 78210, México*

Autor responsable de la comunicación: a259046@alumnos.uaslp.mx

Vanadate materials (VO_x) have drawn significant attention from the scientific community due to their catalytic applications. Among them, cerium(IV) vanadate (CeVO₄) stands out for its favorable properties, including a relatively low band gap (~2.8 eV). Titanium(IV) oxide (TiO₂), meanwhile, has also been extensively studied for its versatile photocatalytic behavior. However, TiO₂ mainly exhibits activity under UV light, with a band gap of approximately 3.2 eV, limiting its effectiveness within the visible spectrum and utilizing only a small portion of the solar spectrum. In this study, TiO₂/CeVO₄ heterojunctions were designed and synthesized to develop a material that combines and enhances the photocatalytic properties of both components. Cerium(IV) vanadate was synthesized via a solvothermal method involving 12 hour reactions at 180 °C. The crystalline phases of TiO₂ and CeVO₄ were identified through X-ray diffraction (XRD) and Rietveld refinement. Raman spectroscopy was performed on the samples, the spectra were deconvoluted, and the results were compared with those reported for LnVO₄-type structures (Ln = lanthanides). Transmission electron microscopy (TEM) was used to examine the sample morphology. UV-Vis-NIR diffuse reflectance spectroscopy was conducted for each sample, and the band gap values were determined using the Kubelka-Munk method and compared with literature data. Photocatalytic studies were performed to analyze and compare within other similar compounds.

Keywords:

Photocatalysis Heterojunction Vanadates Cerium Titanate

Reference:

Mishra, S., et al. (2020). Rapid microwave assisted hydrothermal synthesis cerium vanadate nanoparticle and its photocatalytic and antibacterial studies. *Journal of Physics and Chemistry of Solids*, 137, 109211. <https://doi.org/10.1016/j.jpcs.2019.109211>

Ris work was supported by:

LANAFQB from CIACyT, LINAFO from CIACyT, and Laboratorio de nanoestructurados multifuncionales from CICSaB



PHOTOELECTRODES BASED ON ZNO/FUNCTIONALIZED GRAPHENE NANOCOMPOSITE ON 3D-PRINTED STRUCTURES USING PLASMA- ASSISTED ATOMIC LAYER DEPOSITION (PALD)

Autor: Edgar Homero Ramirez Soria¹

Coautores: Eduardo Martínez Guerra ¹; Maria Isabel Mendivil Palma ¹; Mario Alberto Hidrogo Rico ¹; Tania Ernestina Lara Cenicerros ¹; Alfredo Aguilar Elguezabal ²; Jose Bonilla Cruz ¹

¹ *Subsede Monterrey - Centro de Investigación en Materiales Avanzados, Av. Alianza Norte 202, Apodaca, Nuevo León-México*

² *Laboratorio de Materiales Nanoestructurados - Centro de Investigación en Materiales Avanzados, Chihuahua, Chihuahua- México*

Autor responsable de la comunicación: edgar.ramirez@cimav.edu.mx

Graphene-based materials are used in photoelectronic applications due to their ability to transport electrons across two-dimensional (2D) structures and effectively facilitate the separation of photogenerated electron-hole pairs, thereby reducing electron-hole recombination, a phenomenon frequently observed in semiconductors. The fabrication of composites from graphene-based materials and semiconductors, under optimal conditions, typically involves the formation of bonds between the surfaces of graphene materials and the semiconductor, which can enhance their photocatalytic activity. It is widely recognized that the in-situ method, whereby nanocrystals form and develop on the surfaces of graphene-based materials, yields a homogeneous distribution of semiconductors on the two-dimensional nanosheets of graphene. Furthermore, the functional groups on functionalized graphene can be utilized to control the crystallinity, size, and morphology of the semiconductor crystals being grown.

In this study, we aim to enhance the electron path length and reduce recombination between holes and photogenerated electrons, thereby augmenting the photocatalytic efficiency of ZnO/functionalized graphene. Accordingly, plasma-assisted atomic layer deposition (PALD) was employed to deposit ZnO onto conductive 3D-printed electrodes, which consist of vat-polymerized scaffolds coated with conductive ink-based functionalized graphene. The incorporation of functionalized graphene significantly increased conductivity compared to non-coated 3D-printed scaffolds. Furthermore, by adjusting the chamber temperature during the deposition process, the electrical activity of the ZnO/functionalized graphene was optimized. The resultant photoelectrodes demonstrated photoactivity under ultraviolet-visible excitation, signifying their potential application as photoelectrochemical electrodes.

Keywords:

PALD, 3D-Printing, Photoelectrodes, Nanocomposites

Reference:

Browne, M. P., Plutnar, J., Pourrahimi, A. M., Sofer, Z., & Pumera, M. (2019). Atomic layer deposition as a general method turns any 3D-printed electrode into a desired catalyst: Case study in photoelectrochemistry. *Advanced Energy Materials*, 9(26), 1900994.

Ris work was supported by:

E.H.R.S. expresses appreciation to SECIHTI-Mexico for awarding the "Estancia Posdoctoral Académica Inicial 2022." J.B.C. and E.M.G. extend their gratitude for the Proyecto Interno - CIMAV 25001 and 26005. This endeavor received partial support from the bilateral project CONAHCYT-AFOSR CC0015-2016-05-279915.



DEPOSITION OF $\text{In}_x\text{Ga}_{1-x}\text{N}$ MULTIPLE QUANTUM WELLS VIA APLD: A STRATEGY FOR ATOMIC-SCALE CONTROL OF OPTICAL AND ELECTRONIC PROPERTIES

Autor: Iván Alejandro Jasso Granja¹

Coautores: Cuitlahuac Mójica Sobrevilla ¹; Edgar López Luna ¹; Miguel Ángel Vidal Borbolla ²

¹ Centro de Aplicación de Radiación Infrarroja, Energías Alternativas y Materiales - Coordinación para la Innovación y Aplicación de la Ciencia y Tecnología - Universidad Autónoma de San Luis Potosí.

² Coordinación para la Innovación y Aplicación de la Ciencia y Tecnología - Universidad Autónoma de San Luis Potosí.

Autor responsable de la comunicación: a323066@alumnos.uaslp.mx

This work presents the fabrication of a multiple quantum well nanostructure based on the $\text{In}_x\text{Ga}_{1-x}\text{N}$ alloy, using a novel deposition technique called Atomic Partial Layer Deposition (APLD). This method is derived from Atomic Layer Deposition (ALD), but introduces finer control through ultrashort pulses and sub-monolayer doses, enabling the formation of incomplete layers with atomically variable stoichiometry. Unlike conventional ALD, where each cycle forms a complete monolayer through self-limiting reactions, APLD allows modulation of the amount of each precursor deposited, enabling the creation of ternary or quaternary alloys with a random yet controlled distribution of constituent elements. This capability is particularly valuable for materials such as $\text{In}_x\text{Ga}_{1-x}\text{N}$, where homogeneous indium incorporation is critical to avoid segregation and structural defects.

In this study, GaN barriers were deposited using ALD, while the $\text{In}_x\text{Ga}_{1-x}\text{N}$ quantum wells were deposited via APLD, with precise control over the indium concentration in each well. The result is a series of quantum wells with controlled structural variations, allowing the tuning of optical and electronic properties during deposition, without the need for post-deposition thermal treatments.

The combination of APLD with ALD represents a powerful tool for the engineering of nanostructures with compositional gradients and tunable quantum potential, with applications in optoelectronics, photodetectors, and emerging quantum devices.

Keywords:

Multiple Quantum Wells, Nanostructure, ALD, Atomic Partial Layer Deposition, Sub-Monolayer.

Reference:

H. Hernández-Arriaga, E. López-Luna, E. Martínez-Guerra, M. M. Turrubiarres, A. G. Rodríguez, and M. A. Vidal, Growth of $\text{HfO}_2/\text{TiO}_2$ nanolaminates by atomic layer deposition and $\text{HfO}_2\text{-TiO}_2$ by atomic partial layer deposition, J. Appl. Phys. 121 (2017) 064302. <https://doi.org/10.1063/1.4975676>.

Ris work was supported by:

The authors gratefully acknowledge the support provided through the SNI assistantship scholarship granted by SECIHTI.



ELECTRICAL CHARACTERIZATION OF APLD-DEPOSITED Hf-TiO THIN FILMS: CONTROL OF THE DIELECTRIC CONSTANT BY PARTIAL DOSES

Autor: Cuitlahuac Mójica Sobrevilla¹

Coautores: Edgar López Luna ¹; Iván Alejandro Jasso Granja ¹; Miguel Ángel Vidal Borbolla ²

¹ Centro de Aplicación de Radiación Infrarroja, Energías Alternativas y Materiales - Coordinación para la Innovación y Aplicación de la Ciencia y Tecnología - Universidad Autónoma de San Luis Potosí

² ión Infrarroja, Coordinación para la Innovación y Aplicación de la Ciencia y Tecnología - Universidad Autónoma de San Luis Potosí

Autor responsable de la comunicación: cmesinas15@gmail.com

In this work we present the results of electrical characterization of thin films of hafnium-titanium oxide (HfTiO) deposited by the Atomic Partial Layer Deposition (APLD) technique, a variant of the Atomic Layer Deposition (ALD) that allows precise control of the composition by ultrashort pulses and submonolayer doses. The APLD technique allows the Hf:Ti ratio to be adjusted through the individual exposure time of the precursors, making it easier to obtain films with compositional gradients and adjustable functional properties. HfTiO films were deposited with different doses of Hf, keeping the Ti precursor constant, and electrically characterized in coplanar and transversal configurations by capacitance measurements at 10 Hz. The results show that it is possible to control the effective dielectric constant ϵ_{eff} over a wide range (from ~ 17 to ~ 40), depending on the ratio of HfO_2 and TiO_2 in the mixture. It was observed that a higher concentration of Hf tends to reduce ϵ_{eff} , while a higher Ti content significantly increases the dielectric response. These variations are attributed to the local modulation of the internal electric field and the electron polarizability of the dominant species. APLD's versatility in multi-component complex oxide engineering positions this technique as an effective alternative for the design of high-efficiency dielectric materials, applicable in ferroelectric memories, field-effect transistors (FeFETs), resistive storage devices (RRAM), and advanced RF systems

Keywords:

APLD, Nanocapacitors, Dielectric constant.

Reference:

M. I. Pérez-Valverde, E. López-Luna, E. Martínez-Guerra, J. G. R. Hernández-Arteaga, M. A. Vidal; An innovative approach to control the Hf/Ti ratio in monolayers grown via atomic partial layer deposition. J. Appl. Phys. 21 September 2024; 136 (11): 115301.

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación (Secihti)



GRAPHENE-HETEROSTRUCTURE SENSORS FOR HIGH-SENSITIVITY SENSING

Autores: Uriel Alcides Torices Saucedo¹; Jessica Surisadai Rodríguez Aguilar¹; Marco Antonio Ramírez Orozco¹; Nayeli Colin Becerril¹; Carlos Ernesto Ávila Crisóstomo¹; Jose Angel Guillen-Cervantes²; Luis Martin Reséndiz Mendoza¹; Yenny Lucero Casallas-Moreno³

¹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas. Instituto Politécnico Nacional*

² *Departamento de Física, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Unidad Zacatenco.*

³ *Secretaría de Ciencia, Humanidades, Tecnología e Innovación-Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional*

Autor responsable de la comunicación: topitoeleven@gmail.com

Graphene's outstanding electrical properties make it an ideal candidate for advanced electronic and sensing applications; however, preserving these properties after substrate transfer is a critical challenge. This work focuses on evaluating the performance of a graphene-based sensor formed of commercially acquired monolayer graphene on copper, transferred to silicon dioxide (SiO₂) on silicon substrates, by analyzing its source-drain current-voltage (I-V) characteristics. The main objective is to assess the impact of the transfer process on the integrity and electrical performance of the graphene layer. A wet transfer method was used to transfer the graphene onto the SiO₂/Si substrate. Gold contacts with a thickness of 10 nm were deposited to define a two-terminal configuration, enabling direct measurement of current as a function of applied source-drain voltage. The I-V curve was obtained under ambient conditions using a semiconductor parameter analyzer. Results show a linear and symmetric I-V response, indicative of ohmic behavior and minimal contact resistance, confirming successful preservation of graphene's conductivity post-transfer. Deviations from linearity, when present, were attributed to wrinkles, polymer residues, or interfacial defects introduced during the transfer. This straightforward electrical characterization provides a reliable and non-destructive method to assess the quality of transferred graphene films, which is essential for further integration into field-effect transistor (FET) architectures or sensing platforms.

Keywords:

Graphene, I-V characterization, substrate transfer, ML-G, Graphene-based sensors.

Reference:

Y. Ren, C. Zhu, W. Cai, H. Li, Y. Hao, Y. Wu, S. Chen, Q. Wu, R. D. Piner, and R. S. Ruoff, An improved method for transferring graphene grown by chemical vapor deposition, *Nano* 7 (2012) 01.
<https://doi.org/10.1021/nl203177p>

This work was supported by:

The authors sincerely thank the IPN and SECIHTI for their financial support in this work. We particularly thank SIP 20253723, SIP 20254808, PRORED 20254785, and the Frontier Science projects SECIHTI CF-2023-I-1117 and SECIHTI CBF-2025-I-3719. U.A. Torices Saucedo would like to thank Norma González García, Edmundo Rodríguez, and Miguel Avendaño from the Solid-State Electronics Department at CINVESTAV-Zacatenco for their technical support.



SYNTHESIS AND CHARACTERIZATION OF SILVER CHLORIDE NANOPARTICLES USING EICHHORNIA CRASSIPES EXTRACT

Autor: Martha Lizette Cabrera Meza¹

Coautores: Adalberto Zamudio Ojeda ²; Cesar Miguel Gomez Hermosillo ³; Santiago Jose Guevara Martinez⁴

¹ *Licenciatura en Ciencia de Materiales, Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías*

² *Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías.*

³ *Departamento de Ingeniería en Química, Centro Universitario de Ciencias Exactas e Ingenierías*

⁴ *Departamento de Farmacobiología, Centro Universitario de Ciencias Exactas e Ingenierías.*

Autor responsable de la comunicación: martha.cabrera0504@alumnos.udg.mx

Nanotechnology has increasingly been recognized as a highly promising approach to technological advancement in multiple sectors, especially via the green synthesis of nanoparticles. This methodology has gained relevance in industries such as cosmetics, medicine, and technology, as it significantly reduces the use of toxic chemical reagents, thereby minimizing risks to human health and the environment, while also lowering production costs and time. Specifically, the use of plant extracts rich in secondary metabolites with antioxidant properties has enabled more precise control over the physicochemical characteristics of nanoparticles, such as their size and morphology. In this context, *Eichhornia crassipes*, commonly known as water hyacinth, an invasive species widely distributed in freshwater bodies, represents a promising source of bioactive compounds for the production of silver chloride nanoparticles (ClAg). However, scientific literature on the physicochemical properties and potential applications of *Eichhornia crassipes* remains limited, hindering its comprehensive utilization and ecological control. Therefore, the present study aimed to synthesize and characterize silver chloride nanoparticles using water hyacinth extracts through two different methodologies. Additionally, the antioxidant activity of the extract was assessed. The obtained nanoparticles were characterized by UV-Vis spectroscopy, dynamic light scattering (DLS), and scanning electron microscopy (SEM), revealing a hydrodynamic radius of less than 5 nm and a polydispersity index (PDI) close to zero, confirming their high monodispersity. Furthermore, the antioxidant activity was evaluated in extracts obtained from leaves dried at 100 °C, which showed the highest concentrations of total phenolic compounds (17.66 mg GAE/gDM), flavonoids (7.90 mg QE/gDM), proanthocyanidins (22.05 mg CE/gDM), and tannins (32.05 mg TAE/gDM). These extracts also exhibited high antioxidant capacity, as determined by the ABTS (88.95 %) and DPPH (86.15 %) methods. These compounds not only contribute to the reduction and stabilization of silver nanoparticles, but also appear to play a key role in the biocompatibility observed in assays with model organisms.

Keywords:

Nanoparticles, *Eichhornia crassipes*, Green synthesis, silver oxide, water lily.

Reference:

Juan Carlos Martínez-Espinosa, María Antonieta Ramírez-Morales and Raúl Carrera-Cerritos, "Silver Nanoparticles Synthesized Using *Eichhornia crassipes* Extract from Yuriria Lagoon, and the Perspective for Application as Antimicrobial Agent", *Crystals* 2022, 12, 814.. <https://doi.org/10.3390/cryst12060814>.

Ris work was supported by:

El programa IxM SECIHTI proyecto 348. Asimismo, agradecemos a la M. en C. Ana Iris Peña Maldonado del Laboratorio LINAN del IPICYT, A.C. (San Luis Potosí, México) por la asistencia técnica proporcionada en los ensayos de SEM-EDS.



COMPARATIVE ANALYSIS OF THE EXFOLIATION METHODS FOR 3:1:2 TITANIUM CARBIDES MXENES OBTAINED BY MICROWAVE ASSISTED HYDROTHERMAL SYNTHESIS

Autor: Jorge Luis Peñuela Mendoza¹

Coautores: Ricardo Mis Fernández¹; Eduardo Ernesto Flores Cuevas²; David Meneses Rodríguez¹

¹ *Departamento de Física Aplicada, Centro de Investigación y Estudios Avanzados del Instituto Politécnico Nacional, Unidad Mérida*

² *Centro de Investigaciones y Estudios Avanzados del Instituto Politécnico Nacional*

Autor responsable de la comunicación: jorgepenuelam@gmail.com

MXenes are a promising class of two-dimensional materials due to their suitable electrical, mechanical and chemical properties as well as their notable specific surface area, particularly for applications in energy storage devices. In this work, we compare different exfoliation techniques to improve the specific surface area of titanium carbide MXenes. These MXenes were synthesized by selective etching of Ti_3AlC_2 (MAX phase) with HF in a PTFE vessel using a microwave (MW) reactor during 40 min at 40 °C of temperature. The material obtained was subsequently washed and centrifugated. Three different exfoliation methodologies were employed and evaluated in the multilayer MXenes including lithium chloride intercalation, ultrasonic treatment and ball milling. Morphological and structural studies have demonstrated that titanium carbides MXenes are arranged in an accordion configuration, as evidenced by scanning electron microscopy (SEM) images. The characterization of layered morphology demonstrated the formation of lamellar structures exhibiting a low degree of exfoliation. The presence of a rough and folded surface has led to the formation of channels. These channels have promoted the reactivity of the material by forming ultrathin films with a large surface area, as confirmed by BET analysis. Another characterization performed was X-ray diffraction (XRD), in which significant changes in the diffraction peaks were observed after the application of HF etching treatment. Furthermore, a reduction in the intensity of the peaks corresponding to the MAX phase and the appearance of new peaks associated with the formation of MXenes structures were identified. In addition, Raman spectroscopy yielded insights into the structural and surface chemistry of MXenes in both multilayered and single-layered samples that were synthesized. The effectiveness of the methodology employed for synthesizing MXenes was ultimately confirmed. After a comprehensive evaluation of the available exfoliation methods, it was determined that the ballmilling process is the most effective solution.

Keywords:

Titanium Carbides, MXenes, Bidimensional, Exfoliation

Reference:

M. A. A. M. Abdah, J. Cherusseri, N. A. Dzulkarnain, M. Mokhtar, M. S. Su'ait, Y. S. Tan, M. N. Mustafa, M. Khalid, A. Numan, A. Radwan, *Journal of Electroanalytical Chemistry* 2023, 928, DOI 10.1016/j.jelechem.2022.117050.

Ris work was supported by:

Secretariat of Science, Humanities, Technology and Innovation (SECIHTI) and Research and Advanced Studies Center (Cinvestav) fellowships



SYNTHESIS AND CHARACTERIZATION OF LUMINESCENT GRAPHENE OXIDE NANOPARTICLES FROM ORGANIC WASTE

Autores: Abdu Orduña Diaz¹; Francisco Severiano Carrillo²; MARCO ANTONIO AGUILA JUAREZ¹; Orlando Zaca Moran¹; Zeus Saldaña Ahuatzci¹

¹*Instituto Politécnico Nacional, Centro de Investigación en Biotecnología Aplicada Unidad Tlaxcala, C.P. 90700Car- retera a Santa Inés Tecuexcomac, a 1.5 Km, Ex-Hacienda San Juan Molino*

²*Instituto Politécnico Nacional, Centro de Investigación en Biotecnología Aplicada Unidad Tlaxcala, C.P. 90700Car- retera a Santa Inés Tecuexcomac, a 1.5 Km, Ex-Hacienda San Juan Molino, CONACYT, Av. Insurgentes Sur 1582, Col. Crédito Constructor, Del. Benito Juárez C.P.: 03940, Ciudad de México*

Autor responsable de la comunicación: maguilaj2500@alumno.ipn.mx

This study reports the synthesis of graphene oxide nanoparticles (GONPs) from organic waste such as mandarin and lemon peels. The biomass was previously selected, washed, dehydrated, and subjected to laser ablation, resulting in a black particulate material identified as graphene oxide. The samples were characterized using Fourier-transform infrared spectroscopy (FTIR), fluorescence spectroscopy, and UV-Visible spectroscopy to evaluate their physicochemical properties. FTIR spectra indicated a lower presence of oxygen-containing functional groups in the regions of 3200–3600 cm^{-1} , 1650–1750 cm^{-1} , and 1000–1300 cm^{-1} . On the other hand, fluorescence spectroscopy revealed that the material emits fluorescence in the wavelength range of 480 nm to 520 nm. These fluorescent materials have a wide range of applications, particularly in fields such as biomedicine, imaging diagnostics, biomarker detection, controlled drug delivery, and biosensor design. The combination of their sustainable origin, optical properties, and potential biocompatibility makes them a promising alternative for the development of advanced technological platforms for disease diagnosis and treatment.

Keywords:

Graphene oxide, laser ablation, physicochemical characterization, fluorescence, nanostructures

Reference:

Zaca, O., Severiano, F., Ordu, A., & M, J. F. (2025). Nano Trends Study of properties of graphene oxide nanoparticles obtained by laser ablation from banana , mango , and tangerine peels. 9(December 2024). <https://doi.org/10.1016/j.nwnano.2025.100091>

Ris work was supported by:

Supported by SECITHI through project CF-2023-G-1080, and additionally by a postgraduate scholarship, also funded by the IPN through project SIP20250124.



PREDICTION OF PERFORMANCE PARAMETERS OF A SPR BIOSENSOR WITH HYPERBOLIC METAMATERIAL USING MACHINE LEARNING

Autor: Jesús Madrigal Melchor¹

Coautores: Javier Flores Avalos ¹; Daniel Alberto Rodríguez Reyes ¹; Ireri Aydée Sustaita Torres ²

¹ *Unidad Académica de Ciencia y Tecnología de la Luz y la Materia, Universidad Autónoma de Zacatecas*

² *Unidad Académica de Ingeniería Eléctrica, Universidad Autónoma de Zacatecas*

Autor responsable de la comunicación: jmadrim@uaz.edu.mx

Optical metamaterials are artificial structures designed to precisely manipulate electromagnetic waves. Among them, hyperbolic metamaterials (HMMs) stand out due to their high anisotropy and hyperbolic dispersion relation, enabling applications in negative refraction, high-resolution imaging, and biosensing. Specifically, the integration of HMMs into Surface Plasmon Resonance (SPR) biosensors has enhanced key performance parameters such as sensitivity, quality factor, figure of merit, and detection accuracy, due to the improved confinement of the electromagnetic field at the biosensor/analyte interface [1]. However, predicting performance parameters is challenging because of the variety of metrics involved in SPR biosensors. In this context, artificial intelligence (AI) has emerged as a powerful tool for forecasting performance parameters. In this work, we generate a dataset of SPR biosensors with a Kretschmann-type configuration (prism/metal layer/HMM/analyte) using the Transfer Matrix Method (TMM). This dataset served as the input for training various machine learning models, including linear regression, polynomial regression, Support Vector Machine (SVM), and Random Forest, to predict performance parameters such as sensitivity and figure of merit, which were defined as target outputs. The predicted results showed strong agreement with computational values obtained via the TMM. Finally, the models were validated using techniques such as cross-validation and error minimization metrics, with Random Forest delivering the most accurate predictions.

Keywords:

Hyperbolic Metamaterial, Machine Learning, Biosensors, Surface Plasmon Resonance

Reference:

[1] M. A. Baqir and P. K. Choudhury, "Hyperbolic Metamaterial-Based Optical Biosensor for Detecting Cancer Cells," in *IEEE Photonics Technology Letters*, vol. 35, no. 4, pp. 183-186, 15 Feb. 15, 2023, doi: 10.1109/LPT.2022.3228943.

Ris work was supported by:

secihti



STRUCTURAL AND MAGNETIC PROPERTIES OF Mn-Zn FERRITE ACCORDING TO THE EFFECT ON POLYMER MATRIX

Autores: Luis Yoelvys Naranjo-Sabina¹; Pierre Giovanni Mani González²

Coautores: Carlos Roberto Santillán Rodríguez³; Eduardo Martínez Guerra⁴; Francisco Medellín⁵; Hortensia Reyes¹; Lorena Rivera Ríos¹; Vladimir Escobar⁶

¹ Instituto de Ingeniería y Tecnología, Universidad Autónoma de Ciudad Juárez, Av. del Charro 450, Ciudad Juárez, C.P. 32310, Chihuahua, México.

² Universidad Autónoma de Ciudad Juárez

³ CIMAV Chihuahua Centro de Investigación en Materiales Avanzados, Unidad Chihuahua, Chihuahua 31109, Mexico

⁴ CIMAV Monterrey Centro de Investigación en Materiales Avanzados S.C., Unidad Monterrey, Alianza Norte 202, C.P. 66628 Apodaca, N.L., México

⁵ Centro de Investigación en Química Aplicada, Blvd. Enrique Reyna Hermosillo, 140, C.P. 25294 Saltillo, Coahuila., México

⁶ Instituto Potosino de Investigación Científica y Tecnológica A.C. Camino a la Presa San José, Lomas 4 sección, C.P. 78216 San Luis Potosí., México

Autor responsable de la comunicación: pierre.mani@uacj.mx

Study on Mn-Zn ferrites based on the characterization of their magnetic and structural properties is presented. Mn-Zn ferrites embedded in a polymeric matrix are addressed to understand their potential for electromagnetic interference (EMI) applications. The methodology for the synthesis and characterization of ferrites/polymeric matrix to measure magnetic and structural properties is presented. Vibrating sample magnetometer (VSM), scanning electron microscopy (SEM), X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), and X-ray photoelectron spectroscopy (XPS) are used to measure the magnetic properties, morphological and chemical composition, the crystalline structure, functional groups and stoichiometry, respectively. The obtained results are analysed, revealing information about the crystalline structure, particle size (0.9 μm), crystallite size (23 nm), homogeneity, and magnetization (90 emu/g) of Mn-Zn ferrites. Furthermore, the effect of these ferrites on the magnetic properties of the composite (ferrites/polymeric matrix) is examined based on the percentage (3 %, 5 %, and 7 %) of ferrites used in its preparation, for example.

Keywords:

Mn-Zn ferrites, magnetic properties, structural properties, polymeric matrix.

Reference:

J. Bennet et al Appl. Surf. Sci. 383, 113 (2016). R. Wirecka, et al Surfaces and Interfaces 30, 101865 (2022). L. Shao et al, J. Mater. Sci. Mater. Electron. 32, 20474 (2021).



EXPERIMENTAL AND REORICAL ELECTRONIC STATES STUDIED FOR $\text{GaN}_x\text{As}_{1-x}$ MULTIQUANTUM WELL HETEROSTRUCTURES.

Autores: Jesús Rolando Pinson Ortega¹; Victor Hugo Mendez Garcia²

Coautores: Leticia Ithsmel Espinosa Vega ³; Arely Michelle Puente Rivera ⁴; Guadalupe del Carmen Yopez Barradas ⁴; Alexis Fernández Fernández ⁴; Ángel Iván Méndez García ³; Marcos Ivan Bustos ibarra ⁵; María Fernanda Mora Herrera ¹; Daniel Lopez Vilchis ²; Cristo Manuel Yee Rendon ⁶; Héctor Félix Quintero ⁷; Irving E. Cortes-Mestizo⁸

¹ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología, Universidad Autónoma de San Luis Potosí

² Universidad Autonoma de San Luis Potosi

³ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí

⁴ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

⁵ CIACyT, UASLP

⁶ Universidad Autónoma de Sinaloa

⁷ Facultad de Ciencias Físico-Matemáticas, Universidad Autónoma de Sinaloa

⁸ SECIHTI-UASLP

$\text{GaN}_x\text{As}_{1-x}$ alloys have attracted significant interest due to their nature as highly mismatched alloys (HMA), where the large difference in electronegativity and atomic size between nitrogen and the host matrix atoms leads to a splitting of the conduction band (CB). This interaction gives rise to two distinct subbands: the lower energy E^- band and the higher energy E^+ band. Consequently, three optical transitions are theoretically allowed within a single layer: (i) valence band (VB) to E^- , (ii) E^- to E^+ , and (iii) VB to E^+ . The introduction of quantum confinement (such as in quantum well systems) could further enrich the transition spectrum. Based on these characteristics, we have proposed a novel quantum well heterostructure comprising GaNAs/GaAs/GaNAs layers embedded within AlGaAs barriers. This design enables the formation of two relevant quantum mechanical potential profiles: a symmetrical double-well (SDW), characterized by two potential minima separated by a barrier, and a step-graded quantum well (SGW), formed by sandwiching a deep well between intermediate symmetrical barriers. Both types of potentials are realized using GaNAs as the active HMA material. The heterostructures were grown by MBE, the GaNAs layers, incorporating $\sim 1.4\%$ nitrogen, were grown between $\text{Al}_x\text{Ga}_{1-x}\text{As}$ barriers with varying aluminum content (x from 0.3 to 1), aiming to achieve selective confinement of carriers through both the E^- and E^+ bands. Room-temperature photoreflectance (PR) spectroscopy was performed to identify electronic transitions associated with confined states in the GaNAs quantum wells. The experimental spectra exhibit well-defined transitions associated with the electron-confined quantum states. These energies were compared to theoretical simulations and showed partial agreement with the experimental values. PR combined with band structure simulations is a reliable approach to characterize dilute nitride MQW heterostructures. Raman spectroscopy further revealed good crystalline quality and clear signatures of the nitrogen local vibrational modes.

Keywords:

Molecular Beam Epitaxy, Multi Quantum Well, Quantum confinement, Heterostructure

Ris work was supported by:

The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, CONAHCYT CF-2023-I- 1300, and Investigadoras e Investigadores por Mexico.



MBE QUANTUM DOT SHAPE ENGINEERING THROUGH REAL TIME RHEED MONITORING DURING OVERGROWTH

Autores: Daniel Lopez Vilchis¹; Víctor Hugo Méndez García¹

Coautores: Maria Fernanda Mora Herrera ²; Guadalupe del Carmen Yépez Barradas ³; Alexis Fernández Fernández ³; JESUS ROLANDO PINSON ORTEGA ⁴; Jesús Samuel Sámano González ⁵; Ángel Iván Méndez García ⁶; David Vazquez Cortes ⁷; Irving Eduardo Cortes Mestizo ⁸; Leticia Ithsmel Espinosa Vega ⁶

¹ Universidad Autónoma de San Luis Potosí

² Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

³ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí

⁴ Center for the Innovation and Application of Science and technology, Universidad Autónoma de San Luis Potosí (UASLP), Av. Sierra Leona #550, Col. Lomas 2a Sección, 78210, San Luis Potosí, México.

⁵ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

⁶ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí

⁷ Mechanics and Materials Unit, Okinawa Institute of Science and Technology Graduate University (OIST)

⁸ Secretaría de Ciencia, Humanidades y Tecnología, Universidad Autónoma de San Luis Potosí

Autor responsable de la comunicación: a322730@alumnos.uaslp.mx

In recent decades advances in nanotechnology have arisen beyond the academic field with nanostructures implemented in a variety of products already present in our daily lives. From the wide range of nanostructures Quantum Dots (QD's) exhibit the narrowest density of states (DOS) which can be tailored through composition, size and even shape. In order to comprehend the effects of the size and shape on quantum dots molecular beam epitaxy (MBE) surges as a reliable tool because of the monolayer precision and low concentration of impurities in samples. With the use of MBE, another powerful tool in the research of structural properties is enabled, the Reflection High Energy Electron Diffraction (RHEED) technique. RHEED is widely used in MBE systems as it yields an insight of the whole deposition process through intensity oscillations and the diffraction patterns as the electron beam scatters at the sample's surface. Through RHEED the flattening of the surface, the shape of nano islands, the appearance of chevrons and a wide list of phenomena have been explained before, but the process that a three-dimensional structure undergoes when covered by barely few nanometers of a different material is still under research, and it constituted the objective of this work. First, InAs quantum dots self-assembled on GaAs layers. MBE allows for a great deal of reproducibility in such a way that each layer of QDs we grew observed the same critical thickness and same diffusion parameter as well. Next, the capping process with AlGaAs was started and the diffracted patterns and the RHEED intensity behavior along the overgrowth process were analyzed. It is found that both, the the capping growth rate and the Al original dot's size affects the changes in morphology of QDs. For instance, by increasing the growth rate of AlGaAs the molecular beams interact with InAs in lesser extent, allowing for retain the QDs shape. Similar effect was observed by increasing the Al content of the capping layer. Therefore, this study may serve for establish the bases of search for a higher reproducibility rate and the possibility to tailor the mean size and shape of the dots when encapsulated, which is of great importance in the multilayered stacked QDs heterostructures and devices.

Keywords:

Molecular Beam Epitaxy, Quantum Dots, RHEED, nanostructures.

His work was supported by:

This work was supported by: The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, and financial support from COPOCyT Fideicomiso 23871, SECIHTI CF-2023-I-1300, and Investigadoras e Investigadores por México.



PHYSICS INFORMED MACHINE LEARNING FOR SPR BIOSENSORS.

Autor: Daniel Alberto Rodriguez Reyes¹

Coautores: Ileri Aydée Sustaita Torres²; Jesus Madrigal Melchor³

¹ *Unidad Académica de Ciencia y Tecnología de la Luz y la Materia*

² *Universidad Autónoma de Zacatecas, Unidad Académica de Ingeniería Eléctrica*

³ *Universidad Autónoma de Zacatecas*

Autor responsable de la comunicación: dani070397@gmail.com

Can an artificial intelligence design a biosensor?

We know that machine learning models have been used in the area of particle physics, design of new materials, drug design, astrophysics, meteorology, among others. However, it has been shown that many of the predictions of physical variables by machine learning are not physically plausible, so it is necessary to apply algorithms subject to constraints. Recently, physics-based machine learning has emerged, which allows solving physical systems subject to boundary conditions or desired physical properties. In this poster we present how physics-based machine learning can allow us to perform an inverse design of an SPR biosensor. Finally we will show some results that we have obtained through models to predict performance parameters of a surface plasmon resonance biosensor, as well as the prediction of some geometrical parameters.

Keywords:

Machine Learning, SPR Biosensor, optical properties.

Reference:

Mondal, H. S.(2023). Machine learning for detecting DNA attachment on SPR biosensor. <https://doi.org/10.1038/s41598-023-29395-1>

Patel, S.(2024). Optimization of Novel 2D Material Based SPR Biosensor Using Machine Learning. <https://doi.org/10.1109/TNB>.

Ris work was supported by:

SPR Biosensor



EPITAXIAL GROWTH AND STRUCTURAL CHARACTERIZATION OF InAs NANOWIRES ON GRAPHENE-COATED Si(111) SUBSTRATES

Autor: Miguel González¹

Coautores: Máximo López López²; J.G. Mendoza Alvarez³; Manolo Ramírez López⁴; José Luis Herrera Pérez⁵; yenny L Casallas-Moreno⁶

¹ Upiita-IPN

² Departamento de Física, CINVESTAV-IPN, Apdo. Postal 14-740, 07000 México D.F., México

³ Centro de Investigación y de Estudios Avanzados del I.P.N., Departamento de Física,

⁴ upiita, IPN

⁵ Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional

⁶ Conahcyt-UPiITA-IPN

Autor responsable de la comunicación: mglez0193@gmail.com

Nanoscale semiconductor materials have emerged as a powerful platform for next-generation optoelectronic devices, owing to their tunable properties and high efficiency. Among them, nanowires stand out due to quantum confinement effects that enhance their electronic behavior, making them ideal candidates for applications such as photodetectors and infrared transistors. Within the III-V family, indium arsenide (InAs) is particularly attractive for these purposes due to its direct band gap and high electron mobility at room temperature. In this study, we explore the growth of InAs nanowires using molecular beam epitaxy (MBE) on Si(111) substrates coated with a monolayer of graphene, aiming to improve structural uniformity and crystalline quality. The influence of growth temperature on the nanowires' properties was systematically studied, using advanced characterization techniques including high-resolution X-ray diffraction (HR-XRD), Raman spectroscopy, scanning electron microscopy (SEM), and transmission electron microscopy (TEM). HR-XRD confirmed the crystalline nature of the nanowires, revealing reflections consistent with InAs 111, 022, and 222 planes. SEM images showed that selected samples displayed vertically aligned nanowires along the $\langle 111 \rangle$ crystallographic direction. TEM analysis further revealed well-aligned atomic planes, reinforcing the epitaxial relationship between the nanowires and the substrate. Raman spectroscopy identified a shift in the transverse optical (TO) mode around 210 cm^{-1} , attributed to phonon confinement and variations in nanowire diameter, as well as the presence of the surface optical (SO) mode near 230 cm^{-1} . These observations demonstrate that the inclusion of a graphene monolayer enhances the uniformity and crystalline integrity of InAs nanowires, while temperature plays a critical role in tuning their morphological and structural features. The results confirm the viability of this growth method for future implementation in optoelectronic technologies operating across the near- to mid-infrared spectrum.

Keywords:

Molecular Beam Epitaxy, InAs nanowires, III-V semiconductors, Graphene integration

Reference:

Liu, Junting, et al., J. Phys. Chem. Lett. 10, (2019).

Ris work was supported by:

Authors thank project CONAHCYT-Frontier Science 2023 CF-2023-I-1117, COFAA-IPN and Instituto Politécnico Nacional for financial support.



MANGANESE NANOFERRITES COATED WITH PSIDIUM GUAJAVA EXTRACT FOR MAGNETIC HYPERTHERMIA APPLICATIONS

Autor: Brayan Javier Lorenzano Hernández¹

Coautores: Nidia Esther Moreno Cabrera ¹; Blanca Estela Zendejas Leal ²; Jaime Santoyo Salazar ²

¹ Programa de Doctorado en Nanociencias y Nanotecnología, Centro de Investigación y Estudios Avanzados del Instituto Politécnico Nacional, Av. IPN No. 2508, Col. San Pedro Zacatenco, Ciudad de México 07360, México.

² Departamento de Física, Centro de Investigación y Estudios Avanzados del Instituto Politécnico Nacional, Av. IPN No. 2508, Col. San Pedro Zacatenco, Ciudad de México 07360, México.

Autor responsable de la comunicación: brayan.lorenzano@cinvestav.mx

Magnetic hyperthermia-based therapies have emerged as a promising alternative for the localized treatment of various types of cancer, enabling localized heat generation through the excitation of magnetic nanoparticles under an alternating magnetic field. In this study, manganese ferrite nanoparticles ($\text{MxFe}_3\text{-xO}_4$, where $\text{M} = \text{Mn}^{2+}$) coated with polyphenols extracted from Psidium guajava were synthesized to evaluate their physicochemical, structural, and morphological properties for potential therapeutic application. Transmission electron microscopy (TEM) analysis showed a semispherical morphology with homogeneous coatings and average particle sizes between 8.3 and 13.4 nm. The coating thickness ranged from 2.31 to 2.44 nm, with no significant differences between compositions, suggesting an affinity of the -OH bonds of the plant extract for the nanoparticle surface. Electron diffraction (SAED) and X-ray diffraction (XRD) patterns confirmed the formation of MnFe_2O_3 ferrite with cubic spinel structure and the contribution from the dispersion of polyphenols. The uniform distribution of the rings and the indexing of planes such as (220), (311), (400), (422), (442) and (622), coincide with PDF letter 74-2403. Slight variations in the lattice parameter attributable to the incorporation of Mn^{2+} were observed, suggesting an effect on the lattice strain and crystallite size. Infrared spectroscopy analysis revealed a broad band at 3400 cm^{-1} attributed to the O-H stretching of polyphenols, indicating their uniform presence on the Mn ferrite nanoparticles. Characteristic signals of aromatic C=C and phenolic C-O bonds were identified, confirming the interaction of the coating with the surface. The band at 572 cm^{-1} corresponds to Fe-O stretching. The preliminary results demonstrate adequate control in the synthesis and functionalization of the nanoparticles, and constitute an important advance in their physicochemical characterization.

Keywords:

Nanoparticles, ferrites, polyphenols, hyperthermia, cancer

Reference:

Recent advances of superparamagnetic iron oxide nanoparticles and its applications in neuroscience under external magnetic field

Ris work was supported by:

Programa de Becas Nacionales para Estudios de Posgrado de la Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECIHTI) No. 4019189.



SELF-ORGANIZED METAL NANOPARTICLES ON SiO₂ SURFACE NANOPATTERNS INDUCED BY MEV ION IMPLANTATION

Autor: Cristian Felipe Cruz García¹

Coautores: Miguel Angel Garcia ²; Jorge Rickards ¹; Luis Ricardo De la Vega ³; Erick Lopez ³; Jaqueline Cañetas-Ortega ¹; Juan Gabriel Morales-Morales ¹; Luis Rodríguez Fernández ¹

¹ *Instituto de Física*

² *Facultad de Ciencias*

³ *Academia de Matemáticas*

Autor responsable de la comunicación: cris-106-fis@ciencias.unam.mx

Although the effects of radiation on insulators are primarily known by changes in their optoelectronic properties and structural damage, irradiation of these materials with MeV ions leads to the formation of surface nanopatterns. Furthermore, irradiation of these materials with metal ions at high doses is known to promote the synthesis of near-surface plasmonic nanoparticles. In this work the formation of metal nanoparticles is produced and found to be organized onto patterned surfaces as produced by MeV ion implantation on SiO₂ substrates at an impinging angle of 60°. The ion fluence ranged between $0.4 \times 10^{17} \text{ cm}^{-2}$ and $2.0 \times 10^{17} \text{ cm}^{-2}$. The surface morphology and topography of the implanted substrates were analyzed by atomic force microscopy (AFM) and scanning electron microscopy (SEM), respectively. For the lowest fluences ($0.4 - 0.8 \times 10^{17} \text{ cm}^{-2}$), the formation of isolated surface structures on a flat background was observed whose morphology mimics the exoskeleton of a bug. For intermediate fluences ($0.8 - 1.5 \times 10^{17} \text{ cm}^{-2}$), a ripple background now appears and begins to surround the bugs. At the highest fluences ($1.8 - 2.0 \times 10^{17} \text{ cm}^{-2}$), the surface shows only a ripple pattern. According to SEM-EDS analysis, the formation of metal nanoparticles was observed along the crests of the surface ripples. The growth dynamics of the ripples were studied based on the classical models for pattern formation, while the formation of metal nanoparticles along the crests of the ripples was explained by a geometric shadowing effect. Finally, the optical absorption of the samples shows the presence of a localized surface plasmon resonance (LSPR), associated with the metal nanoparticles.

Keywords:

silica glass, ion implantation, surface patterns, surface bugs, linear growth

Ris work was supported by:

Dirección General de Asuntos del Personal Académico (DGAPA) from Universidad Nacional Autónoma de México under Programa de Apoyo a Proyectos de Investigación e Innovación Tecnológica (PAPIIT) grant IN110425.



COMPARATIVE DFT STUDY OF PRISTINE AND NITROGEN-DOPED GRAPHYNE AS NANOCARRIERS FOR THE DELIVERY OF TAMOXIFEN IN BREAST CANCER TREATMENT

Autores: César Arturo Quej Solís¹; Christian Alejandro Celaya López²

Coautores: Francisco Ramón Peñuñuri Anguiano ¹; César Alberto Cab Cauich ¹; Miguel Reina ³

¹ *Universidad Autónoma de Yucatán*

² *Centro de Nanociencias y Nanotecnología-UNAM*

³ *Facultad de Química - UNAM*

Autor responsable de la comunicación: cesaraqs27@gmail.com

Breast cancer remains a major global health challenge due to its high incidence, mortality, and limitations of current treatments, including drug resistance and adverse effects. Tamoxifen (TAM) is the standard endocrine therapy for estrogen receptor-positive breast cancer, but its efficacy is often compromised by these limitations. Nanomaterials, particularly carbon-based structures like γ - graphyne (GY), have emerged as promising candidates to improve drug delivery. In this context, we present a comparative density functional theory (DFT) study of pristine GY and nitrogen-doped GY (N-GY) as nanocarriers for TAM delivery. Taking into account recent advances in the synthesis of nitrogen-doped graphyne (Yang et al., 2020), we analyzed and compared the structural stability, adsorption energy, and electronic reactivity of TAM/GY and TAM/N-GY systems. Our results show that TAM exhibits similar adsorption energies on both surfaces (-1.08 eV for GY and -1.06 eV for N- GY), suggesting that nitrogen doping does not significantly enhance TAM binding. Density of states and charge density difference analyses confirm that TAM adsorption on both materials proceeds through stable noncovalent interactions. Furthermore, ab initio molecular dynamics simulations at 300 K demonstrate that both systems maintain structural integrity under physiological conditions. These findings provide valuable insights into the role of nitrogen doping in drug delivery and suggest that pristine GY may serve as an effective and resource-efficient nanocarrier for tamoxifen in breast cancer treatment.

Keywords:

Graphyne, breast cancer, drug delivery, DFT, molecular dynamics

Reference:

Yang, C., Qiao, C., Chen, Y., Zhao, X., Wu, L., Li, Y., Jia, Y., Wang, S., and Cui, X., Nitrogen doped γ -Graphyne: a novel anode for High-Capacity rechargeable Alkali-Ion batteries. *Small*, 16(10) (2020) <https://doi.org/10.1002/sml.201907365>

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECIHTI), the Facultad de Ingeniería of the Universidad Autónoma de Yucatán (FIUDAY), and the Centro de Nanociencias y Nanotecnología of the Universidad Autónoma de México (CNyN-UNAM).



EVALUATION OF CURCUMIN-FUNCTIONALIZED IRON MAGNETIC NANOPARTICLES ON SPERMATOGENESIS IN CD1 MICE.

Autor: Daniela Flores-Ortiz¹

Coautores: Gerardo Norberto Escalona-Cardoso ¹; Jaime Santoyo Salazar ²; Margarita Lizeth Alvarado Noguez ³; Placido Rojas-Franco ¹; Rolando Castillo ⁴

¹ *Departamento de Fisiología, Escuela Nacional de Ciencias Biológicas-Instituto Politécnico Nacional*

² *Departamento de Física, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional*

³ *Departamento de Física, Centro de Investigación y de Estudios Avanzados-IPN*

⁴ *Instituto de Física, Universidad Nacional Autónoma de México*

Autor responsable de la comunicación: projasf@ipn.mx

Superparamagnetic iron oxide nanoparticles (SPIONs) have attracted considerable attention in recent years due to their broad range of scientific and technological applications, particularly in the development of functionalized nanomaterials with bioactive therapeutic agents. Among these, curcumin, the principal polyphenolic component derived from *Curcuma longa*, stands out for its diverse pharmacological effects, including antioxidant, antiinflammatory, and anticancer properties. Pre-clinical studies in rodent models have revealed the protective role of curcumin in gonadal tissues subjected to exogenous stress or pathological insults.

In the present study, we report the eco-friendly synthesis of superparamagnetic magnetite nanoparticles functionalized with curcumin, aiming to evaluate their potential toxicity on male reproductive function, specifically spermatogenesis. The resulting nanostructures were characterized using X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), and Thermogravimetric Analysis (TGA). The particles showed a predominantly spherical shape with an average core size of ~15 nm, and a curcumin-based organic composition of 22%.

For in vivo assessment, five groups of male mice were employed (Control, SPIONs at 5 mg/kg, curcumin at 100 mg/kg, and SPION-curcumin hybrids at 5 and 10 mg/kg), each consisting of n = 8 individuals weighing between 28 and 30 g. Evaluated parameters included sperm motility and count, as well as the extent of lipid peroxidation in testicular tissue. Results indicated no significant alterations in sperm quality following SPION-curcumin treatment. Interestingly, a reduction in testicular lipid peroxidation levels was observed.

These findings suggest that curcumin-functionalized SPIONs do not exert deleterious effects on spermatogenesis in male mice and may even confer protective antioxidant benefits at the testicular level.

Keywords:

curcumin, magnetite nanoparticles, spermatogenesis, polyphenol, CD1 mice



SYNERGISTIC HETEROJUNCTION OF CeO₂ NANOTUBES AND La₂Ti₂O₇ NANOSHEETS FOR ENHANCED PHOTOCATALYTIC HYDROGEN EVOLUTION

Autor: Laura Marcela Prieto Zuleta¹

Coautores: Aida Catalina Hernandez Arteaga ²; Edgar Giovanny Villabona Leal ³; Hiram Joazet Ojeda Galván ⁴; Hugo Ricardo Navarro Contreras ⁵; Lourdes Bazán Díaz ⁶; Maritza Iveth Pérez Valverde ⁷; Socorro Oros Ruíz ⁸

¹ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología, Universidad Autónoma de San Luis Potosí. Av. Sierra Leona #550-2^a, Lomas de San Luis, 78210 San Luis Potosí, S.L.P., México.

² Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología, UASLP

³ Departamento de Biotecnológicas Y Ambientales Química, Universidad Autónoma de Guadalajara

⁴ Universidad Autónoma de San Luis Potosí

⁵ Coordinación para la Aplicación de la Ciencia y la Tecnología, UASLP

⁶ Universidad Nacional Autónoma de México (UNAM)

⁷ Tecnológico de Monterrey

⁸ Instituto de Física, UASLP

Autor responsable de la comunicación: lauraprieto@utp.edu.co

Photocatalysis has emerged as an environmentally friendly and economically viable technology harnessing solar light irradiation, offering a promising alternative for green hydrogen generation and greenhouse gas emission reduction [1]. In recent years, extensive research has been conducted on the development of heterojunctions using semiconductors to enhance photocatalytic activity. This study introduces a novel heterojunction NPs@CeO₂@La₂Ti₂O₇ (NPs: Ag, Au) with varying molar ratios, employing semiconductors with CeO₂ nanotube and La₂Ti₂O₇ nanosheet morphologies via hydrothermal synthesis. This methodology boasts several advantages, including innovation, a focus on green chemistry, high performance and efficiency, simplicity of equipment, and operation at intermediate temperatures. The incorporation of NPs via the photo-deposition technique with noble metals such as gold (Au) and silver (Ag) in a 1 wt.% ratio in the formed heterojunction CeO₂@La₂Ti₂O₇ demonstrates a sensitizing effect. Various characterization techniques such as X-ray diffraction (XRD), transmission electron microscopy (TEM), Raman spectroscopy, and diffuse reflectance were employed to confirm the formation of the junction, its crystallinity, morphology, and characteristics. The photocatalytic response of undecorated heterojunctions (CeO₂@La₂Ti₂O₇)

with a molar ratio of 1:2 exhibited an excellent green hydrogen generation rate of 1695 $\mu\text{mol}\cdot\text{h}^{-1}\cdot\text{g}^{-1}$, representing a significant enhancement compared to pure La₂Ti₂O₇ and CeO₂ materials, with improvement factors of 8.2 and 2.5, respectively. Furthermore, the same heterojunction with a molar ratio of 2:1 displayed a hydrogen generation rate of 2049 $\mu\text{mol}\cdot\text{h}^{-1}\cdot\text{g}^{-1}$, resulting in enhancement factors of 9.9 and 3 compared to pristine materials, respectively. Additionally, the addition of AgNPs and AuNPs on the surface of the heterojunction led to an improved performance in green hydrogen generation compared to undecorated heterojunctions, achieving values of up to 2 $\mu\text{mol}\cdot\text{h}^{-1}\cdot\text{g}^{-1}$ for AuNP@CeO₂@La₂Ti₂O₇ (2:1) and 1857 $\mu\text{mol}\cdot\text{h}^{-1}\cdot\text{g}^{-1}$ for AuNP@CeO₂@La₂Ti₂O₇ (1:2).

Keywords:

La₂Ti₂O₇, CeO₂, HJ, photocatalysis, hydrogen generation, hydrothermal synthesis

Reference:

L. M. Prieto-Zuleta et al., "Photocatalytic NT-CeO₂@La₂Ti₂O₇ (1D@2D) Heterojunction With Enhanced Visible Light Activity," *Acta Microscópica*, vol. 32, no. 2, pp. 30–41, 2023.

Ris work was supported by:

Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos-UASLP. Acknowledges SECIHTI



EVALUATION OF THE SPERMATOGENESIS TOXICITY OF MAGNETITE NANOPARTICLES (Fe_3O_4) COATED WITH CURCUMA LONGA L. IN CD1 MICE.

Autor: Alejandra Barrera-Tonis¹

Coautores: Gerardo Norberto Escalona-Cardoso ¹; Jaime Santoyo Salazar ²; Margarita Lizeth Alvarado Noguez ³; Placido Rojas-Franco ¹; Rolando Castillo ⁴

¹ *Departamento de Fisiología, Escuela Nacional de Ciencias Biológicas-Instituto Politécnico Nacional*

² *Departamento de Física, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional*

³ *Departamento de Física, Centro de Investigación y de Estudios Avanzados-IPN*

⁴ *Instituto de Física, Universidad Nacional Autónoma de México*

Currently, superparamagnetic iron oxide nanoparticles (SPIONs) are being extensively studied for their scientific and technological applications, particularly in the functionalization with biologically active compounds for therapeutic purposes. One such compound of interest is curcumin, which exhibits multiple pharmacological properties, notably antioxidant, anti-inflammatory, and anticancer activities. In experimental models involving mice and rats, curcumin has demonstrated a protective effect on the ovaries and testes against exogenous stress or pathological conditions.

In this research work, a green synthesis of superparamagnetic magnetite nanoparticles coated with Curcuma longa extract was carried out, and their toxicity on spermatogenesis was evaluated. The synthesized nanoparticles were characterized by X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), and Thermogravimetric Analysis (TGA). The nanoparticles exhibited a spherical morphology with an average diameter of approximately 13 nm, and an estimated organic coating thickness of ~1.5 nm.

For the biological evaluation, five groups of male mice (Control, SPIONs at 5 mg/kg, Curcuma at 100 mg/kg, and SPION-Curcuma at 5 and 10 mg/kg) with a sample size of $n = 8$ (body weight 28–30 g) were used. Sperm parameters, including motility and sperm count, were assessed, as well as lipid peroxidation in testicular tissue. The administration of SPION-Curcuma did not induce significant changes in sperm motility or count. Moreover, a decrease in testicular lipid peroxidation was observed.

Therefore, it is proposed that SPION-Curcuma administration does not exert toxic effects on spermatogenesis in male mice.

Keywords:

Magnetite nanoparticles, Curcuma longa L., spermatogenesis, toxicity, CD1 mice



PLASMA AND VACUUM

CHAIRMEN

Dr. José G. Quiñones-Galván, (CUCEI, UdeG), jose.quinones@academicos.udg.mx

Dr. Miguel Ángel Santana-Aranda, (CUCEI, UdeG), msantana.aranda@academicos.udg.mx

Plasma and vacuum science and technology, are widely used in a great variety of synthesis and characterization processes used in materials science, as well as in many industrial developments. Plasmas are quasineutral distributions of particles (ions, electrons, neutral molecules and atoms), which exhibit collective effects; such as, Debye shielding, plasma oscillations, acoustic waves and sheath formation. Plasmas occur more commonly than usually considered; more than 99% of the known universe consists of plasmas. Plasma research has led, not only to a better understanding of the universe, but to many practical uses: new manufacturing techniques and consumer products.

The term "Vacuum" describes pressure conditions below standard atmospheric pressure. Vacuum technology is applied to all processes and physical measurement carried out under vacuum conditions.

A large variety of deposition and characterization techniques work under vacuum conditions and many of them make use of plasmas

- Sputtering
- Pulsed Laser Deposition
- Plasma Enhanced CVD
- Plasma Assisted MBE
- Atomic Layer Deposition
- Plasma Polymerization
- Plasma Etching
- Closed Space Sublimation
- and any other PVD techniques
- Inductively Coupled Plasma
- Laser Induced Breakdown Spectroscopy
- Mass Spectroscopies
- Scanning Probe Microscopies (SEM, STM)
- X-ray Photoelectron Spectroscopy
- etc.

Furthermore, plasmas can occur within liquids, either during Cavitation phenomena or by laser ablation, the later allowing for the synthesis of Nanoparticles.

Although plasma and vacuum science and technology are often considered to be mature fields, with little new developments; in fact, arc processes, nanotechnology and biomaterials continue to provide and demand new research in this field.

We invite you to present in this symposium your latest research, observations and developments in this very important basic area of study.



INFLUENCE OF WORKING PRESSURE ON ELECTRICAL PROPERTIES OF PULSED LASER DEPOSITED Nd₂O₃ THIN FILMS: A PRELIMINARY IMPEDANCE SPECTROSCOPY STUDY

Autor: RIVERA RESÉNDIZ, Laura Patricia¹

Coautores: Arias López Juan; Pérez Álvarez Jonatan 1; Quiñones Galván José Guadalupe²

¹ *Universidad de Guadalajara*

² *Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara*

Autor responsable de la comunicación: laura.rivera@academicos.udg.mx

Nd₂O₃ thin films deposited by pulsed laser ablation under different background pressures exhibit significant variations in plasma parameters such as ion density and average ion energy. These variations can influence the structural and chemical composition of the resulting films. In this work, we explore the impact of deposition pressure on the electrical properties of the films through impedance spectroscopy. This contribution aims to highlight preliminary findings from Bode and Nyquist plots, which provide insights into the electrical response of the films. The results are expected to shed light on the correlation between plasma dynamics during deposition and the electrical behavior of the thin films, contributing to the optimization of deposition conditions for targeted functionalities.

Keywords:

PLD, Nd₂O₃, Plasma parameters Impedance Spectroscopy, Electrical properties.

His work was supported by:
Universidad de Guadalajara



A SPATIAL STUDY OF TARGET POISONING IN REACTIVE MAGNETRON SPUTTERING VIA LIBS

Autor: Roberto Sangines¹

Coautores: Julio Cruz ²; Stephen Muhl²; Noemi Abundiz Cisneros ¹; Estrella Terán Hinojosa¹; Martinez Fuentes Marco Antonio²; Roberto Machorro Mejía¹.

¹ *SECIHTI, Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México*

² *Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México*

Autor responsable de la comunicación: sangines@ens.cnyn.unam.mx

Reactive sputtering of a metal target in a mixture of inert and reactive gases enables the production of compound films, the composition of which can be altered by using different mass flow rate ratios of the reactive gas (oxygen or nitrogen) to the working gas (argon). These compound films have a wide range of potential applications, including tailored optical filters (e.g. SiN_xO_y systems) and tribological and biocompatible coatings (e.g. binary refractory metal oxynitrides). Real-time monitoring of some plasma properties can provide adequate control of target poisoning and produce different film compositions with good reproducibility, which is essential for growing complex systems such as graded films. Several studies have investigated obtaining the film composition during deposition by monitoring the deposition process in real time. These methods include monitoring the voltage and current from the power supply. Another non-invasive diagnostic method is optical emission spectroscopy, which has been shown to effectively estimate film composition after proper calibration [1]. In this study, we have developed a methodology that correlates plasma emission with target poisoning. Correlating the degree of target poisoning with the physical properties of the plasma will enable modelling of changes to the target surface and improve our understanding of the poisoning process. To this end, we will present results from laser-induced breakdown spectroscopy (LIBS) to study the composition of the target surface along the radial direction. Multivariate statistical methods, such as principal component analysis, are employed to map the composition. The emission lines produced by the LIBS plasma were studied, including emission from the target material (silicon), in both neutral and ionized states. However, traces of oxygen and nitrogen were also detected, despite the estimated compound formation on the target surface being a few hundred nanometres

Keywords:

reactive magnetron sputtering, target poisoning, LIBS

Reference:

R. Rodríguez-López, et al, "Plasma emission spectroscopy and optical properties of reactive-sputtered silicon oxynitride films," J. Phys. D: Appl. Phys., 57, 285302, 2024. DOI: 10.1088/1361-6463/ad3d6a

Ris work was supported by:

Universidad Nacional Autónoma de México (PAPIIT-UNAM, IG102023); Secretaría de Ciencias, Humanidades, Tecnología e Innovación, (SECIHTI, CF-2023-I-704)



PLASMA DYNAMICS AND PROPERTY TUNING OF CUIRIN FILMS BY PULSED LASER DEPOSITION: A TIME-RESOLVED OPTICAL EMISSION STUDY

Autor: Karen Rodriguez¹

Coautores: Jorge Cruz Gómez ²; FRANCISCO DE MOURE FLORES ³; José Santos Cruz ³; Mayo Villagran Muniz¹

¹ *Instituto de Ciencias Aplicadas y Tecnología, Universidad Nacional Autónoma de México*

² *Escuela Superior de Física y Matemáticas del Instituto Politécnico Nacional*

³ *UNIVERSIDAD AUTÓNOMA DE QUERÉTARO*

Autor responsable de la comunicación: karen.uaq@outlook.com

Cuprous iodide (CuI) is a p-type semiconductor with a wide direct bandgap (~ 3.1 eV), high hole mobility (>40 cm²/V·s), and a high exciton binding energy, making it a strong candidate for optoelectronic and thermoelectric applications. Pulsed Laser Deposition (PLD) provides a feasible method for producing high-purity CuI thin films with controlled stoichiometry. However, understanding plasma dynamics during PLD is crucial, as it influences film growth mechanisms and quality. This study used time-resolved Optical Emission Spectroscopy (OES) to examine plasma behavior during CuI deposition at 1.2, 1.7, and 2.2 J/cm² laser fluences. Emission lines from neutral and singly ionized Cu and I species were analyzed to determine spatially resolved electron temperature and density along the plasma plume. The findings showed that plasma evolution is mainly driven by ion redistribution among various ionization states rather than the amount of ablated material, highlighting the importance of laser fluence in controlling plasma properties. CuI thin films deposited under identical conditions were thoroughly characterized. X-ray diffraction revealed improved crystallinity and reduced microstrain at 1.2 J/cm², while higher fluences caused structural disorder. Raman spectroscopy confirmed these trends, showing phonon mode shifts and suppression of the LO mode. Morphological analysis indicated smooth, dense films at 1.2 and 1.7 J/cm², with increased roughness at 2.2 J/cm². All films showed high visible transmittance (80–95%) and a slight decrease in optical bandgap with increased fluence. The film deposited at 1.2 J/cm² demonstrated the best electrical performance, with high carrier concentration, low resistivity, and adequate mobility. These results emphasize the critical role of laser fluence in tuning plasma behavior and thin-film properties, providing valuable insights for optimizing CuI films in optoelectronic and photovoltaic device manufacturing.

Keywords:

Cuprous Iodide, PLD, OES, Plasma Dynamics, Thin Films, Laser Fluence

Work was supported by:

FONFIVE-UAQ 2025



INFLUENCE OF PLASMA DYNAMICS AND SUBSTRATE TEMPERATURE ON THE GROWTH AND PROPERTIES OF Bi_2S_3 FILMS BY PLD

Autor: Karen Rodriguez¹

Coautores: Jorge Cruz Gómez ²; José Santos Cruz ³; FRANCISCO DE MOURE FLORES ³; Mayo Villagran Muniz

¹ *Instituto de Ciencias Aplicadas y Tecnología, Universidad Nacional Autónoma de México*

² *Escuela Superior de Física y Matemáticas del Instituto Politécnico Nacional*

³ *UNIVERSIDAD AUTÓNOMA DE QUERÉTARO*

Autor responsable de la comunicación: karen.uaq@outlook.com

Bismuth sulfide (Bi_2S_3) is a non-toxic, earth-abundant, and low-cost n-type semiconductor with a direct bandgap (1.3–1.7 eV), high absorption coefficient, and compatibility with various materials, making it a promising candidate for optoelectronic and photovoltaic applications. Among the fabrication methods, Pulsed Laser Deposition (PLD) enables the growth of high-quality Bi_2S_3 thin films with excellent stoichiometric control. However, plasma behavior during PLD remains underexplored, despite its key influence on film quality. In this work, time-resolved Optical Emission Spectroscopy (OES) was used to investigate the dynamics of laser-induced plasma (LIP) during Bi_2S_3 deposition. Emission lines from neutral and singly ionized Bi and S species were analyzed to extract spatial and temporal profiles of electron temperature and density along the plasma plume. The highest values were found near the target, gradually decreasing with time and distance due to recombination. These diagnostics are essential for improving process reproducibility and controlling film growth. Bi_2S_3 thin films were deposited at substrate temperatures ranging from room temperature to 250 °C. Structural, morphological, and optical properties were examined using XRD, Raman spectroscopy, SEM, and UV-Vis spectrophotometry. Films grown at 150–200 °C showed improved crystallinity, uniform morphology, and favorable optical behavior. Raman data confirmed structural changes with temperature, while SEM revealed particle size growth and localized splashing effects typical of PLD. Optical bandgaps ranged from 1.75 to 1.61 eV with increasing temperature; transmittance varied between 8% and 26%. Electrical measurements confirmed n-type conductivity, with carrier concentrations of 10^{12} cm^{-3} . These results demonstrate that substrate temperature and plasma conditions greatly influence the structural and optoelectronic properties of Bi_2S_3 films, providing important insights for their integration into future electronic, photovoltaic, and thermoelectric devices.

Keywords:

Bi_2S_3 films, PLD, OES, Plasma Dynamics, Laser Fluence



CARBON-DOPED TiO₂ RIN FILMS DEPOSITED BY PLD: ROLE OF PLASMA PARAMETERS

Autor: José Guadalupe Quiñones Galván¹

Coautores: Laura Patricia Rivera Reséndiz²; Omar Gaspar Ramírez¹; Abril Vazquez Francisco³; José Didino García Aguilar⁴; César Rivera Tello²; Miguel Angel Santana-Aranda⁵

¹ Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara

² Universidad de Guadalajara

³ Departamento de Ingeniería de Proyectos, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara

⁴ Centro de Estudios Científicos y Tecnológicos N° 16 "Hidalgo"

⁵ Departamento de Física, CUCEI, Universidad de Guadalajara

Autor responsable de la comunicación: jose.quinones@academicos.udg.mx

Titanium dioxide (TiO₂) is a widely used material in photocatalysis due to its stability, non-toxicity, and abundance; however, its wide bandgap limits its response to UV light. Carbon doping has proven effective in narrowing the bandgap and enhancing visible-light activity by modifying the electronic structure of TiO₂ [1]. In this work, TiO₂:C thin films were deposited on quartz substrates using pulsed laser deposition (PLD) with coaxial Ti/C targets under a constant Ar/O₂ (80/20) atmosphere at 20 mTorr. Prior to deposition, time-of-flight curves of individual Ti and C plasmas were recorded to estimate the mean kinetic energy and ion density of Ti and C plasmas. A pure TiO₂ film and three TiO₂:C films were then deposited by fixing the Ti plasma conditions and varying the C plasma conditions, aiming to modulate carbon incorporation into the matrix. The as-deposited films were characterized by UV-Vis spectroscopy and X-ray diffraction (XRD), showing amorphous structures. After thermal treatment in air at 500 °C, the samples were reanalyzed by UV-Vis, XRD, Raman spectroscopy and X-ray photoelectron spectroscopy (XPS). Additionally, density functional theory (DFT) simulations were conducted to explore the band structure and density of states of TiO₂ doped with different C contents, supporting the experimental findings.

Keywords:

PLD, TiO₂, TiO₂:C, plasma diagnosis

Reference:

1. Di Valentin, C., Pacchioni, G., Selloni, A. Theory of carbon doping of titanium dioxide. Chem. Mater. 17, 6656–6665 (2005).

Ris work was supported by:

Universidad de Guadalajara



APPLICATION OF SPARK-INDUCED BREAKDOWN SPECTROSCOPY (SIBS) FOR THE ANALYSIS OF INSULATING MATERIALS

Autor: Marco Antonio Martinez Fuentes¹

Coautores: Carlos Ramos Vilchis²; Stephen Muhl³

¹ Instituto de Investigaciones en Materiales - UNAM

² Universidad Nacional Autónoma de México

³ Instituto de Investigaciones en Materiales, Uni Nacional Autonoma de Mexico

Autor responsable de la comunicación: mamf@ciencias.unam.mx

Various established techniques exist for determining the elemental composition of materials. Among them, Laser-Induced Breakdown Spectroscopy (LIBS) and Spark-Induced Breakdown Spectroscopy (SIBS) stand out. Similar to LIBS, SIBS offers key advantages such as rapid analysis, minimal sample preparation, and strong potential for miniaturization and portability. In addition, SIBS provides greater pulse energy relative to its size and is generally more cost-effective than LIBS [1]. While SIBS is typically applied to conductive materials, the aim of this work is to explore its applicability to insulating materials. This study reports the characterization of several insulating oxides by analyzing their optical emission lines generated via SIBS under atmospheric conditions. The insulators examined include: cerium oxide (CeO_2) 99.5%, lanthanum oxide (La_2O_3) 99.99%, manganese oxide (MnO_2) 99.9%, niobium oxide (Nb_2O_5) 99.9%, silicon oxide (SiO_2) 99.5%, titanium oxide (TiO_2) 99.9%, tungsten oxide ($\text{WO}_2.9$) 99.99%, and zirconium oxide (ZrO_2) 99.9%. The emission spectra for each oxide, as well as for selected mixtures, are presented. The overall objective is to evaluate the potential of SIBS for identifying and quantifying trace elements in insulating materials.

Keywords:

SPARK, SIBS, CeO_2 , La_2O_3 , MnO_2 , Nb_2O_5 , SiO_2 , TiO_2 , $\text{WO}_2.9$, ZrO_2

Reference:

[1] Iyll-Joon Doh, Carmen Gondhalekar, Valery Patsekin, Bartek Rajwa, Keegan Hernandez, Euiwon Bae, and J. Paul Robinson, "A Portable Spark-Induced Breakdown Spectroscopic (SIBS) Instrument and its Analytical Performance", *Applied Spectroscopy*, 2019, Vol. 73(6) 698–708. DOI: 10.1177/0003702819844792

Ris work was supported by:

This work was supported by PAPIIT- IG101123, M Martinez would like to thank CONAHCYT (Mexico) for his postdoctoral fellowship



XPS AND OPTICAL CHARACTERIZATION OF HEXAGONAL PHASE GaN RIN FILMS SYNTHESIZED BY PULSED LASER DEPOSITION (PLD)

Autor: Jesus Adrian Cano Salazar¹

Coautores: Cristo Manuel Yee Rendon ²; Dainet Berman-Mendoza ³; José Guadalupe Quiñones Galván ⁴; Rafael Garcia-Guitierrez ¹

¹ *Departamento de Investigación en Física, Universidad de Sonora*

² *Universidad Autónoma de Sinaloa*

³ *Departamento de Investigación en Física, Universidad de Sonora,*

⁴ *Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara*

Autor responsable de la comunicación: a222230125@unison.mx

In this work, we present the synthesis and comprehensive characterization of gallium nitride (GaN) thin films deposited on quartz substrates via pulsed laser deposition (PLD) using prefabricated GaN powder targets. The study correlates structural, optical, and chemical properties to validate phase purity and optoelectronic suitability. Photoluminescence (PL) spectroscopy reveals a near-band- edge emission at ~365 nm, characteristic of hexagonal-phase GaN, alongside a emission at ~475 nm, deviating from the typical yellow luminescence linked to point defects. Structural analysis via X- ray diffraction (XRD) confirms the wurtzite crystal structure, with dominant (002), (101), and (001) diffraction planes aligned with hexagonal symmetry. Sharp XRD peaks and low full-width-at-half- maximum (FWHM) values ($<0.3^\circ$) indicate high crystallinity and minimal lattice disorder. Complementary X-ray photoelectron spectroscopy (XPS) studies probed surface chemistry and bonding states. Survey spectra confirm Ga and N as primary elements. The Ga 3d peak at 20 eV aligns with Ga-N bonding in hexagonal GaN, while the Ga 2p doublet at 1118.9 eV (Ga 2p_{3/2}) and 1145.0 eV (Ga 2p_{1/2}) reflects spin-orbit splitting consistent with Ga³⁺ states. The N 1s peak at 397.4 eV corroborates stoichiometric GaN formation. A secondary O 1s peak at 531.5 eV corresponds to superficial Ga-O bonding, attributed to ambient oxidation. Depth profiling confirms oxidation is confined to surface layers, preserving bulk structural and chemical integrity. The combined PL, XRD, and XPS results demonstrate PLD's efficacy in synthesizing phase-pure GaN thin films with minimal defects and controlled stoichiometry. The method's versatility, coupled with prefabricated targets, positions it as a scalable approach for nitride-based semiconductors. These findings underscore PLD-synthesized GaN's viability as a cornerstone material for next-generation technologies, particularly in renewable energy and optoelectronic systems.

Keywords:

GaN, PL, XPS, XRD, Films

Reference:

Bornemann, S., Meyer, T., Voss, T., & Waag, A. (2022). Ablation threshold of GaN films for ultrashort laser pulses and the role of threading dislocations as damage precursors. *Optics Express*, 30(26), 47744. <https://doi.org/10.1364/oe.471111>

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación



ANALYSIS OF THE PHYSICAL PROPERTIES OF SrTiO_3 THIN FILMS GROWN BY PLD WITH A 1064 nm WAVELENGTH

Autores: Dagoberto Cardona Ramírez¹; José Guadalupe Quiñones Galván²; José Miguel Blancas Flores³; Pablo Agustín Calderón Franco¹

¹ *Facultad de Ciencias Fisico- Matemáticas "Mat. Luis Manuel Rivera Gutiérrez", Universidad Michoacana de San Nicolás de Hidalgo*

² *Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara*

³ *Departamento de Ciencias Básicas, Aplicadas e Ingenierías, Centro Universitario de Tonalá, Universidad de Guadalajara*

Autor responsable de la comunicación: pablo.agustin.calderon@umich.mx

SrTiO_3 or STO is a semiconductor material with a perovskite structure and a band gap of 3.2 eV. This material has been demonstrated to be manufactured using physical deposition techniques, such as laser ablation or PLD, at a laser wavelength of 264 nm. However, it is not known for certain whether it has been synthesized at a laser wavelength of 1064 nm. In this work, STO thin films were deposited on silicon substrates by means of PLD using 1064 nm and low laser fluences. The films were subjected to a post deposition heat treatment of 700 °C for one hour. Plasma analysis and the structural, morphological, and optical properties of the films were studied using Langmuir probe, XRD, SE, AFM, and diffuse UV-Vis. Plasma analysis indicates an increase in plasma density and kinetic energy with increasing laser fluence. X-ray diffraction patterns show an increase in crystallinity at 700 °C, an increase in grain size and interplanar spacing, in contrast to the results at room temperature. SEM and AFM studies indicate that particle agglomeration generates some roughness, in addition to the effect of temperature on thickness and roughness, which decrease after heat treatment. Finally, diffuse UV-Vis spectra indicate greater diffusion of the films at room temperature, so the band gap value of the films was estimated at 700 °C and presents approximate values between

3.06 and 3.1 eV. Modifications to the deposition time, laser spot, laser energy, the use of another variant of the technique such as crossed beams where two targets are ablated simultaneously, etc... This is to improve the properties of the material.

Keywords:

semiconductor, thin film, laser fluence, laser ablation, plasma parameters

Reference:

B. Kinaci, N. Akin, I. Kars Durukan, T. Memmedli, and S. Özçelik, "The study on characterizations of SrTiO_3 thin films with different growth temperatures," *Superlattices Microstruct.*, vol. 76, pp. 234–243, 2014, doi: 10.1016/j.spmi.2014.10.018.

Ris work was supported by:

We thank the Laser Processing Laboratory, the Nanomaterials and Intelligent Data Science Laboratory (NANOCIDI), and the Nanomaterials Laboratory incorporated into the University of Guadalajara for their collaboration in this work.



SURFACE PLASMON RESONANCE OF GOLD AND SILVER NANOPARTICLES DEPOSITED BY PLD ON SUBSTRATES WITH CONTROLLED ROUGHNESS

Autor: Abril Vazquez Francisco¹

Coautores: José Guadalupe Quiñones Galván²; José Miguel Blancas Flores³; Laura Patricia Rivera Reséndiz⁴; Oscar Blanco Alonso²

¹ *Departamento de Ingeniería de Proyectos, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara*

² *Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara*

³ *Departamento de Ciencias Básicas, Aplicadas e Ingenierías, Centro Universitario de Tonalá, Universidad de Guadalajara*

⁴ *Universidad de Guadalajara*

Autor responsable de la comunicación: abril.vazquez4166@alumnos.udg.mx

Gold and silver nanoparticles were deposited on PET diffraction gratings via pulsed laser deposition (PLD). In both cases, a fluence of 12 J/cm² was used, and 600 laser pulses were employed. Five nanostructured films of each material (gold and silver) were grown, varying the number of lines per millimeter on the gratings (0, 80, 300, 600, and 1600 lines/mm). The laser-produced plasmas were diagnosed using a planar Langmuir probe, from which time-of-flight (TOF) curves were obtained. These TOF curves were used to calculate the average kinetic energy and the ion density of the ablated species. The ion density was 8.87×10¹³ cm⁻³ for gold and 6.6×10¹³ cm⁻³ for silver, while the average kinetic energy was 221.7 eV for gold and 340.1 eV for silver. The nanostructured thin films were optically characterized by UV-Vis spectroscopy. Localized surface plasmon resonance (LSPR) signals were observed in all samples, centered near 600 nm for gold and around 500 nm for silver. Analysis of the absorption bands revealed that, in the case of gold, the peak position shifted slightly toward longer wavelengths as the number of lines per millimeter in the diffraction gratings increased, indicating a slight increase in nanoparticle size with increasing substrate roughness. On the other hand, the peak position for silver shifted slightly toward shorter wavelengths as the number of lines per millimeter increased, suggesting a decrease in particle size with increasing substrate roughness. For both materials, the maximum absorption increased with the number of lines per millimeter, which suggests an increase in the number of deposited particles as substrate roughness increased.

Keywords:

Pulsed laser deposition, nanoparticles, fluence, plasmon resonance

Reference:

M. A. García, Surface plasmons in metallic nanoparticles: fundamentals and applications, J Phys D Appl Phys 44 (2011). <https://doi.org/10.1088/0022-3727/44/28/283001>

Ris work was supported by:

Universidad de Guadalajara, SECIHTI



EFFECT OF DEPOSITION TECHNIQUE ON OPTOELECTRONIC PROPERTIES OF TRANSPARENT SEMICONDUCTOR FILMS OBTAINED IN VACUUM BY PVD AND PLD

Autor: Jorge Cruz Gómez¹

Coautores: Karen Rodríguez Rosales ¹; José Otero Angel ¹; Angel Guillen-Cervantes ²; José Santos Cruz ¹; Gerardo Contreras-Puente ³; FRANCISCO DE MOURE FLORES ¹

¹ UNIVERSIDAD AUTÓNOMA DE QUERÉTARO

² Departamento de Física, Cinvestav-IPN

³ Escuela Superior de Física y Matemáticas, Escuela Superior de Ingeniería Mecánica y Eléctrica, Instituto Politécnico Nacional

Autor responsable de la comunicación: francisco.javier.demoure@uaq.mx

Due to their optoelectronic properties, CuI thin films are a promising material for transparent device applications, such as thin-film transistors, light-emitting diodes, flat-panel displays, gas sensors, and solar cells. Significant advances have been made in the research of *n*-type transparent conductors. Developing satisfactory *p*-type transparent conductors remains a significant challenge. CuI is a *p*-type conductive semiconductor material with a wide bandgap of 3.1 eV and high hole mobility in bulk. In this work, CuI thin films were obtained in vacuum by physical vapor deposition (PVD) and pulse laser deposition (PLD) techniques. The structural, optical, and morphological properties were analyzed, and the results are discussed in terms of the deposition parameters.

The authors acknowledge the technical support of Marcela Guerrero, A. Távira Fuentes, and A. García-Sotelo (from the CINVESTAV-IPN). The authors acknowledge the financial support for this work from FONFIVE-UAQ 2025.

Keywords:

CuI thin films, transparent semiconductor, *p*-type conductivity

Reference:

W. Peng, L. Li, S. Yu, H. Zheng, and P. Yang, "Structure, binding energy and optoelectrical properties of *p*-type CuI thin films: The effects of thickness," *Appl Surf Sci*, vol. 502, p. 144424, Feb. 2020

Ris work was supported by:

FONFIVE-UAQ 2025



ULTRA-THIN P-TYPE NICKEL OXIDE FILMS GROWN BY RPLD AT ROOM TEMPERATURE: XPS IN SITU CHARACTERIZATION

Autor: Ivonne Julieta Silva Contreras¹

Coautores: Oscar Edel Contreras López²; Wencel José de la Cruz Hernández²

¹ Centro de Investigación Científica y Educación Superior de Ensenada, Baja California

² Centro de Nanociencias y Nanotecnología-UNAM

Autor responsable de la comunicación: ivonne@ens.cnyn.unam.mx

Nickel oxide (NiO) is a low-cost p-type semiconductor material with electrical, magnetic, and optical properties that have been exploited in catalysis, energy storage, and electronic devices. In the last decade, a growing interest in developing flexible electronic devices has driven the synthesis of metal oxides at lower temperatures with electrical properties suitable for electronic applications. Techniques such as reactive pulsed laser deposition (RPLD) enable the synthesis of metal oxide thin films at room temperature and modify their stoichiometry.

In this work, NiO_x thin films were grown at room temperature by RPLD on glass substrates using a nickel target under varying oxygen pressures from 3 to 28 mTorr. The chemical composition of the thin films was analyzed in situ via X-ray photoelectron spectroscopy (XPS). Additionally, the electrical and structural properties of NiO_x thin films were characterized using Van der Pauw and Hall effect techniques, as well as X-ray diffraction (XRD).

The results of the chemical analysis showed that all the deposited thin films in an oxygen atmosphere were nickel oxide, with the oxygen to nickel ratio ranging from 1.0 to 1.3 in NiO_x. The electrical resistivity spanned from 53.5 to 4.88 Ω cm, the carrier density was around $\times 10^{18} \text{ cm}^{-3}$, and the highest mobility obtained was $1.16 \text{ cm}^2/\text{Vs}$. The films were characterized as polycrystalline, presenting a body-centered cubic (bcc) crystal structure. Due to the change in stoichiometry, it was found that the electrical properties depend closely on the oxygen pressure during deposition. Additionally, we demonstrated that obtaining a p-type NiO film involves a close relationship between laser energy and oxygen pressure.

Keywords:

NiO, thin films, p-type, RPLD, XPS

Reference:

Nail, B. A. et al. Nickel oxide particles catalyze photochemical hydrogen evolution from water-nanoscaling promotes p-type character and minority carrier extraction. ACS Nano 9, 5135–5142 (2015).

Ris work was supported by:

This work was financially supported by projects DGAPA-PAPIIT-IT103125 y DGAPA-PAPIIT-IN119023.



DIFFUSION WELDING OF SURFACE-TREATED ALUMINUM PLATES VIA PLASMA SPUTTERING

Autores: Beiker Martínez Rueda¹; Fabio Antonio Xavier²; Marcia Mantelli¹; Rodrigo Perito³

¹ *The Heat Pipe Laboratory –LABTUCAL, Mechanical Engineering Department, Federal University of Santa Catarina*

² *The Precision Engineering Laboratory –LMP, Mechanical Engineering Department, Federal University of Santa Catarina*

³ *Materials Laboratory –LabMat, Mechanical Engineering Department, Federal University of Santa Catarina*

Autor responsable de la comunicación: beiker.rueda@labtucal.ufsc.br

Aluminum is an interesting material for the fabrication of thermal devices due to its good relationship between mechanical and thermal properties [1]. Further, as it is a very reactive metal with oxygen, it forms an extremely stable layer of aluminum oxide (Al₂O₃), which acts as a corrosion-resistant barrier [2].

The diffusion welding process is highly recommended for the fabrication of thermal devices, but the layer of Al₂O₃ acts as a barrier for the diffusion process of aluminum [3]. In this work, a surface treatment via plasma sputtering was performed to remove the Al₂O₃ layer (in situ surface activation) and to deposit a thin layer of copper to produce a coating with customized properties that facilitate the metallurgic consolidation by diffusion welding process in a vacuum furnace. To evaluate the influence of the surface treatment, the surface finish of the pairs samples to be joined was studied by white light interferometry. The morphological characteristics of the joint welded were analyzed by metallography, SEM and EDS tests.

The results showed a joint with good integrity and absence of the intermetallic phases that could induce corrosive processes. Thus, demonstrating the viability of this diffusion welding process of aluminum for the fabrication of thermal devices.

Keywords:

Surface treatment, plasma sputtering, aluminum, aluminum oxide, diffusion welding

Reference:

- [1] Liang, Y., et al., *Applied Thermal Engineering*. 241 (2024) 122211.
- [2] Zlatanovic, L., et al., *Science and Technology of Welding and Joining*. 28 (2023) 5 331-351.
- [3] Ben-Haroush, M. et al., *Materials*. 16 (2023) 2.

Ris work was supported by:

the CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) - PROEX (Programa de Excelência Acadêmica) - Brasil, LABTUCAL-UFSC, LABMAT-UFSC and LMP-UFSC



CHEMICAL EVOLUTION OF YTTRIUM OXIDATION IN THE PRESENCE OF YF_3 : A MULTILAYER MODELING APPROACH

Autor: Orlando Cortazar Martinez¹

Coautores: Alberto Herrera Gómez²; Dulce María Guzmán Bucio³; Joaquin Gerardo Raboño Borbolla⁴

¹ CINESTAV, Unidad Querétaro

² Centro de Investigación y de Estudios Avanzados del IPN - Unidad Querétaro

³ Centro de Investigación y Estudios Avanzados (CINESTAV) unidad Querétaro

⁴ Cinvestav, Unidad Querétaro

Autor responsable de la comunicación: orlando.cortazar@cinvestav.mx

The early stages of yttrium oxidation are of significant interest due to their impact on protective coatings and advanced material applications. Yttrium readily reacts with environmental species, forming complex surface layers that strongly influence its properties and performance in electronic and optical systems. In this study, we investigate the initial oxidation of metallic yttrium in the presence of fluorine using X-ray Photoelectron Spectroscopy (XPS), incorporating newly acquired angle-resolved data (ARXPS) to improve depth sensitivity, refine chemical composition analysis, and develop a more accurate oxidation model.

Metallic yttrium films (99.9% metal trace, Sigma-Aldrich) were deposited by thermal sublimation onto Si(100) substrates under ultra-high vacuum conditions. The base pressure during deposition was 8×10^{-9} Torr, and the pressure during sublimation reached 6.5×10^{-7} Torr. Oxidation was induced by controlled exposure to ultra-pure oxygen, using dosages ranging from 10 L to 1×10^{-8} L ($1 \text{ L} \equiv 1 \times 10^{-6} \text{ Torr} \cdot \text{s}$). The metallic and oxidized films were characterized using an XPS system equipped with a monochromatic Al K α source (1487.6 eV, XR5, ThermoFisher) and a 7-channeltron hemispherical analyzer (Alpha110, ThermoFisher), assembled by Intercovamex.

Quantitative analysis of the Y 3d, O 1s, and F 1s core levels was performed using ARXPS data. Given the asymmetric nature of the Y 3d peak in metallic and partially oxidized states, we conducted a comparative analysis between conventional fitting procedures and advanced models employing Narrow Shirley background and Coupled Resonance (CR) line shapes. These refined strategies offered enhanced chemical insight and improved reliability. Both fitting approaches used a combination of Shirley-Vegh-Salvi-Castle (SVSC) background, the two-parameter Tougaard background, and base-line correction. A block-fitting methodology was applied using a unit peak derived from metallic yttrium.

Relying solely on non-angular XPS can lead to an oversimplified interpretation of oxide growth and hinder a complete understanding of the oxidation kinetics. By incorporating ARXPS, improved background modeling, and a Multilayer Model (MLM), we resolved the oxidation sequence and fluorine incorporation dynamics. This approach allowed us to quantify the effects of exposure conditions on oxide layer formation and to distinguish the presence and distribution of Y_2O_3 and YF_3 within the topmost nanometers of the surface.

Keywords:

ARXPS, Background Shirley, Coupled Resonance, Background Tougaard, Chemical composition

Reference:

A. Herrera-Gomez, Internal Report. CINESTAV-Unidad Querétaro. "Self-consistent ARXPS analysis for multilayer conformal films with abrupt interfaces," 2008.

Ris work was supported by:

This research was partially supported by the Proyecto Fronteras 58518, Conahcyt, Mexico.



TIME-RESOLVED PERMITTIVITY MEASUREMENT OF LASER-INDUCED PLASMA IN AIR USING A HIGH-VOLTAGE RC CIRCUIT

Autores: Citlali Sánchez-Aké¹; Fausto Bredice²; Mayo Villagran Muniz³; Tupak García-Fernández⁴; Ulises Vargas Nolasco⁵

¹ Instituto de Ciencias Aplicadas y Tecnología, Universidad Nacional Autónoma de México.

² Centro de Investigaciones Ópticas (CIOp)

³ Instituto de Ciencias Aplicadas y Tecnología, Universidad Nacional Autónoma de México

⁴ Universidad Autónoma de la Ciudad de México, Unidad San Lorenzo Tezonco

⁵ Programa de Maestría y Doctorado en Ingeniería, Universidad Nacional Autónoma de México

Autor responsable de la comunicación: ulisesvrnl@gmail.com

Abstract

We present an electrical diagnostic technique for measuring the time-dependent dielectric permittivity of a laser-induced plasma in air, using a high-voltage RC circuit. The experimental setup consists of a nanosecond-pulsed laser focused between two parallel electrodes forming a capacitor, initially charged by a high-voltage source and connected in series with a resistor. The plasma is generated in ambient air within the electrode gap, acting as a transient conductive medium that discharges the system. The voltage drop across the resistor is monitored using an oscilloscope. By employing a high-voltage probe with a 500 MHz bandwidth, the actual voltage during plasma formation is accurately captured, allowing for the reconstruction of the transient current. Based on Kirchhoff's and Maxwell's equations, we developed a dynamic model to calculate the system's capacitance and infer the time-resolved permittivity of the plasma. This method enables in situ measurements of dielectric permittivity during the plasma formation and evolution processes. Although the technique has been demonstrated in air, it is adaptable to other media, such as metallic surfaces or microdroplets water, allowing the characterization of plasmas in a wide range of environments. Our research offers new perspectives for the diagnosis of transient plasmas via dielectric permittivity measurements, with potential applications in material processing.

Keywords:

permittivity, laser induced plasma, RC circuit, Maxwell's equations

Reference:

U. Vargas-Nolasco, T. García-Fernández, C. Sánchez-Aké, M. Villagrán-Muniz, and F. Bredice, "Measurement of Laser Pulse Energy and Duration through Air Induced Breakdown Under Electric Field Action," IEEE Transactions on Instrumentation and Measurement, vol. 74, pp. 1–6, Jan. 2025, doi: 10.1109/TIM.2024.3500051.

Ris work was supported by:

CONACYT-CBF2023-2024-1625, UACM-CCYT-2025-CON-03, UNAM-PAPIIT IN108424, UNAM-PA-PIIT IN111725



SYNTHESIS OF AU NANOPARTICLES ON TiO₂ RIN FILMS BY PULSED LASER ABLATION FOR ENHANCED PHOTOCATALYTIC ACTIVITY

Autor: Omar Hernández Martínez¹

Coautores: Karen Rodríguez Rosales²; Arturo Velasco Hernandez³; José Santos Cruz⁴; FRANCISCO DE MOURE FLORES⁴; Citlali Sánchez Aké⁵; Mayo Villagran Muniz²

¹ *Universidad Autónoma de Querétaro*

² *Instituto de Ciencias Aplicadas y Tecnología, Universidad Nacional Autónoma de México*

³ *Facultad de Química, Universidad Autónoma de Querétaro*

⁴ *UNIVERSIDAD AUTÓNOMA DE QUERÉTARO*

⁵ *Universidad Nacional Autónoma de México*

Autor responsable de la comunicación: ohernandez35@alumnos.uaq.mx

Titanium dioxide (TiO₂) is a widely studied photocatalyst due to its chemical stability and strong oxidizing power; however, its photocatalytic activity under visible light is limited by its wide bandgap (~3.2 eV). In this work, TiO₂/Au nanocomposite films were developed by depositing Au thin films via physical vapor deposition (PVD), followed by pulsed laser ablation (PLA) in vacuum, using a 248 nm KrF excimer laser to induce the formation of Au nanoparticles (Au NPs). The objective was to enhance TiO₂ activity by exploiting localized surface plasmon resonance (LSPR) effects of the Au NPs, thereby improving visible light absorption and photocatalytic efficiency.

TiO₂ thin films were prepared using the sol-gel method and subjected to a thermal treatment at 550 °C to promote crystallization in the anatase phase, which exhibits the highest photocatalytic activity among TiO₂ polymorphs. Au layers of 10 and 15 nm were deposited by PVD and irradiated in a vacuum chamber at 1.3×10^{-3} Torr, varying laser fluence to control the size, morphology, and distribution of the Au NPs. Structural and morphological analysis via SEM revealed size optimization as a function of fluence and number of pulses. Optical characterization confirmed bandgap narrowing and LSPR-induced absorption shifts.

Depressing methylene blue (MB) under UV irradiation evaluated the photocatalytic performance. The most efficient system (15 nm Au film irradiated at 15 mJ) achieved ~85% MB degradation after 4 hours. Compared to direct photolysis, the TiO₂/Au system exhibited significantly enhanced degradation kinetics, highlighting the synergistic effect of the Au NPs.

These findings demonstrate that laser-processed TiO₂/Au nanocomposites are promising for environmental remediation applications under UV and potentially visible light, due to tunable plasmonic enhancement.

Keywords:

TiO₂ thin films, Au nanoparticles, PLD, sol-gel, PVD, photocatalysis

Ris work was supported by:

UAQ-UNAM



MODELING THE INELASTIC BACKGROUND IN XPS AND HAXPES: A TOOL FOR ACCURATE ANALYSIS OF LAYERED MATERIALS

Autor: Dulce María Guzmán Bucio¹

Coautores: Dagoberto Cabrera-German²; Jorge Alejandro Torres Ochoa³; Orlando Cortazar Martinez⁴; Joaquin Gerardo Raboño Borbolla⁵; Milton Vázquez Lepe⁶; Conan Weiland⁷; Joseph Woicik⁷; Alberto Herrera Gómez⁸

¹ Centro de Investigación y Estudios Avanzados (CINVESTAV) unidad Querétaro

² Universidad de Sonora

³ CINVESTAV-Querétaro

⁴ CINVESTAV, Unidad Querétaro

⁵ Cinvestav, Unidad Querétaro

⁶ Universidad de Guadalajara

⁷ National Institute of Standards and Technology

⁸ Centro de Investigación y de Estudios Avanzados del IPN - Unidad Querétaro

Autor responsable de la comunicación: dulce.guzman@cinvestav.mx

Precise surface and interface characterization is a cornerstone of materials science, especially as engineered structures become increasingly complex. In X-ray Photoelectron Spectroscopy (XPS) and Hard X-ray Photoemission Spectroscopy (HAXPES), accurate chemical analysis relies on the ability to separate true photoemission peaks from background signals. These background signals include both an intrinsic background, which originates from physical processes occurring before the electron is ejected from the atom, and an extrinsic inelastic background, which results from electron scattering as the photoelectrons travel through the material. This work focuses specifically on modeling the extrinsic inelastic background, as it plays a dominant role in shaping the measured spectra of complex, layered samples.

Most commonly used inelastic background methods assume simple, semi-infinite systems—an assumption that fails in the context of multilayer films or nanoscale heterostructures. This limitation is even more significant in HAXPES, where the greater probing depth allows measurable contributions from buried layers, sometimes located tens of nanometers beneath the surface.

In this work, we present a modeling method that accounts for finite film thicknesses, overlayers, and multilayer geometries, enabling a more realistic calculation of the inelastic background in complex samples. The approach includes both photoelectron attenuation and X-ray absorption effects, assuming a straight-line trajectory for inelastically scattered electrons. Beyond background correction, the method also facilitates depth profiling of layered materials, making it especially valuable for interface analysis.

This approach has been implemented in the free analysis software AAnalyzer®. We demonstrate its utility through the analysis of XPS spectra from an Al/Ti/Si structure, where the modeled background closely aligns with experimental data. This validates the method as a reliable and practical solution for characterizing modern, multilayered materials systems.

Keywords:

layered samples, photoemission, HAXPES

Reference:

A. Herrera-Gomez, The photoemission background signal due to inelastic scattering in conformal thin layers - Internal Report, 2019.

Ris work was supported by:

Use of the Brookhaven National Laboratory is supported by the U.S. Department of Energy's (DOE) Office of Science. This work was partially financed by CONACyT Project Fronteras 58518, Mexico.



CHEMICAL CHARACTERIZATION OF BIOLOGICAL SYSTEMS USING X-RAY PHOTOELECTRON SPECTROSCOPY

Autor: Yazael Rafael Morales Flores¹

Coautores: Orlando Cortazar Martinez ²; Dulce María Guzmán Bucio ³; Fanis Missirlis ⁴; Alberto Herrera Gómez⁵

¹ CINESTAV

² CINESTAV, Unidad Querétaro

³ Centro de Investigación y Estudios Avanzados (CINESTAV) unidad Querétaro

⁴ Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Fisiología, Biofísica y Neurociencias, Mexico

⁵ Centro de Investigación y de Estudios Avanzados del IPN - Unidad Querétaro

Autor responsable de la comunicación: yazael.morales@cinvestav.mx

In biological systems, metal ions are essential to their physiology, making it particularly interesting to study how they acquire, recognize, and sequester essential metal ions.

These cations must reach appropriate binding sites on enzymes or other proteins whose activities support various intracellular or extracellular environments.

In particular, iron absorption in *Drosophila Melanogaster* is an essential process for its development and behavior. Due to the high reactivity between iron and oxygen, iron plays a key role in aerobic metabolism. However, excess iron catalyzes harmful oxidative stress. Therefore, iron concentration in subcellular compartments and extracellular fluids is tightly regulated. Understanding the relationship between the oxidation states of iron in *Drosophila Melanogaster* and its diet may provide valuable insights into how cells detect and process this essential element.

To evaluate the iron oxidation states, we characterized *Drosophila Melanogaster* samples using an X-ray photoelectron spectroscopy (XPS) instrument with a non-monochromatic Al source (1487.6 eV, XR4 from ThermoFisher) and a 7-channeltron hemispherical spectrometer (Alpha110, from ThermoFisher).

In this study, we quantified the chemical composition of the iron in *Drosophila Melanogaster* using a modified version of the MultiLayer Model. This approach relies on peak intensities and physical parameters such as differential photoelectric cross-sections and effective attenuation lengths, the latter being sensitive to the specific material under investigation and providing self-consistent results. The analysis was motivated by the essential roles that metal ions play throughout the life cycle of *Drosophila Melanogaster* and across its various organs, despite their relatively low atomic concentrations.

Keywords:

Drosophila Melanogaster, iron, chemical composition, XPS

Reference:

A. Herrera-Gomez, Internal Report. CINESTAV-Unidad Querétaro. "Self-consistent ARXPS analysis for multilayer conformal films with abrupt interfaces" 2008.

Ris work was supported by:

This work was partially financed by CONAHcyT Project Fronteras 58518, Mexico.



RENEWABLE ENERGY: MATERIALS AND DEVICES

CHAIRMEN

Dr. Mario Fidel García Sánchez (UPIITA-IPN), rusonil@yahoo.com

Dr. Issis Claudette Romero Ibarra (UPIITA-IPN), iromero@ipn.mx

The symposium Renewable Energy: Materials and Devices, has the aim to provide a forum to present and discuss the research relating to the science and technology of energy generation, storage, and managements. An important theme is the research concerning to first generation solar cells, based on mono and poly-crystalline silicon; second generation cells, including CdTe, CIGS, CZTS, amorphous silicon, micro-crystalline and polymorphous silicon; third generation cells, based on the use of quantum dots, nanowires, carbon nanotubes, photo-electrochemical cells, polymer solar cells, nano-crystalline cells, dye-sensitized cells, perovskite solar cells, etc. Moreover, the symposium cover other topics in renewable energies, emphasizing but not limited to:

- Biomass Conversion
- Solar Thermal Applications
- Wind Energy Technology
- Water Treatment
- Solar and Low Energy Architecture
- Geothermal Technology
- Wave, Tide and Ocean Thermal Energies
- Hydrogen Production Technology and Fuel Cells

The symposium covers the synthesis of new materials, characterization and applications in catalytic process, energy storage and energy production devices. Oral and posters sessions are designed to promote the exchange of the advances in these fields by the participants.



OBTAINING THERMOCHEMICAL PROPERTIES USING THERMAL AND CALORIMETRIC TECHNIQUES FOR A SUBSTRATE USED IN COMPOSTING

Autor: Maria Fernanda Saviñon Flores¹

Coautores: Guillermo Santamaria Juárez¹; Jesús Andrés Arzola Flores¹; Juana Deisy Santamaría Juárez¹; Miguel Angel García Castro¹

¹ Benemerita Universidad Autonoma de Puebla

Autor responsable de la comunicación: maria.savinon@alumno.buap.mx

The study of combustion enthalpy as a thermochemical property has been approached from various perspectives. This property has been of great importance in the modeling of chemical, biochemical, or physicochemical processes described by material and energy balances, such as the composting process. This process can be summarized as the sum of different metabolic processes that take place in the presence of oxygen. Within the description of this process, which is well defined by temperature at its various stages, are thermochemical properties such as combustion enthalpy and heat capacity. In this work, the combustion enthalpy and heat capacity were obtained using thermal and calorimetric techniques such as differential scanning calorimetry (DSC) and combustion calorimetry, respectively.

Keywords:

Thermochemical properties; Combustion calorimetry; Differential scanning calorimetry; Composting.

Reference:

Lavoisier, A., Laplace, P. S. "Memoir on heat. Historical Society of Chemistry". 1782. ISBN: 978-1-904-85024-2



RENEWABLE ENERGY / 388

HYDROGEN PRODUCTION FROM A PLATFORM MOLECULE BY HETEROGENEOUS CATALYSIS USING A LAMINAR OXIDE MATERIAL

Autores: Carlos Eduardo Santolalla Vargas¹; Cesar Lopez Galvan²; Issis Claudette Romero Ibarra³

¹ *CIEMAD*

² *Instituto Politecnico Nacional*

³ *IPN*

Autor responsable de la comunicación: cesarlg060@gmail.com

This work focuses on the production of hydrogen from glycerol using heterogeneous catalysis with laminar oxides and microwave heating. The main motivation is the growing concern about climate change and the need for clean and sustainable energy sources. Hydrogen is considered an energy carrier with great potential, and glycerol, a biodiesel byproduct, is a platform molecule for its production.

The methodology included the characterization of catalysts such as sodium, zirconium, and zinc silicates by X-ray diffraction (XRD). These catalysts were evaluated in the microwave-assisted glycerol/water reaction. The resulting samples were analyzed with Fourier Transform Infrared (FT-IR) spectroscopy to identify changes in functional groups.

The XRD results confirmed the structure and composition of the catalysts. FT-IR analysis showed a decrease in the intensity of the CH-OH functional group peaks, which is interpreted as the formation of byproducts and the release of hydrogen. It was concluded that all catalysts were active, with sodium zirconium silicate ($\text{Na}_2\text{ZrSiO}_4$) being the most efficient for hydrogen production. The study highlights the potential of layered oxides to valorize industrial waste such as glycerol, promoting a circular economy.

Keywords:

Hydrogen, Heterogeneous catalysis, Microwaves, Glycerol, Laminar oxide

Reference:

Amin, M. e. (2022). Hydrogen production through renewable and non-renewable energy processes and their impact on climate change. *International Journal of Hydrogen Energy* (Vol. 47, Número 77), 33112– 33134.

Ris work was supported by:

Proyectos SIP-IPN 2275 y 20250118 “Materiales avanzados para transformación de compuestos orgánicos con aplicaciones en energía y medioambiente” y CVN/CESA-002/2024 proyecto “Sustentabilidad hídrica en la Ciudad de México”



RE OPTICAL RESPONSE OF STACKED NON-PERIODIC PLATE SYSTEMS USING REPORTED EXPERIMENTAL REFRACTIVE INDICES (n AND k)

Autor: José Javier Gamez Marin¹

Coautores: Carolina Janani Diliegros Godines²; Felipe Perez Rodriguez²; Francisco Javier Flores Ruiz²

¹ *Estudiante*

² *IFUAP*

Autor responsable de la comunicación: jjgamezmarin@gmail.com

In this work, we use the transfer matrix formalism to study the optical response of stacked non-periodic plate systems using reported experimental refractive indices (n and k). We show that a proper implementation of formalism allows anticipating and optimization the optical response of designs that include metal-insulator-metal, metal-dielectric-metal, metal-metal, metal-dielectric, among others, for the development of optical filters, broadband light absorbers, photonic materials, solar cells, etc. As a case study, we present a numerical study of antireflective (AR) coatings to improve the efficiency of CdTe-based solar cells. Two types of coating were analyzed, one based on a ZnO monolayer, and the other based on the metamaterial ZnO/Cd₂SnO₄. Metamaterial has a filling factor f_{ZnO} of 0.25 composed of three bilayers and a total thickness equal to ZnO ($f_{\text{ZnO}} = 1.00$). The AR coating is located between the glass substrate and the Cd₂SnO₄/CdS/CdTe solar cell, which is an experimentally feasible configuration. The optical response of the solar cell structures was analyzed using the transfer matrix formalism, which was fed with experimental data of the dielectric function for each layer composing the cell and the AR.

Keywords:

Transfer Matrix Method, Optical Response, Non-periodic Structures

Reference:

Markoš, P., & Soukoulis, C. M. (2008). Wave propagation: From electrons to photonic crystals and left-handed materials. Princeton University Press

Ris work was supported by:

The authors acknowledge CONAHCyT for the grants received through the projects FOINS-CONAHCyT 2016-01-2488 and CF-2023-I-1429



NUMERICAL ANALYSIS OF CDS/SB₂S₃ SOLAR CELL PERFORMANCE UNDER VARIABLE OPERATING CONDITIONS USING SCAPS-1D

Autor: Leticia Treviño Yarcé¹

Coautores: Antonio Coyopol Solís ¹; Crisóforo Morales-Ruíz ¹; Enrique Rosendo-Andrés ¹; Godofredo García Salgado ¹; María Josefina Robles Aguila ¹; Reina Galeazzi-Isasmendi ¹; Román Romano Trujillo ¹

¹ Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: col538203@colaborador.buap.mx

In the pursuit of cost-effective and environmentally friendly photovoltaic technologies, Sb₂S₃-based thin-film solar cells have emerged as a promising alternative due to their thermal stability, abundance, and non-toxic nature. This work presents a detailed numerical analysis of the ITO/CdS/Sb₂S₃/Pt heterostructure using the SCAPS-1D simulation tool, focusing on critical parameters such as back contact work function, layer thicknesses, defect densities, internal resistances, and operating temperature.

The simulation results indicate that using platinum as the back contact significantly enhances band alignment and carrier transport, enabling a power conversion efficiency of 26.83% under standard AM1.5G illumination. Moreover, the device exhibits excellent thermal stability, with efficiency decreasing by less than 2% across a temperature range from 10°C to 60°C. When compared with state-of-the-art thin-film solar cell efficiencies reported by the NREL chart, the proposed structure demonstrates superior performance.

This study underscores the relevance of numerical modeling for guiding the optimization of emerging photovoltaic architectures and offers strategic insights for the development of stable, high-efficiency solar devices based on readily available materials such as Sb₂S₃ and CdS.

Keywords:

Solar cells, SCAPS-1D, Sb₂S₃, CdS, power conversion efficiency.

Reference:

Leticia Treviño Yarcé et al 2025 Mater. Res. Express 12 055904, 10.1088/2053-1591/adbab5

Ris work was supported by:

Benemérita Universidad Autónoma de Puebla



NUMERICAL SIMULATION AND MODELING OF WO₃/CuO SOLAR CELLS USING SCAPS-1D

Autor: Adriana Hernández Teniza¹

Coautores: Antonio Coyopol Solís ¹; Crisóforo Morales Ruíz ¹; Enrique Rosendo Andrés ¹; Godofredo García Salgado ¹; Leticia Treviño Yarcé ¹; María Josefina Robles Águila ¹; Reina Galeazzi Isasmendi ¹; Román Romano Trujillo ¹

¹ Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: adriana.hernandezteni@alumno.buap.mx

Increasing environmental pollution impetus, the development of sustainable technologies for generation clean energy. In this context, photovoltaic energy is presented as a key alternative, where the modeling and analysis of solar cells can optimize their design, reduce costs and enhance their performance. This study focuses on the simulation of solar cells with SCAPS-1D software, using cupric oxide (CuO) as the absorber layer and tungsten trioxide (WO₃) as the window layer. We analyzed the effects of thickness in both layers, the concentration of n-type and p-type carriers, and different materials for electrical contacts, such as platinum (Pt), nickel (Ni), gold (Au), silicon (Si), iron (Fe), silver (Ag), copper (Cu), aluminum (Al), and some TCO materials such as ITO and AZO. The series and parallel resistance and the working temperature of the solar cell were considered. The results indicated that an optimal thickness of 0.05 μm for the window layer and 3 μm for the absorber layer enables efficiencies close to 20%. In addition, using platinum for the back contact and aluminum for the front contact increased efficiency by up to 9%, demonstrating the importance of selecting appropriate materials for the contacts to maximize device capacity. The results allowed identifying the ideally solar cell configuration (Al/WO₃/CuO/Pt) to maximize efficiency by 28.37%, which, was found with a $V_{oc} = 1.1568\text{V}$, $J_{sc} = 28.25\text{mA/cm}^2$ and an $FF = 86.8\%$. These results reflected that it is possible to develop solar cells with sustainable materials, efficient and low environmental impact.

Keywords:

photovoltaic energy, SCAPS-1D, solar cells, CuO, WO₃

Reference:

Leticia Treviño Yarcé et al 2025 Mater. Res. Express 12 055904 DOI 10.1088/2053-1591/adbab5

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación (CVU 1008841)



MOLYBDENUM OXIDE RIN FILMS AND NANOSTRUCTURES BY VAPOR-PHASE METHODS: KEY MATERIALS FOR SUSTAINABLE ENERGY

Autor: OSVALDO de Melo¹

¹ *Escuela Superior de Física y Matemáticas, Escuela Superior de Ingeniería Mecánica y Eléctrica, Instituto Politécnico Nacional*

Autor responsable de la comunicación: odemelo@gmail.com

The compounds in the Molybdenum oxide family (MoO_3) play a significant role in renewable energy technologies, particularly in solar power, energy storage, hydrogen production, and smart windows. MoO_3 serves as an efficient hole transport layer (HTL) in organic and perovskite solar cells, an anode material in Li-ion batteries, and an active pseudocapacitive material in supercapacitors. Related compounds are also promising in catalysis for Hydrogen Evolution Reaction or Photocatalytic Water Splitting while MoO_x -based materials enable electrochromic smart windows. The ability to synthesize MoO_x compounds with different proportions of molybdenum and oxygen and different Mo valences, spanning from MoO_2 (IV) to MoO_3 (VI) oxide, and including the non-stoichiometric

Magnelli phases ($\text{Mo}_n\text{O}_{3n-1}$ with $n=1,2,3,\dots$), allows their use in a wide range of applications including energy, electronics, photocatalysis, and even in optical, and biological fields [1]. In this talk, I will review recently developed vapor phase techniques for the growth of various compounds of the MoO_x family with different morphologies including epitaxial flakes, films and rods of MoO_2 , cauliflowers like Mo_4O_{11} , layered MoO_3 crystals, $\text{MoO}_3/\text{Mo}_5\text{O}_{14}$ composites, as well as spatially resolved MoO_x phases by laser localized oxidation of MoO_2 . We analyze phase/morphology control through thermodynamic (Gibbs free energy) and computational (DFT) approaches.

Keywords:

Molybdenum oxides compounds, vapor phase growth. phase stability

Reference:

O. Concepción, O. de Melo, The versatile family of molybdenum oxides: synthesis, properties, and recent applications, J. Phys.: Condens. Matter 35 (2023) 143002

Ris work was supported by:

SIP-IPN projects 20220207 and 20221713, 20240682



ON THE PROSPECTS OF USING ALUMOBOROSILICATE GLASS AS A HYDROGEN BATTERY

Autor: Yuriy Kudriavtsev¹

Coautores: Miguel Angel Avendano-Ibarra ²; Rene Asomoza ¹; Yuliana Elvira Saucillo ²

¹ *Departamento Ingeniería Eléctrica - SEES, CINVESTAV, Zacatenco*

² *Departamento Ingeniería Eléctrica - SEES, CINVESTAV*

Autor responsable de la comunicación: yuliana.elvira.s@cinvestav.mx

The interaction of water vapor with the surface of aluminosilicate and borosilicate glasses of a certain composition can occur through two different mechanisms [1]. If the glass surface is covered with a thin layer of adsorbed water, then after a short period of ion exchange between the protons of the adsorbed water and the alkali metals of the glass (limited by the saturation of the water with alkalis), further saturation of the glass surface with hydrogen is the result of the reaction of silicon oxide to form silicon hydroxide. In the case of the formation of a thick layer of adsorbed water on the glass the ion exchange process does not stop, and the exchange of all alkali elements leads to

the formation of a growing layer of glass saturated with "internal water". Thus, it is possible (thin adsorbed layer) to obtain glass, containing a layer saturated with hydrogen at a concentration of up to approximately 10 at.%. Heating such glass led to the release of hydrogen from the glass in a gaseous state (H₂, H₂O, ...). This report presents the results of a study of the composition of gas released during heating of pre-hydrated aluminosilicate (obsidian) and borosilicate (Pyrex) glasses in a system based on a quadrupole mass spectrometer. The release of water and hydrogen molecules at temperatures above 350°C for several hours is shown. A strong dependence of the composition of the released gases on the average size of the glass powder was found. With too fine a glass powder, water emission prevails, while with glass pieces of about 1-3 mm in size, hydrogen emission prevails after a short period of intense water emission. The report discusses the results obtained and the prospects for the use of alumoborosilicate glasses in hydrogen energy producing.

Keywords:

alumoborosilicate glasses, hydration of glasses, hydrogen emission, hydrogen energy.

Reference:

Y. Kudriavtsev, R. Asomoza, Comparative analysis of corrosion of borosilicate glasses in water vapor, *Solid State Ionics*, 371 (2021) 115754. <https://doi.org/10.1016/j.ssi.2021.115754>

Ris work was supported by:

SECIHTI, grant CF-2023-I-2207



UNDERSTANDING THE PERFORMANCE LIMITING EFFECTS OF HOLE TRANSPORT LAYERS IN PEROVSKITE SOLAR CELLS

Autores: Arturo Morales-Acevedo¹; David Mateus Torres-Herrera¹

Coautor: Rosa Nava Sánchez¹

¹ *CINVESTAV*

Autor responsable de la comunicación: amorales@cinvestav.mx

High efficiency hybrid perovskite solar cells require hole transport layers (HTL) that enable efficient charge extraction, minimizing interfacial recombination losses, and enhancing device stability. The HTL material can produce effects that significantly affect the photovoltaic device's performance. In this study, first as a way of understanding such effects, a fast analytical method is shown to extract the saturation current density (J_0) and the light-generated current density (J_L) from the illuminated J-V curves. Together with approximate estimates for the series (R_s) and shunt (R_{sh}) resistances, the method enables a fast and more comprehensive evaluation of the HTL related effects, facilitating the design of mitigation strategies for undesired effects. Then the method was applied to hybrid perovskite solar cells with the architecture FTO/TiO₂/CsFAPbI₃/HTL/Au, comparing two HTLs: CuSCN and Spiro-OMeTAD. Devices employing Spiro-OMeTAD exhibited significantly better performance ($PCE = 10.7 \pm 1.2\%$) than those using CuSCN ($PCE = 4.5 \pm 0.8\%$), which is attributed to the higher resistivity and increased density of interfacial traps for the CsFAPbI₃/CuSCN devices. Based on this analysis, strategies can be devised to achieve even better solar cell efficiencies, as will be discussed at the end.

Keywords:

Perovskites, Solar cells, Hole Transport Layers

Reference:

D. Mateus Torres-Herrera, Olaf Ramírez-Iturbe, Rosa Nava-Sánchez and Arturo Morales-Acevedo, "On the Vegard's law compliance for CsxFA(1-x)PbI₃ perovskite thin films", Phys. Scrip. 99, 095962 (2024)

Ris work was supported by:

SECIHTI Postdoctoral Fellowship for DMTH



GROWTH OF ZnO RIN FILMS FOR SOLAR CELL APPLICATIONS.

Autor: Eduardo Merino Montes¹

Coautores: Mario Fidel García Sánchez ²; José Francisco Malagón García ³; Edgardo Saucedo ⁴; Frank Güell Vilàs

¹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas IPN*

² *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas*

³ *Instituto Politécnico Nacional*

⁴ *Universitat Politècnica de Catalunya*

⁵ *Universitat de Barcelona*

Autor responsable de la comunicación: merinoed@outlook.com

In this research, zinc oxide (ZnO) thin films were synthesized using the ultrasonic spray pyrolysis technique to characterize their structural, optical, and electrical properties, with potential application as passivation layers in second-generation kesterite-based solar cells. ZnO can reduce charge carrier recombination at the device interface, potentially improving overall efficiency. Films were deposited from a solution of zinc acetate dihydrate in anhydrous methanol, with growth temperatures ranging from 350 °C to 450 °C in 25 °C intervals, on glass and silicon substrates, and using precursor concentrations of 0.1 M, 0.05 M, and 0.025 M. X-ray diffraction (XRD) revealed a hexagonal wurtzite structure with preferential orientation along the (002) plane. In glass substrates, UV-Vis spectroscopy revealed high optical transmittance in glass-based samples, exceeding 85% for 0.025 M, 80% for 0.05 M, and 70% for 0.1 M films. Photoluminescence spectra displayed broad visible emissions (blue, green, yellow, orange, and red), associated with intrinsic defects such as oxygen and zinc vacancies and interstitials. A thermal treatment at 500 °C for 4 hours in ambient air resulted in a thickness increase of over 50%, as measured by profilometry, along with changes in structural and optical properties. The optical band gap ranged from 3.24 to 3.29 eV. Films synthesized at 375°C and 400°C exhibited better crystallinity, higher transmittance, and a wider band gap, indicating these conditions as optimal for photovoltaic applications.

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación (Secihti)

Keywords:

ZnO, thin films, ultrasonic spray pyrolysis

Reference:

Galdámez-Martínez, A., Santana, G., Güell, F., Martínez-Alanis, P. R., & Dutt, A. (2020). A review on ZnO nanowires' photoluminescence and optoelectronic applications. *Nanomaterials*, 10(5), 857. <https://doi.org/10.3390/nano10050857>



PHOTOCATALYTIC HYDROGEN PRODUCTION USING Ag₂S QUANTUM DOTS SYNTHESIZED VIA SILAR TECHNIQUE: INFLUENCE OF DEPOSITION PARAMETERS

Autor: Julián Alfaro Chacón¹

Coautores: Gilbert Ortíz Rabell ¹; Isaías Juárez Ramírez ¹

¹ *Universidad Autónoma de Nuevo León, Facultad de Ingeniería Civil, Departamento de Ecomateriales y Energía*

Autor responsable de la comunicación: julian.alfaro9312@gmail.com

The growing global demand for sustainable energy has increased interest in hydrogen production through photocatalytic water splitting, which uses light energy to split water molecules into hydrogen and oxygen, offering a promising clean energy alternative. Among the recent challenges, quantum dots have emerged as effective sensitizers that enhance photocatalytic performance due to their strong light absorption, and excellent charge separation capabilities. Specifically, Silver sulfide (Ag₂S) quantum dots are promising due to their low toxicity and narrow band gap (0.9–1.1 eV), which allows them to absorb visible light efficiently. In this work, QDs have been deposited by a simple and low-cost method, the Successive Ionic Layer Adsorption and Reaction (SILAR). This method allows the controlled growth of nanostructured films by dipping a substrate into alternating precursor solutions. Key parameters, such as the number of deposition cycles and the concentration of the precursor solutions, influence the size and coverage of the particles, as well as their optical and electronic properties. Therefore, our research focuses on how these SILAR parameters affect the optical and elemental characteristics of Ag₂S QD films and their ability to generate hydrogen. The results showed that although more cycles and higher concentrations improved light absorption, the best hydrogen production was seen in samples with fewer cycles and lower concentrations. It is assumed that better exposure of active surface sites and reduced electron-hole recombination occurred as evidenced by photoluminescence (PL) analysis. Elemental analysis revealed deviations from ideal stoichiometry, suggesting surface defects that may influence charge dynamics. These results highlight the importance of tuning synthesis conditions to optimize QD-based photocatalysts for efficient solar hydrogen production.

Keywords:

Hydrogen, photocatalysis, quantum dots, SILAR technique, Silver sulfide

Reference:

Baozhu Shi, Yan Qi, Lecheng Tian. Fabrication of Ag₂S quantum dots sensitized CdSe photoelectrodes and its photoelectric performance. *Materials Chemistry and Physics* 2020.
<https://doi.org/10.1016/j.matchemphys.2019.122177>

Ris work was supported by:

PROACTI UANL 2024



SYNTHESIS OF MOLYBDENUM DISULFIDE THROUGH THERMOCOLLOIDAL METHOD.

Autor: Araceli Flores Conde¹

Coautores: Sergio Armando Tomás Velázquez²; Usiel Omar García Vidal³

¹ *Escuela Superior de Ingeniería Mecánica y Eléctrica-Instituto Politécnico Nacional, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional*

² *Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional*

³ *UPIITA-IPN*

Autor responsable de la comunicación: araceli.flores@cinvestav.mx

Two-dimensional Molybdenum disulfide, MoS₂, has been extensively studied and synthesized by different methods, including chemical vapor deposition, laser ablation, microwave synthesis, and mechanical exfoliation; however, most of these methods need specialized equipment to carry out the preparation of materials. In this work, MoS₂ was synthesized by a thermocolloidal method using MoO₃ and elemental sulphur as raw materials, and oleylamine and oleic acid as solvents. During the synthesis process, oleylamine and oleic acid were respectively taken at different volume ratios, i.e., 100-0, 50-50, and 0-100, and as a result different morphologies were obtained. As confirmed by XRD, XPS, Raman spectroscopy, SEM, and TEM, the semiconducting 2H-MoS₂ phase was mainly obtained for the 100-0 and 50-50 ratios. In particular, the sample fabricated at a ratio of 50-50 showed an exceptional result, as it was formed by four layers.

Keywords:

Thermocolloidal synthesis, MoS₂, Raman, XPS, oleylamine

Reference:

P. Wu, W. Li, Z. Liu, Z. Cheng, Preparation and Tribological Properties of Oleic Acid-Decorated MoS₂ Nanosheets with Good Oil Dispersion, *J. Dispersion Sci. Technol.* 39 (2018) 1742-1751.
<https://doi.org/10.1080/01932691.2018.1>

Ris work was supported by:

(SECIHTI) through a Postdoctoral scholarship (CVU: 421076) provided to A. Flores-Conde, who also acknowledges SNII-SECIHTI a fellowship and CINVESTAV for the use of facilities. This research was partially supported by SECIHTI through project 205733 and SIP-IPN, 20241289, 20242890



STUDY AND SIMULATION OF THE SEMITRANSSPARENT SOLAR CELL BASED ON THE HETEROJUNCTION n-TiO₂/p-NiO USING SCAPS-1D

Autor: Maria del Rayo Morales Díaz¹

Coautores: Antonio Coyopol Solís¹; Crisóforo Morales Ruíz¹; Enrique Rosendo Andrés²; Godofredo García Salgado¹; Leticia Treviño Yarcé¹; María Josefina Robles Aguila¹; Reina Galeazzi Isasmendi¹; Román Romano Trujillo¹

¹ Benemérita Universidad Autónoma de Puebla

² Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: md223570529@alm.buap.mx

In searching for sustainable alternatives to replace scarce or toxic semiconductors, transparent conductive oxides (TCOs) have emerged as promising candidates.

Due to their high electric conductivity and optic transmission, TCOs allow the development of new configurations in photovoltaic devices. In this investigation, the study and numerical simulation was made, based on the heterojunction p-NiO/n-TiO₂ using a one-dimensional approach.

According to the property of the materials, two lighting configurations were evaluated: the first one related with the illumination from the type p region (NiO) and the second one related with the illumination from the type n (TiO₂). In the first one, when NiO works as a window layer, the cell achieves an efficiency of 10.93%, with photovoltaic parameters Voc=2.34 V, Jsc=9.16 mA/cm² y FF=71.18% using thicknesses of 275 nm for the window layer and 1800 nm for the absorbent layer. In the second configuration, when the cell is illuminated from type n, the efficiency decreases to 7.11%, with Voc= 2.26 V, Jsc=5.99 mA/cm² and FF= 60.14%, using a thickness for the window layer of 275 nm and absorbent layer of 1400 nm.

Both configurations were evaluated for the election of the front and back contacts, according to the work function of the materials and it was determined the use of aluminum and iron as metallic contacts. This heterojunction was analyzed under different parameters of temperature and electrical resistance with the purpose of finding the behavior that favors the characteristics of the materials in the heterojunction.

The results indicate that the illumination from the type p region is favorable due to better alignment of the energy bands and a higher concentration of acceptor carriers, which stimulate the separation and efficient recollection of carriers.

Keywords:

Heterojunction, Transparent Conductive Oxides, SCAPS 1D

Reference:

- Mouchou, R. (2020). Numerical Simulation and optimization of p-NiO/nTiO₂ solar cell system using SCAPS. ELSEVIER, 835-841.
- Ukoba, K. O. (2018). Modeling of fabricated NiO/TiO₂ P-N Heterojunction Solar Cells. International Journal of Applied Engineering Research, 9701-9705.

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación (CVU 1076490)



OPTOELECTRONIC EVALUATION OF METASTABILITIES IN KESTERITE/CdS SOLAR CELLS USING MULTIWAVELENGTH ILLUMINATION

Autores: Alex Jimenez-Arguijo¹; Mario Fidel García Sánchez²; Outman El Khouja¹; Yuancai Gong¹; Sergio Giraldo¹; Marcel Placidi¹; Eduardo Merino Montes²; Pastor Alan Rodríguez Echevarría²; Zacharie Jehl¹; Edgardo Saucedo¹

¹ *Electronic Engineering Department, Universitat Politècnica de Catalunya (UPC), Photovoltaic Lab – Micro and Nano Technologies Group (MNT), EEBE, Av. Eduard Maristany 10-14, Barcelona 08019, Catalonia, Spain*

² *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas-Instituto Politécnico Nacional, Av. IPN No 2580, Gustavo A. Madero, C.P. 07340, CDMX, México.*

Autor responsable de la comunicación: mgarciasan@ipn.mx

The ideality factor change of J-V curve upon illumination suggesting metastable effects. In this work, high-quality kesterite $\text{Cu}_2\text{ZnSn}(\text{S},\text{Se})_4$ (CZTSSe) solar cells with four different thickness of CdS were characterized. The I-V curves were measured using a calibrated AAA solar simulator (G2V) based LED light with a light equivalent to AM1.5G conditions. Different cells were selected with photovoltaic conversion efficiencies and fill factors close to or greater than 8% and 50%, respectively. The J-V curves of these cells were evaluated while light is turn on and off, to analyze the influence of light soaking in the ideality factor. EQE measurements were performance with and without a white light illumination. The J-V curves of these cells were characterized using nine different wavelengths, preserving the photon flux. All devices are measured before and after hot plate annealing at 100 °C for 1 h. Changes in illumination time altered the ideality factor of the J-V curves; this was influenced by the CdS thickness and the hot plate treatment applied. On the other hand, the ideality of the J-V curves is also dependent of the wavelength photon flux, with important variations in wavelength between 2.34 and 2.64 eV, close to the band gap of CdS. Results are related to the photoinduced defects in CdS and at CdS-kesterite interface.

Keywords:

Kesterites solar cells, EQE, J-V curves, defects

Reference:

Y. Gong, A. Jimenez-Arguijo, A. Gon Medaille, S. Moser, A. Basak, R. Scaffidi, R. Carron, D. Flandre, B. Vermang, S. Giraldo, H. Xin, A. Perez-Rodriguez, E. Saucedo, *Adv. Funct. Mater.* 34 (2024) 2404669

Ris work was supported by:

This work was supported by IPN under project 20250260



NiO AND WO₃ AS BASE MATERIALS FOR ELECTROCHROMIC DEVICES

Autores: Israel Omar Perez Lopez¹; Jose Luis Enriquez Carrejo²; Victor Sosa³; Fidel Gamboa³; Juan Carlos Mixteco Sanchez⁴

¹ SECIHTI-Departamento de Física Aplicada, Cinvestav Unidad Mérida, Km 6 Ant. Carr. Progreso, A.P. 73, Cordemex, C.P. 97310. Yucatán, México

² Departamento de Física y Matemáticas, Instituto de Ingeniería y Tecnología, Universidad Autónoma de Ciudad Juárez

³ Departamento de Física Aplicada, Cinvestav Unidad Mérida, Km 6 Ant. Carr. Progreso, A.P. 73, Cordemex, C.P. 97310. Yucatán, México

⁴ Departamento de Ciencias Naturales y Exactas, CU Valles, Universidad de Guadalajara, Carr. a Guadalajara km.45.5, C.P. 46600, Ameca, Jalisco, México

Autor responsable de la comunicación: israel.perez@cinvestav.mx

In this work we report on the research developed around NiO and WO₃ used as electrochromic materials for electrochromic devices with special emphasis in half cells [2-4]. We also show the effects of the liquid electrolyte LiClO₄ on the transparent conductor oxides such as indium tin oxide and fluorine-doped tin oxide [1,3]. Using different techniques combined with ab initio calculations we characterized the materials and measured their electrochromic properties such as the coloration efficiency and chemical properties [5]. We realized that the effect of the electrolyte on both the electrochromic materials and the conductive layers is to degrade the materials leading to changes in chemical composition as revealed by X-ray photoelectron spectroscopy. Efficiencies are relatively small for both NiO and WO₃ samples. Ab initio calculations helped us understand optical properties of these materials. We also explored the effect of lithium insertion on the electronic properties of these materials. We found that the band gap is reduced and the absorption coefficient is increased in the infrared region for WO₃ whereas for NiO the effect applies in the boundary between the infrared and the visible region

Keywords:

Electrolyte, electrochromic device, transition metal oxides

Reference:

[1] Israel Perez, et al, Assessing the effect of LiClO₄ electrolyte on the electrochemical properties of indium tin oxide thin films, JART, To be published in June, 2025

Ris work was supported by:

NA



EXPLORING THE PERFORMANCE OF FILMS OF SOLID PHASE SOLUTION (CdTe)_{1-x}Al_x AS A PHOTOVOLTAIC MATERIAL.

Autores: Miguel Meléndez-Lira¹; Tatsuya Tanaka²; Masakazu Kobayashi²

¹ *Departamento de Física, Cinvestav*

² *Department of Electrical Engineering and Bioscience, Waseda University, Shinjuku, Tokyo*

Autor responsable de la comunicación: miguel.melendez@cinvestav.mx

CdTe is a direct band gap semiconductor with optimal properties to produce solar cells, between them are its 1.5 eV direct band gap value, close to the maximum of the spectral sun irradiance at earth surface and a high optical absorption coefficient. A systematic study on this material has produce technological advances conducting to the production of reliable commercial photovoltaic modules. However, still the efficiency limit of CdTe based solar cell needs to be reached. Elements of group III can be employed to control CdTe conductivity however other electronic properties, such as bandgap, can be modified producing pseudo alloys opening the possibility to improve the efficiency of CdTe based solar cells [1].

Here the results of structural, chemical and electronic properties of (CdTe)_{1-x}Al_x films deposited by RF co-sputtering on molybdenum/glass and p-type silicon are presented. In order to explore the potential of (CdTe)_{1-x}Al_x as a photovoltaic material 5 heterostructures Glass/Mo/(CdTe)_{1-x}Al_x/ZnInS/ZnO:Al were prepared and their I-V characteristic were determined in a 4 x 4 array [2]. Results are correlated with the structural characteristics and composition of the analyzed element. In the case of (CdTe)_{1-x}Al_x/Si rectifying and spectral response characteristics are reported.

Keywords:

semiconductors, photovoltaics, thin films

Reference:

- [1] Meléndez-Lira et al. (2024). Materials Research Express, 11(4), 045901.
- [2] Uruno, A., & Kobayashi, M. (2013). Growth of AgGaTe 2 layers by a closed-space sublimation method. Journal of electronic materials, 42, 859-862.

Ris work was supported by:

partially funded by CONAHCyT



OPTICAL PROPERTIES OF FLEXIBLE PET/ITO AND PII/ITO SUBSTRATES EXPOSED TO VISIBLE SOLAR RADIATION

Autor: Carlos Montero Tavera¹

¹ *Universidad de Guanajuato*

Autor responsable de la comunicación: carmontero6@hotmail.com

In this research we show the effects of visible solar radiation on the optical properties of PET/ITO (polyethylene terephthalate/indium tin oxide) and PII/ITO (polyimide/indium tin oxide) substrates for possible use as flexible substrates in organic solar cells. ITO/PET is commercially available while ITO for PII substrate was sputter deposited. Additionally, TiO₂ was deposited at room temperature on the PET/ITO substrate by spin-coating, and TiO₂ was deposited on the PII/ITO substrate by spray- pyrolysis at 350°C to analyze their effects on the optical properties of the flexible substrates.

Keywords:

solar-cell, spin-coating, spray-pyrolysis, flexible-substrate, sputtering

Reference:

M. Oviedo-Mendoza, et al., "Improving P3HT:PCBM absorber layers by blending TiO₂/CdS nanocomposites for application in photovoltaic solar cells," *Journal of Materials Science: Materials in Electronics*, vol. 32, no. 1, pp. 102–112, Jan. 2021, doi: 10.1007/s10854-020-04705-9.

Ris work was supported by:

This work was partially supported by CONAHCYT under the PDCPN 2015 program (grant 28). C. Montero-Tavera acknowledges CONAHCYT- México for postdoctoral scholarship Investigadores por México 2022 (3) (CVU: 295183), conducted at the Department of Mechanical Engineering, Universidad de Guanajuato.



ENHANCED OXYGEN EVOLUTION IN ALKALINE MEDIUM USING SPRAY- DEPOSITED RUTHENIUM-COBALT OXIDE ON NICKEL FOAM

Autor: Miriam Tellez Cruz¹

Coautores: Amauri Serrano Lazaro ²; Lilian Olvera Garza ¹; Monserrat Bizarro Sordo ¹

¹ *Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México*

² *Instituto de Ciencias Aplicadas y Tecnología, Universidad Nacional Autónoma de México*

Autor responsable de la comunicación: miriamtellez@materiales.unam.mx

Ruthenium-cobalt oxide ($\text{Ru}_{1-x}\text{Co}_x\text{O}_2$) electrocatalysts were fabricated on nickel foam using pneumatic spray pyrolysis to boost oxygen evolution reaction (OER) efficiency in alkaline environments. Among them, the $\text{Ru}_{0.9}\text{Co}_{0.1}\text{O}_2$ composition exhibited superior activity, requiring only 290 mV over-potential at 10 mA cm^{-2} and showing a Tafel slope of 40 mV dec^{-1} , surpassing pure RuO_2 (320 mV). Structural analysis indicated that cobalt doping caused lattice contraction in the RuO_2 rutile framework, which enhanced electronic conductivity and stabilized catalytic sites. The spray pyrolysis method produced evenly distributed spherical nanoparticles, while the use of EDTA and citric acid as ligands controlled the crystallite size to 10 nm and generated oxygen vacancies. Durability tests demonstrated excellent stability, with just a 30 mV increase in overpotential after 80 hours of operation. Overall, this research demonstrates that $\text{Ru}_{0.9}\text{Co}_{0.1}\text{O}_2$ is a promising, scalable, and cost-effective anode material for industrial water electrolysis at high current densities.

Keywords:

oxygen evolution reaction, spray pyrolysis, electrocatalyst, citric acid, EDTA

Reference:

Sun, H., & Jung, W. (2021). Recent advances in doped ruthenium oxides as high-efficiency electrocatalysts for the oxygen evolution reaction. *Journal of Materials Chemistry A*, 9(28), 15506-15521.

Ris work was supported by:

DGAPA PAPIIT IN101824



EFFECTS OF THE SURFACE TERMINATION ON THE ELECTROCHEMICAL PROPERTIES OF THE $\text{Ti}(3-x)\text{Mo}_x\text{C}_2\text{T}_z$ ($\text{T}_z = \text{O}, \text{S}$) MXENES

Autor: Victor Hugo Medina Macias¹

Coautor: Rodrigo Ponce Perez²

¹ CICESE, CNYN-UNAM

² CNYN UNAM

Autor responsable de la comunicación: vmedina@cicese.edu.mx

Double transition metal (DTM) MXenes are a family of two-dimensional composite nanomaterials with excellent potential when applied as electrodes for energy storage devices; $\text{Ti}(3-x)\text{Mo}_x\text{C}_2\text{T}_z$ DTM MXenes are promising electrode materials for energy storage devices. Yet, we currently lack an understanding of the possible chemical configurations of Ti/Mo-based DTM MXenes and the effect of surface terminations on their capacity to function as reliable electrodes. In this study, we demonstrate the thermodynamic stability, in addition to the structural and electrochemical properties, of $\text{Ti}(3-x)\text{Mo}_x\text{C}_2\text{T}_z$ ($\text{T}_z = \text{O}, \text{S}$) DTM MXenes using first-principles DFT-based methods. A solid understanding of their chemical composition and material properties gives insights into their electrode performance in energy storage devices, focusing on Li-ion batteries. A defect formation energy formalism was employed to study the thermodynamic stabilities of the compositional variations of the $\text{Ti}(3-x)\text{Mo}_x\text{C}_2$ pristine MXenes. The most stable configuration was selected as the base for placing surface terminations. The surface terminations (O, S) were placed in 3 high-symmetry sites on the DTM MXene, and the most stable systems were chosen to study the lithiation process. Electrochemical characterization was carried out employing Open Circuit Voltage (OCV) curves. Our results show a potential Janus-like structure that induces changes in the $\text{Ti}(3-x)\text{Mo}_x\text{C}_2$ MXene's ability to allow the surface transport and intercalation of lithium ions, possibly paving the way for enhanced energy storage devices.

We thank DGAPA-UNAM projects IA100624 and IN101523 for the financial support. Calculations were performed in the DGCTIC-UNAM Supercomputing Center, project LANCAD-UNAM-DGTIC-422 and LANCAD-UNAM-DGTIC-150.

Keywords:

MXene, 2D-Nanomaterials, Transition-Metal-Carbides, Double-Transition-Metal-MXenes, Electrode, Li-ion-Batteries, Titanium-Molybdenum-MXene



ELECTRICAL BEHAVIOR OF BISMUTH FERRITE MICROSTRUCTURES AS A FUNCTION OF BISMUTH CONTENT

Autor: Jaqueline Vázquez Zúñiga¹

Coautores: JOSE ALBERTO LUNA LOPEZ¹; Zaira Jocelyn Hernández Simón¹; Adolfo David Quintero González¹; Eduardo Flores Cuevas²; Karim Monfil Leyva¹; Gabriel Omar Mendoza Conde¹

¹ CIDS-IC-BUAP

² CINVESTAV-Merida

Autor responsable de la comunicación: jose.luna@correo.buap.mx

The multiferroic material bismuth ferrite (BiFeO_3 or BFO) exhibits a wide range of applications due to its status as the par excellence ferroelectric and multiferroic material, as evidenced by its high Curie temperature, which has prompted extensive research on its properties. One of the most interesting properties of BFO is its well-known intrinsic photovoltaic effect, which has been the subject of investigation and has yielded interesting results, as evidenced by a published work [1] in which a very good photovoltaic response was obtained. The objective of this study was to modify the bismuth content and thereby analyze and change the electrical and photoelectric properties of the material. The BFO microstructures were obtained using the ultrasonic spray pyrolysis deposition technique. Precursor solutions were fabricated with different percentages of excess or deficiency of bismuth. The percentages used were 5%, 10%, and 15% (bismuth excess) and -5%, -10%, and -15% (bismuth deficiency). The microstructures were deposited at a temperature of 100°C on a p-type silicon substrate, and a contact of indium-doped tin oxide (ITO) was subsequently placed on them. An exhaustive analysis of the electrical and photoelectric response was carried out on the fabricated samples. The results obtained demonstrate alterations in the photoelectric response in accordance with the excess or deficiency of bismuth. The deposition technique employed in this study offers distinct advantages, including reduced production costs, simplified deposition processes, and enhanced scalability. The fabricated structures demonstrate competitiveness, rivaling those produced using significantly more intricate techniques and structures.

Keywords:

BFO; Bismuth; Electrical behavior; Photovoltaic; Spray Pyrolysis

Reference:

Simón, Z. J. H., López, J. A. L., et. al. Outstanding photoelectrical response in BiFeO_3 hollow microspheres deposited by USP technique. JAC, 955 (2023), 170215.

Ris work was supported by:

SECIHTI BASIC SCIENCE G-952-2025 and VIEP PROJECT-518-2025



SYNTHESIS AND PHOTOCATALYTIC EVALUATION OF ZnO-Cu₂O FILMS FOR INDIGO CARMINE DYE DEGRADATION.

Autor: Karla Edith Arizmendi García¹

Coautores: Miriam Tellez Cruz ¹; Monserrat Bizarro Sordo ¹

¹ *Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México*

Autor responsable de la comunicación: kedith.agarcia@ciencias.unam.mx

Water contamination by industrial dyes is a significant environmental issue, as they can damage the ecosystems in water bodies. Heterogeneous photocatalysis has shown to be a promising method to tackle this problem. Current investigations are devoted to developing efficient photocatalytic thin film materials that can degrade organic pollutants in water using light. This work presents the synthesis of copper (Cu)-incorporated zinc oxide (ZnO) thin films as efficient photocatalysts for indigo carmine dye degradation. ZnO films were synthesized via spray pyrolysis, with Cu integration achieved through chemical reduction, inducing critical structural and electronic modifications. The incorporation of Cu⁺ ions into ZnO's wurtzite lattice reduced the lattice parameters determined by XRD and oxygen vacancies analyzed by photoluminescence. Optical characterization showed a narrowed bandgap (3.1 eV vs. ZnO's 3.3 eV), enabling visiblelight absorption at 405 nm. Cu acted as an electron trap, reducing electron-hole recombination compared to pristine ZnO. Photocatalytic tests under 405 nm LED irradiation demonstrated that Cu-ZnO films achieved complete dye degradation

in 2 hours -33% faster than unmodified ZnO (3 hours). The synergistic effects of improved light absorption, efficient charge separation, and enhanced surface reactivity also granted exceptional cyclability, with 98% efficiency retention over three cycles. These results highlight Cu's dual role as a structural modifier and electronic promoter in ZnO, advancing reusable photocatalytic systems for wastewater treatment.

Keywords:

Photocatalysis, zinc oxide, copper doping, indigo carmine, spray-pyrolysis.

Reference:

N. S. Portillo-Vélez, A. Hernández-Gordillo, and M. Bizarro, Morphological effect of ZnO nanoflakes and nanobars on the photocatalytic dye degradation, *Catal. Today* 287 (2017) 106–112.
<https://doi.org/10.1016/j.cattod.2016.10.023>.

Ris work was supported by:

This project was funded by DGAPA PAPIIT IN101824.



ENHANCED PHOTOCATALYSIS ZnO/CuO HETEROJUNCTION VIA A MODIFIED SILAR METHOD

Autores: Gerardo Rodríguez-Jiménez¹; Víctor Hugo Martínez-Landeros²; Lázaro Abdiel Falcón-Franco¹; Jesús Alfonso Mercado-Silva³; Bertha Alicia Puente-Urbina³; Luis Alfonso García-Cerda³; Dagoberto Vázquez-Obregón⁴

¹ Facultad de Metalurgia, Universidad Autónoma de Coahuila

² Facultad de Metalurgia, Universidad Autónoma de Coahuila.

³ Materiales Avanzados, Centro de Investigación en Química Aplicada

⁴ Metal-Mecánica, Tecnológico Nacional de México

Autor responsable de la comunicación: gerardo.jimenez@uadec.edu.mx

The development of semiconductor nanostructures based on metal oxides has emerged as a promising technology for addressing environmental challenges related to water pollution through photocatalysis. In this study, thin-film heterostructures composed of zinc oxide (ZnO) and copper oxide (CuO) were synthesized using a modified version of the Successive Ionic Layer Adsorption and Reaction (SILAR) method.

Zinc sulfate ($\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$) and copper chloride (CuCl_2) were used as precursors and ammonium hydroxide (NH_4OH) was employed as a complexing agent. Thin films were deposited onto glass substrates through alternating immersions in cationic and anionic solutions, with intermediate rinses in deionized water. After deposition, the samples underwent thermal treatment at 400 °C for 3 hours to enhance structural quality. Characterization by SEM, XRD, and UV-Vis spectroscopy revealed improvements in crystallinity, surface morphology, and a reduction in the optical bandgap attributed to the formation of a p-n junction between the two oxides. This junction facilitates charge separation and reduces electron recombination, thus increasing photocatalytic efficiency. The photocatalytic activity was evaluated through the degradation of methylene blue under ultraviolet light irradiation for 6 hours, with absorbance measurements taken at hourly intervals. The results showed that the ZnO/CuO heterostructures exhibited higher degradation efficiency compared to the individual oxides, confirming the advantages of combining different semiconductor types (n-type and p-type). These findings highlight the potential of these metal oxide heterostructures as a promising solution for the degradation of organic pollutants in water.

Keywords:

Thin films, heterojunctions, ZnO/CuO, photocatalysis, methylene blue.

Reference:

K. Mubeen, A. Irshad, A. Safeen, U. Aziz, K. Safeen, T. Ghani, K. Khan, Z. Ali, I. ul Haq, and A. Shah, Band structure tuning of ZnO/CuO composites for enhanced photocatalytic activity, J. Saudi Chem. Soc. 27 (2023) 101639.
<https://doi.org/10.1016/j.jscs.2023.101639>

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación



ZnO AND Sn-ZnO THIN FILMS OBTAINED BY SILAR: STRUCTURAL, OPTICAL ANALYSIS AND PHOTOCATALYTIC PERFORMANCE

Autores: José Higinio Mayorga Estrada¹; Víctor Hugo Martínez-Landeros²; Sergio García Villareal¹; Bertha Alicia Puente-Urbina³; Jesús Alfonso Mercado-Silva³; Luis Alfonso García-Cerda³; Dagoberto Vázquez-Obregón⁴

¹ *Facultad de metalurgia, Universidad Autónoma de Coahuila*

² *Facultad de Metalurgia, Universidad Autónoma de Coahuila.*

³ *Materiales Avanzados, Centro de Investigación en Química Aplicada*

⁴ *Metal-Mecánica, Tecnológico Nacional de México*

Autor responsable de la comunicación: jose.mayorga@uadec.edu.mx

Environmental contamination by organic pollutants has increased the need for efficient and sustainable treatment technologies. Photocatalysis offers a promising approach by enabling the degradation of these compounds through light-driven reactions. ZnO and Sn-ZnO thin films were synthesized via the Successive Ionic Layer Adsorption and Reaction (SILAR) method, using zinc sulfate as the base precursor and incorporating tin at concentrations of 1%, 3%, and 5% wt. The films were deposited on glass substrates. X-ray diffraction (XRD) analysis revealed changes in diffraction peak profiles and lattice parameters, indicating incorporation of Sn and the formation of structural distortions. A decrease in crystallite size was observed as tin content increased, suggesting the generation of defects in the ZnO lattice. Optical properties were characterized using UV-Vis spectroscopy, and the optical band gap was estimated by the Tauc method, revealing a reduction in band gap energy with increasing Sn concentration. This behavior is attributed to the introduction of intermediate energy states and increased structural disorder. The photocatalytic activity was evaluated through the degradation of methylene blue under UV irradiation. Enhanced degradation efficiency was observed in Sn-doped films attributed to improved light absorption and increased surface reactivity resulting from doping.

Keywords:

Zinc oxide, tin doping, SILAR, photocatalysis, methylene blue

Reference:

Kumari, H., Sonia, Suman, Ranga, R., Chahal, S., Devi, S., Sharma, S., Kumar, S., Kumar, P., Kumar, S., Kumar, A., & Parmar, R. (2023). A Review on Photocatalysis Used For Wastewater Treatment: Dye Degradation.

Ris work was supported by:

SECIHTI



BAND GAP DEPENDENCE ON ENERGY DENSITY IN LASER ANNEALING OF CdS THIN FILMS FOR PHOTOVOLTAICS APPLICATIONS

Autor: Mitzi Deyanira Gómez Osorio¹

Coautores: Cesar Hernandez Vasquez²; Daniel Jiménez Olarte¹; Jesús Roberto González Castillo¹; José Manuel Flores Márquez³; Sergio Ramírez Velasco¹

¹ ESIME-Instituto Politécnico Nacional

² ESCOM-Instituto Politécnico Nacional

³ ESIQIE-Instituto Politécnico Nacional

Autor responsable de la comunicación: gomezosoriomitzi132014@gmail.com

CdS is a widely used material in thin-film solar cells. After thin-film growth, it is generally annealed to improve its physical and chemical properties. Thermal annealing in furnaces in an air atmosphere have been found to improve the band gap energy, however, other thermal treatment techniques have recently been implemented on CdS thin films, one of which is laser annealing, where the operating parameters influence the resulting physical and chemical properties of the irradiated materials. In this work, CdS thin films grown by chemical bath deposition were laser annealed by varying the energy density of a 532 nm pulsed laser and its impact on the band gap energy was evaluated by means of UV-Vis spectroscopy.

Keywords:

laser annealing, CdS, energy band gap

Reference:

M. L. Albor Aguilera et al., "Improving the optical and crystalline properties on CdS thin films growth on small and large area by using CBD technique," *Revista Mexicana de Física*, vol. 62, no. 2, pp. 129– 134, 2016, [Online]. Available: <https://www.redalyc.org/articulo.oa?id=57044663006>

Ris work was supported by:

Instituto Politécnico Nacional SIP 20250251 and BEIFI-IPN



SOLAR CELL IMPROVED PERFORMANCE BY THE OPTIMIZATION OF BROMIDE INCORPORATION IN THE HYBRID PEROVSKITE ABSORBERS DEPOSITED BY A TWO STEP DEPOSITION METHOD

Autores: David Mateus Torres-Herrera¹; Arturo Morales-Acevedo¹

Coautor: Rosa Nava-Sánchez ¹

¹ *Departamento de Ingeniería Eléctrica –SEES, Centro de Investigación y de Estudios Avanzados del I. P. N., Avenida I. P. N. #2508, 07360, Ciudad de México, México*

Autor responsable de la comunicación: mateus.torres.h@cinvestav.mx

Hybrid perovskite solar cells have rapidly advanced as the next-generation photovoltaic technology due to their present outstanding high-power conversion efficiencies (PCE). Methylammonium-free perovskites, especially FAPbI₃-based compositions, have emerged as a robust alternative for achieving good stability. However, to further enhance the photovoltaic performance of solar cells based on such perovskite materials, various strategies have been proposed, including partial cationic and anionic substitution. In this work, we report the effect of partial anionic substitution of iodide with bromide (10–20%) in perovskites prepared via a two-step spin-coating method, forming Cs_xFA_{1-x}Pb(I_{1-y}Br_y)₃. The incorporation of bromide results in a gradual increase of the perovskite bandgap energy, as confirmed by UV-Vis transmittance spectroscopy, and a decrease of the lattice parameter, as observed by X-ray diffraction (XRD). In addition, SEM analysis reveals a more uniform morphology on the surface of the Br-containing samples. FTO/TiO₂/Cs_xFA_{1-x}Pb(I_{1-y}Br_y)₃/CuSCN/Au devices fabricated with an optimum 15% Br content in the precursor solution for the perovskite achieved the highest PCE (9.9 ± 0.4 %), compared to reference devices without Br (4.5 ± 0.8 %). These findings demonstrate that an optimum bromide incorporation is an effective strategy for improving the photovoltaic performance of hybrid perovskite solar cells. An explanation for these results will be given, suggesting ways for further efficiency improvement soon.

Keywords:

Hybrid perovskites, Mixed anion, Bandgap tuning, Solar cells

Reference:

D.M. Torres-Herrera, O. Ramirez-Iturbe, R. Nava-Sánchez and A. Morales-Acevedo, On the Vegard's law compliance for Cs_xFA(1-x)PbI₃ perovskite thin films, Phys. Scr. 99 (2024) 095962. <https://doi.org/10.1088/1402-4896/ad6d12>.

Ris work was supported by:

SECIHTI-México supports the postdoctoral fellowship granted to DMTH.



OPTIMIZATION AND COMPARISON OF PHOTOVOLTAIC ENERGY PRODUCTION IN SILICON AND CdTe SOLAR PANELS UNDER REAL-WORLD CONDITIONS

Autores: Jose Antonio Herdia Cancino¹; Hiram Jesús Higuera Valenzuela²; Jesús Raúl Martínez¹; Ricardo Andrés Britto Hurtado¹; Manuel Munguía¹

Coautores: Alejandro Otoniel¹; Cristian López¹; Ricardo Arvayo¹; Carlos Gilberto Ledgard Quiroz³; José Martín Ríos González³

¹ PE INGENIERO MECATRÓNICO - UNIVERSIDAD ESTATAL DE SONORA

² PE INGENIERO BIOMÉDICO- UNIVERSIDAD ESTATAL DE SONORA

³ CECATI 69

Autor responsable de la comunicación: jose.heredia@ues.mx

This study evaluates and compares the energy performance of *silicon (Si)* and *cadmium telluride (CdTe)* photovoltaic (PV) panels under real operating conditions, incorporating a *low-cost and feasible tilt-angle adjustment mechanism* to enhance energy yield in residential installations. A seasonal manual tracking system was implemented for both technologies, analyzing their power generation under varying climatic conditions (irradiance, temperature, and humidity). The results show, that

seasonal angle adjustments increased energy production by 3–7% compared to fixed installations, proving to be a cost-effective solution for small-scale PV systems. Besides, due to its superior temperature coefficient, CdTe panels outperformed Si by 4–6% in high-temperature environments (>30°C), demonstrating better thermal stability. While, inverter efficiency was found to degrade by up to 10% when exposed to excessive heat (e.g., under-panel placement), emphasizing the need for improved thermal management to extend system lifespan. As conclusion, manual tilt optimization is a practical alternative to automated trackers for residential applications. CdTe exhibits higher resilience in hot climates and need to have more diffusion to increase its presences for users, finally inverter placement and cooling strategies are critical for long-term PV system performance.

Keywords:

Photovoltaic optimization, Tilt-angle adjustment, Temperature coefficient, Si-CdTe.

Reference:

Mansour, R. B., Khan, M. A. M., Alsulaiman, F. A., & Mansour, R. B. J. I. A. (2021). Optimizing the solar PV tilt angle to maximize the power output: A case study for Saudi Arabia. 9, 15914-15928.

Ris work was supported by:

CECATI 69



INITIAL STUDY OF HYBRID MATERIAL USING POROUS SILICON AND CONDUCTIVE POLYMERS AS SOLID ELECTROLYTE

Autor: Laura Elvira Serrano de la Rosa¹

Coautores: José Alberto Vázquez González ¹; Mauricio Pacio Castillo ¹

¹ *Benemerita Universidad Autonoma de Puebla*

Autor responsable de la comunicación: laura.serranod@correo.buap.mx

This work presents a first approximation of a solid-state electrolyte based on porous silicon (PS) infiltrated with conducting polymers, specifically polyaniline (PANI) and polypyrrole (PPy), at varying concentrations. The goal is to evaluate the feasibility of this hybrid material for energy storage applications, such as in batteries or supercapacitors. Porous silicon was obtained through electrochemical anodization under two different porosity conditions. Conducting polymers were synthesized in the laboratory and infiltrated into the porous matrix via a dropwise method. The samples were characterized using current-voltage (I-V) measurements, cyclic voltammetry, and electrochemical impedance spectroscopy (EIS), while scanning electron microscopy (SEM) was employed to verify morphological and infiltration parameters. Preliminary results reveal that the incorporation of conducting polymers significantly alters the electrical behavior of the porous silicon matrix. Charge accumulation phenomena were observed, and impedance data suggested the presence of capacitive behavior. The experimental data fit well with an equivalent circuit model composed of four RC elements in parallel connected in series, each representing the multiple interfaces within the hybrid structure. This electrical model aligns with the expected physical behavior of a layered porous material embedded with electroactive compounds. The study provides an encouraging first step toward the development of hybrid solid-state electrolytes with promising performance in supercapacitor applications. Future work will focus on optimizing polymer infiltration and enhancing ionic conductivity while maintaining mechanical and thermal stability of the composite.

Keywords:

Impedance, Porous silicon, Conductive Polymers, solid electrolyte

Reference:

Q. Guo, P. Fan, Y. Zhang, L. Guan, H. Wang, A. Croft, and G. Z. Chen, Alkali and alkaline earth metals in liquid salts for supercapatteries, *RSC Sustain.* 2 (2024) 101–124. <https://doi.org/10.1039/d3su00197k>.

Ris work was supported by:

Institutional resources



VANADIUM OXIDE RIN FILMS AS CATALYSTS FOR GREEN HYDROGEN PRODUCTION: TOWARD A RENEWABLE ENERGY FUTURE

Autores: Mario Fidel García Sánchez¹; Pastor Alan Rodríguez Echeverría²

Coautores: Edgardo Saucedo ³; Edoardo Maggi ³; Gabriela Mariela Reyes Chaparro ⁴; Issis Claudette Romero Ibarra ⁵; José Francisco Malagón García ⁶

¹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas*

² *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas. Instituto Politécnico Nacional*

³ *Universitat Politècnica de Catalunya*

⁴ *UPHITA - IPN*

⁵ *IPN*

⁶ *Instituto Politécnico Nacional*

Autor responsable de la comunicación: prodrigueze1300@alumno.ipn.mx

This study addresses the urgent need to mitigate climate change through the development of clean energy sources, highlighting green hydrogen as a promising alternative due to its potential for re- newable energy storage and transportation. The objective was to assess the viability of vanadium oxides as catalysts in hydrogen production via electrolysis. To this end, nanostructured thin films of vanadium oxide were synthesized using the ultrasonic spray pyrolysis technique, employing vanadyl acetylacetonate as the vanadium precursor. The films were structurally and optically characterized, with X-ray diffraction and UV-Vis spectroscopy confirming the presence of VO₂ and V₂O₅ phases. Subsequent electrochemical evaluation, conducted through cyclic voltammetry and chronoamper- ometry, demonstrated photoactivity and suitable catalytic behavior for hydrogen evolution reactions. Films synthesized at 350 °C and 400 °C exhibited the highest hydrogen production at lower electrical potentials, while higher potentials resulted in less efficient electrolytic processes. In conclusion, the structural, optical, and electrochemical properties of vanadium oxide films indicate their potential as effective catalysts for green hydrogen generation, contributing to the advancement of sustainable technologies for the energy transition.

Keywords:

Green hydrogen, electrolysis, Vanadium Oxide, Thin films, ultrasonic spray pyrolysis.

Reference:

Li, H., et al, Y. (2024). Recent Advances in Vanadium-Based Electrocatalysts for Hydrogen and Oxygen Evolution Reactions: A Review. *Catalysts*, 14(6), 368. <https://doi.org/10.3390/catal14060368>

Ris work was supported by:

SECIHTI , IPN



OPTIMIZATION OF ORGANIC SOLAR CELLS WITH P3HT:PCBM MATERIAL BY VARYING TRANSPORT LAYERS USING SCAPS- 1D

Autores: Luis Alberto Barajas Rodríguez¹; Luis Martin Reséndiz Mendoza¹; Víctor Cabrera Arenas¹

¹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas*

Autor responsable de la comunicación: lbarajasr1101@alumno.ipn.mx

An alternative to mitigate global warming is the use of renewable energies such as solar energy, which can be harnessed through photovoltaic solar cells, classified according to the materials and technologies used in their fabrication. In recent years, electron transport layers (ETL) and hole transport layers (HTL) have been incorporated into the structure of organic solar cells, and their influence on device performance is still under study. Therefore, computational tools such as simulators are necessary to optimize these devices. In this work, the P3HT:PCBM blend was used as the active layer, adding electron and hole transport layers. Using the SCAPS-1D simulator, the thicknesses of the transport layers were varied to analyze their influence on key parameters such as conversion efficiency, open-circuit voltage, current density, and fill factor. The optimal thicknesses were determined, at which these organic materials provide higher energy conversion efficiency under standard illumination conditions. This contributes to the development of more efficient devices, resulting in time and cost savings associated with experimental fabrication.

Keywords:

Organic Solar Cell, Transport Layer, Numerical Simulator, Photovoltaic Solar energy

Reference:

S. Zhou, J. Sun, C. Zhou, y Z. Deng, "Comparison of recombination models in organic bulk heterojunction solar cells", *Physica B* 415 (2013) 28-33. <https://doi.org/10.1016/j.physb.2013.01.030>.



TWO-STEP SYNTHESIS AND CHARACTERIZATION OF CuS PHOTOELECTRODES FOR THEIR APPLICATION IN SOLAR WATER SPLITTING IN PECS

Autor: Bryan Alessandro Burgos Alamilla¹

Coautores: Alberto Gabriel Vega Poot²; Eduardo Camacho Espinosa³; Eduardo Ernesto Flores Cuevas⁴; Javier Melchor Trujeque Gil⁵; Mariely Loeza Poot⁶; Mario Andrés Elias García; Ricardo Javier Mis Fernández³

¹ Universidad Autónoma de Yucatán

² Universidad Modelo

³ Centro de Investigación y de Estudios Avanzados del IPN Unidad Mérida

⁴ Centro de Investigaciones y Estudios Avanzados del Instituto Politécnico Nacional (CINVESTAV-IPN)

⁵ Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional

⁶ Centro de Investigación y de Estudios Avanzados del IPN Unidad Mérida, Departamento de Física Aplicada.

Autor responsable de la comunicación: burgosbryan1602@gmail.com

In recent years, the dependence on energy production from fossil fuels has become a matter of significant concern. In response to this challenge, hydrogen has emerged as a promising solution for increasing green energy generation. One of the most viable and economical ways to obtain hydrogen is through solar water splitting into a photoelectrochemical cell (PEC). Among the materials used in PECs as photoelectrodes, Covellite (CuS) stands out due to its optoelectronic properties. This non-toxic earth-abundant material has a bandgap between 1.6 and 2.2 eV and electrical resistivity around $10^{-4} \Omega \cdot \text{cm}$. In this work, we evaluated the photoelectrochemical response and stability of synthesized CuS, obtained through a two-step process. First, the metallic Cu thin films were deposited by DC-sputtering, then sulfurized in a temperature range of 180 to 200°C. These films were characterized by X-ray diffraction (XRD) and Raman spectroscopy. Both characterization techniques indicated only the presence of Covellite peaks. XRD patterns showed a preferential growth in the (1 1 0) plane without significant changes in crystallite size or unit cell volume. The PEC characterization was performed on the sample sulfurized at 180°C due to its superior film quality. The electrodes were evaluated in PECs using a three-electrode configuration (Pt as counterelectrode and Ag/AgCl [3M] as reference electrode, using a KOH electrolyte) by linear sweep voltammetry (LSV) and chronoamperometry. The LSV results indicate cathodic current ranging from -0.7 to -0.3V bias with a peak value of -0.67 mA/cm^2 at -0.5V. Finally, the chronoamperometry at -0.1, -0.3, and -0.5 V of bias potential indicates a cathodic photocurrent. These results confirm the synthesis of p-type covellite by a two-step process, which has potential for photoelectrochemical applications due to its photocurrent generation and good performance.

Keywords:

Thin Films, Metal Sulfides, PEC, Water Splitting, Green Hydrogen.

Reference:

G.Y. Shaikh et al., Structural, Optical, Photoelectrochemical, and Electronic Properties of the Photocathode CuS and the Efficient CuS/CdS Heterojunction, ACS Omega 7 (34) (2022) 30233–30240.
<https://doi.org/10.1021/acsomega.2c>

Work was supported by:

Authors are grateful for the use of facilities of LANNBio-CINVESTAV-Mérida, supported by the grants: FOMIX-Yucatán 2008-108160, CONACYT LAB-2009-01-123913, 292692, 294643, 188345 and 204822.



RENEWABLE ENERGY / 229

IMPLEMENTATION OF A TREATMENT TRAIN OF COAGULATION-FLOCCULATION, BIOLOGICAL AND ADVANCED OXIDATION PROCESSES FOR THE ELIMINATION OF EMERGING CONTAMINANTS FROM CDMX WASTEWATER

Autores: Beatriz Elena Bonola Barrientos¹; Claudia Guerrero Barajas²; Issis Claudette Romero Ibarra¹; Jorge Gabriel Vázquez Arenas³

¹ UPIITA - Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas IPN

² UPIBI - Unidad Profesional Interdisciplinaria de Biotecnología IPN

³ Centro Mexicano para la Producción más Limpia-IPN

Autor responsable de la comunicación: betybonola27@gmail.com

Abstract:

The significant water imbalance in Mexico City promotes the maximum use of effluents from Wastewater Treatment Plants (WWTPs). At the national level, these plants do not have the capacity to remove recalcitrant emerging contaminants, which constitute a restriction for generating drinking water, in addition to being toxic. In order to contribute to the solution of these problems, this project is composed of three processes: 1) Coagulation-Flocculation Process. Evaluation of the impact of coagulation-flocculation on the removal efficiency of emerging contaminants (EC) in wastewater from a WWTP San Juan Ixhuatepec in Mexico City. 2) Biological Process. Removal of emerging contaminants present in wastewater from primary treatment effluent by a methanogenic consortium. 3) Advanced Oxidation Process (AOP). Design of hybrid processes to produce oxidizing and radical species for the mineralization of emerging contaminants. Each treatment will determine the degradation efficiency of emerging contaminants, facilitating their potential application on a larger scale. Therefore, this project aims to evaluate the efficiency of each stage of a treatment train (Coagulation-Flocculation, Bioprocess and Advanced Oxidation) in the elimination of four emerging contaminants (Ciprofloxacin, Cefadroxil, Sulfamethoxazole and Carbamazepine) from wastewater in Mexico City and evaluate the potential for direct use of resources. The original sample presented a total organic carbon (TOC) content of 1200 mg L⁻¹, while it decreased to 200 mg L⁻¹ after the coagulation-flocculation process and to 65.5 mg L⁻¹ after AOP, without biological process. For the secondary process, a methanogenic activity of 2.3 mg CH₄ -COD/mg VSS L day was found in the sludge, and the presence of methane and carbon dioxide (CH₄ and CO₂) was detected by FTIR (gas module).

Keywords:

Ciprofloxacin, Cefadroxil, Sulfamethoxazole, Carbamazepine and Emerging contaminants

Reference:

- [1] V. H. Robledo Zacarías et al., Revista Internacional de Contaminación Ambiental, 33 (2017) 221–235.
- [2] A.E. Yanez-Rios, et al. JECE 8 (2020) 104357

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación Secihti, México



ULTRA-HIGH PHOTOCATALYTIC ACTIVITY OF ZnS THIN FILM WITH CU ISLANDS FOR DYE DEGRADATION

Autor: Paulina García Albarrán¹

Coautores: Miriam Marisol Téllez Cruz ¹; Monserrat Bizarro Sordo ¹

¹ *Instituto de investigaciones en Materiales, Universidad Autónoma de México*

Autor responsable de la comunicación: pauga31al@gmail.com

Water contamination by dyes, primarily from industries such as textiles, poses a severe threat to aquatic ecosystems and human health. It is crucial to find practical solutions to prevent long-term environmental damage. Photocatalysts are a promising solution because they completely degrade harmful pollutants into harmless byproducts using only light energy. This work focuses on developing a thin film of semiconductor material (ZnS) and a transition metal (Cu) to boost photocatalytic activity. Thin films of zinc sulfide were synthesized by spray pyrolysis using ZnCl₂ and thiourea as precursors; the metallic Cu islands incorporation was achieved by chemical reduction using copper chloride and ascorbic acid, as Cu source and reducing agent, respectively. The photocatalytic activity was evaluated by following the UV-visible absorption spectrum of an indigo carmine (IC) dye solution irradiated with a 365 nm light source as a function of time. The structural modifications of the thin films were analyzed using SEM, XRD, diffusive reflectance, and PL. The results of IC photo-degradation showed that the addition of 30 wt.% Cu improved the photocatalytic activity from 26% in 3 h (ZnS) to 100% in only 10 minutes, keeping the activity even after 3 photocatalytic cycles, suggesting a very good candidate material for application in treating water contaminated with dyes.

Keywords:

ZnS-Cu, thin films, photocatalysis, photodegradation, Indigo Carmine

Reference:

Chauhan, R., Kumar, A., & Chaudhary, R. P. (2014). Photocatalytic degradation of methylene blue with Cu doped ZnS nanoparticles. *Journal of luminescence*, 145, 6-12

Ris work was supported by:

DGAPA PAPIIT IN101824



RENEWABLE ENERGY / 261

ENHANCED PHOTODEGRADATION OF CIPROFLOXACIN USING BORON NITRIDE- BiVO_4 NANOCOMPOSITE PHOTOCATALYSTS

Autor: Gloria Isabel Siller-Monroy¹

Coautor: Issis Claudette Romero Ibarra²

¹ UPIITA-IPN

² IPN

Autor responsable de la comunicación: isabesill@gmail.com

Nowadays, access to safe water is decreasing due to diverse factors, including an increase in population and pollution. One of the main causes of water pollution are pharmaceutical compounds, such as ciprofloxacin, which, after being ingested, is integrated into water supplies as a pollutant and an indirect agent in promoting antibiotic resistance. In this study, we explore a novel material: boron nitride (BN) because of its properties, such as thermal stability and graphite-like structure. This material shows promise for water treatment as an adsorbent and as a catalyst in advanced oxidation process (AOPs). Synthesis of BN is generally reported with precursors like melamine, temperatures above 1000 °C and under controlled atmospheres, nevertheless, in this research BN was obtained under calcination method at temperatures between 450-600 °C and without controlled atmosphere. Additionally, BiVO_4 , a commonly researched visible light photocatalyst, was synthesized via hydrothermal microwave-assisted method. Subsequently, via ultrasonic bath we synthesized a composite of BiVO_4 -BN, which was evaluated in the photodegradation of ciprofloxacin. The incorporation of BN on BiVO_4 increased the photo-degradation rate of ciprofloxacin from 48% in 4 hours to more than 60%.

Keywords:

Boron-Nitride, BiVO_4 , Ciprofloxacin, photo-catalysis

Reference:

[1] Z. Du et al., "Ultrathin h-BN/ Bi_2MoO_6 heterojunction with synergetic effect for visible-light photocatalytic tetracycline degradation," *J Colloid Interface Sci*, vol. 589, pp. 545-555, May 2021, doi: 10.1016/j.jcis.2021.01.027

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación



GREEN DIESEL PRODUCTION VIA HYDROTREATING OF WASTE COOKING OIL USING Ni CATALYST SUPPORTED ON ZEOLITE DESILICATED

Autor: Isaac Nava Bravo¹

Coautores: José Luis Sánchez Cupil ¹; Rogelio Cuevas García ¹; Aída Gutiérrez Alejandre ¹; Jorge Fernando Ramírez Solís ¹

¹ *Facultad de Química, UNAM*

Autor responsable de la comunicación: inavab1986@gmail.com

Introduction: Hydrotreating (HT) of waste cooking oils (WCO) has gained global interest in response to the depletion of petroleum, the primary source of fossil fuels. Zeolites, traditionally used in the petrochemical industry, are being explored for the conversion of fatty acids (FAs) into biofuel production. The conversion depends on the type of zeolite and its pore size, as triglycerides and their corresponding FAs can reach molecular dimensions of 7.5 and 2.5 nm, respectively (Sousa et al., 2018). The use of mesoporous zeolites and the adjustment of their structure via desilication with NaOH may help improve access to catalytic active sites to produce green diesel hydrocarbons: n- heptadecane (C17) and n- octadecane (C18). **Objective:** To evaluate Ni/ desilicated HBeta by NaOH treatment in the production of C17 and C18 hydrocarbons from WCO (10 wt% in decalin). **Method- ology:** Mesoporous HBeta zeolite (Si/Al= 150) was modified by desilication with 0.4 M NaOH. Two catalysts were prepared via incipient wetness impregnation with 10% nickel (Ni). The catalysts were designated as 10NiHB(150)D for desilicated zeolite, and 10NiHB(150)NoD for non-desilicated one. Before HT of WCO, the catalysts were reduced at 490 °C under H₂. The HT tests were carried out in a Parr 452 HC high-pressure reactor at 340 °C, 700 psi H₂, for 6 h using ~0.09 g of catalyst. **Re- sults:** NaOH treatment increased the support's surface area (from 532.325 to 607.698 m²/g) and total pore volume (from 0.863 to 0.976 cm³/g), while maintaining a pore diameter of approximately 6.5 nm. The C18/C17 selectivity ratio was higher for the 10NiHB(150)D catalyst (1.20) compared to 0.85 (10NiB(150)NoD), indicating that the desilicated support favored deoxygenation pathways that con- serve the carbon chain length of the FAs. **Conclusion:** C18 hydrocarbons suitable for green diesel were successfully produced through HT of WCO using Ni-supported HBeta catalysts, with enhanced performance achieved by zeolite desilication.

Keywords:

HBeta, n-heptadecane, n-octadecane, deoxygenation, mesoporous, desilication

Reference:

F.P. Sousa, L.N. Silva, D.B. de Rezende, et al., Simultaneous deoxygenation, cracking and isomerization of palm kernel oil and palm olein over beta zeolite to produce biogasoline, green diesel and biojet-fuel, Fuel223(2018) 149–156. doi: 10.1016/j.fuel.2018.03.020.

Ris work was supported by:

UNAM Posdoctoral Program (POSDOC, DGAPA-UNAM) for the postdoctoral fellowship granted for the period from February 1, 2025, to January 31, 2026, to carry out a postdoctoral stay of Dr. Isaac Nava Bravo at Faculty of Chemistry, UNAM.



INCORPORATION OF NANO-GRAPHITE INTO PDINO ELECTRON TRANSPORT LAYER FOR ORGANIC SOLAR CELLS

Autor: Luis Martin Reséndiz Mendoza¹

Coautores: Magaly Ramírez Como ²; Luz Elena Santos Alcántara ³; Mónica Monserrat Valdez-Mata ⁴; Anisleidy Broche ³; Liliana Fernanda Hernández-García ¹; Yasuhiro Matsumoto ³

¹ Sección de Estudios de Posgrado e Investigación, Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional

² Departamento de Física Aplicada, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional

³ Sección de Electrónica del Estado Sólido, Departamento de Ingeniería Eléctrica, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional

⁴ Sección de Estudios de Posgrado e Investigación, Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas

Autor responsable de la comunicación: magaly.ramirez@cinvestav.mx

Organic solar cell (OSC) research has primarily focused on developing materials that enhance the power conversion efficiency (PCE) of the device. A key component in enhancing OSC performance is the electron transport layer (ETL), which plays a crucial role in enhancing charge transport within the devices. N,N'-Bis(N,N-dimethylpropan-1-amine oxide)perylene-3,4,9,10-tetracarboxylic diimide (PDINO) is currently commonly used as ETL due to its excellent conductivity, transparency, and ideal work function. Furthermore, to optimize ETL performance, the incorporation of nanoparticles (NPs) has been investigated, improving the conductivity and stability of the devices. The nano-graphite (GNPs) is an attractive material due to its ease of synthesis, excellent dispersion, and unique combination of electrical, optical, and mechanical properties[1]. GNPs have great potential to enhance charge transport in OSCs due to their high conductivity. Furthermore, these nanoparticles exhibit high carrier mobility, making them ideal for improving OSC performance. This study researches the impact of incorporating GNPs within PDINO as a hybrid electron transport layer in organic solar cells based on the non-fullerene BTP-4Cl. The device structure was ITO/PDINO:GNPs/PBDB-T-2F:BTP-4Cl/MoO₃/Ag. The concentration of GNPs in the PDINO layer was varied to investigate its effect on device performance. Current-voltage measurements were performed to evaluate cell performance parameters and analyze which of them were improved by the incorporation of GNPs. The efficiency PCE increased with a 10% v/v GNP concentration, reaching a maximum PCE of 12.11%, which implies an improvement of 21% compared to the device without GNPs. This improvement was mainly attributed to the open-circuit voltage (VOC). Furthermore, the fill factor (FF) improved, and the series resistance (RS) decreased as the GNP concentration increased, indicating enhanced charge extraction and carrier transport within the device. This preliminary study illustrates the potential of GNPs to enhance cell performance, indicating promising prospects for GNPs within the buffer layers of OSCs.

Keywords:

Carbon Dots, graphite nanoparticles, carbon nanoparticles, hybrid ETL, PDINO dopants

Reference:

[1] J. Kastner, I. Gnatiuk, M. Wagner, D. Holzinger, V. Rudelstorfer, G. Hesser, A. Fuchsbaauer, and S. Hild, Grinded nano-graphite inkjet inks for application in organic solar cells, *Nanotechnology*, 30 (2019) 045601. <https://doi.org/10.1088/1361-6528/aae67a>

Ris work was supported by:

the Secretaría de Ciencia, Humanidades, Tecnología e Innovación under project awarded to CVU 704226 and fellowships awarded to CVU 1323370, 1022110, 511261; Secretaría de Investigación y Posgrado del Instituto



Politécnico Nacional under grant 20251123; CINVESTAV.
RENEWABLE ENERGY / 273

VALORIZATION OF RESIDUAL MEZCAL BAGASSE FOR BIOETHANOL PRODUCTION AND CHARACTERIZATION OF ITS PRECURSORS.

Autores: Josua Esquiliano Pareja¹; Mario Alberto Hernandez Avila²; Pablo Manuel Sedas Pingarron²; Issis Claudette Romero Ibarra¹; Luis Jorge Rodriguez Castillo¹; Carlos Eduardo Santolalla Vargas³

¹ IPN

² Instituto Politécnico Nacional

³ CIEMAD

Autores responsables de la comunicación: jesquilianop2000@alumno.ipn.mx, mhernandeza2010@alumno.ipn.mx, pablomsp10@gmail.com

The artisanal production of mezcal generates a large amount of organic waste, including agave bagasse and vinasse, which represent a growing environmental problem due to inadequate disposal practices. This project focuses on the valorization of residual Agave potatorum (Tobalá) bagasse for its conversion into bioethanol, as well as the characterization of its precursors. This process may offer economic benefits due to the chemical composition of biomass. In this study, samples were collected directly from a mezcal distillery (palenque) in the state of Puebla. The samples were pretreated and analyzed by thermogravimetric analysis (TGA). The weight loss percentages and decomposition temperatures suggest that the agave bagasse contains cellulose, hemicellulose, and lignin in proportions like those of other agave species. Fourier-transform infrared spectroscopy (FTIR) was also conducted, revealing the presence of aldehyde C=O peaks, phenols, and carboxylic acid groups as-

sociated with lignin decomposition from previous pretreatments. Peaks associated with alkane C-H and ether C-O-C bonds, commonly found in cellulose, were also identified. Based on this characterization, four acid hydrolysis reactions were carried out using diluted H₂SO₄ in three different concentrations and ratios: 25:1/0.7N, 10:1/0.5N, 10:1/0.3N, and 7:1/0.5N. The results show that the Brix degrees of reducing sugars in the hydrolysates vary depending on the conditions, with some combinations achieving a yield in L/kg comparable to Agave tequilana. These results demonstrate that agave bagasse has suitable structural and thermal characteristics to be used as raw material for bioethanol production, confirming the technical feasibility of the process and its potential as a bioethanol feedstock.

Keywords:

Valorization, Hydrolysis, Biomass, Bioethanol, TGA, FTIR

Reference:

K. R. Corbin et al., Prospecting for energy-rich renewable raw materials: Agave leaf case study, PLoS One, vol. 10, núm. 8, p. e0135382, 2015. doi.org/10.1371/journal.pone.0252201

Ris work was supported by:

Proyectos SIP-IPN 2275 y 20250118 (Materiales avanzados para transformación de compuestos orgánicos con aplicaciones en energía y medioambiente), CVN/CESA-002/2024 proyecto "Sustentabilidad hídrica en la Ciudad de México"



RENEWABLE ENERGY / 275

CHARACTERIZATION OF NANOSTRUCTURED CERIUM OXIDE THIN FILMS IN THE PHOTOELECTROCATALYTIC WATER-SPLITTING PROCESS

Autores: Gabriela Mariela Reyes Chaparro¹; Inti Zumeta Dubé²; Mario Fidel García Sánchez³

¹ UPIITA - IPN

² Laboratory of Ion Channel Research. VIB-KU Leuven

³ Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas

Autor responsable de la comunicación: mreys.gaby@gmail.com

Hydrogen has emerged as an energy vector in the transition toward clean and sustainable energy sources. Its high energy content per unit of mass and its potential use in mobile, stationary, and industrial applications make it a viable alternative to fossil fuels. However, its positive environmental impact depends primarily on the production method. In this context, hydrogen generation through photoelectrocatalytic processes stands out as a promising approach, as it harnesses solar energy to split water without generating polluting emissions. The search for efficient, stable, and economically viable materials for these applications has led to growing interest in metal oxides, particularly cerium oxide (CeO₂). This material exhibits remarkable properties such as high ionic mobility, thermal stability, and a strong capacity for reversible Ce³⁺/Ce⁴⁺ redox transitions, which facilitate the generation and transport of oxygen vacancies. These characteristics make CeO₂ an attractive candidate as a catalyst and support material in photoelectrocatalytic hydrogen production processes.

This study focuses on the synthesis of nanostructured cerium oxide thin films deposited on titanium substrates using ultrasonic spray pyrolysis. The effect of thermal annealing on the structural, optical, and electrical properties of the films is evaluated, as well as their performance in hydrogen generation under illumination with a Xenon lamp, under conditions simulating solar radiation. Polycrystalline thin films with a bandgap around 3.0 eV were obtained. Electrochemical measurements show a favorable response to the light incidence generating -2.0 mA/cm² on darkness and -16 mA/cm² under illumination. These results suggest their potential use in the photoelectrocatalytic water-splitting process.

Reference:

Garraín, Banacloche, Aparicio. "Sustainability indicator for the manufacturing and use of a fuel cell prototype and hydrogen storage for portable uses". *Energías* (2021)
Dariusz, Pawel, Ewelina. "Use of hydrogen in public transports systems". *Journal of Cleaner Production* 335 (2022)

Ris work was supported by:

IPN under project 20242336 and 20250260

Author approval:

I confirm

Author will attend:

I confirm

Keywords:

Films, Hydrogen, Cerium Oxide, Energy, Green Hydrogen, photoelectrocatalytic



RENEWABLE ENERGY / 278

OBTAINING THE EMPIRICAL FORMULA OF ORGANIC COMPOUNDS BY IMPLEMENTING A POST-COMBUSTION GAS SENSUS SYSTEM IN A STATIC BOMB CALORIMETER

Autor: Fidel Aaron Maruri Valderrabano¹

Coautores: Guillermo Santamaría Juárez ¹; Jesús Andrés Arzola Flores ¹; Juana Deisy Santamaría Juárez ¹; Miguel Ángel García Castro ¹

¹ Benemerita Universidad Autonoma de Puebla

Autor responsable de la comunicación: mv223470624@alm.buap.mx

In a laboratory, the empirical formula of a compound is crucial, as it represents the simplest ratio of atoms in a molecule. Traditionally, methods for establishing this atomic ratio have relied on a series of analytical techniques that, while effective, can be notoriously laborious, time-consuming, and require the use of complex and often expensive laboratory equipment. This has presented a challenge, especially in environments where resources are limited or greater efficiency in the process is sought. However, an innovative approach integrates a post-combustion gas sensing system with a static bomb calorimeter to simplify and optimize this process. Through computer-aided design, the coupling of accessories, the programming of gas sensors based on Arduino open-source code, the creation of an electrical circuit, and the application of the static bomb calorimeter's own methodology, a system capable of analyzing the gases resulting from a combustion reaction was developed.

Keywords:

Calorimetry , combustion, empirical formula, analysis

Reference:

Kohse-Höinghaus, K. "Combustion in the future: The importance of chemistry". Proceedings Of The Combustion Institute, 38(1), 1-56. 2021. <https://doi.org/10.1016/j.proci.2020.06.375>

Ris work was supported by:

dont have supported



RENEWABLE ENERGY / 292

MODEL FOR ESTIMATING TEMPERATURE IN LASER ANNEALING OF CdS THIN FILMS

Autores: Ailyn Diaz Esquivel¹; Mucio Josué Cardoso Hernández¹

Coautores: Cesar Hernandez Vasquez ²; Daniel Jiménez Olarte ¹; JOSÉ MANUEL FLORES MÁRQUEZ ³; Jesús Roberto González Castillo ¹; Sergio Ramírez Velasco ¹

¹ ESIME-Instituto Politécnico Nacional

² ESCOM- Instituto Politécnico Nacional

³ INSTITUTO POLITÉCNICO NACIONAL - ESIQIE

Autores responsables de la comunicación: ailyndiaz8@gmail.com, muciojosuecardosoherandez@gmail.com

In the processing of thin-film solar cells, one of the fundamental steps that improves their performance is the annealing of the thin films that comprise them. This annealing can be performed with pulsed lasers with pulse durations in the nanosecond, picosecond, or femtosecond range; these short timescales make it difficult to directly measure the temperature reached by the materials upon irradiation. In this work, a thermal model was developed to estimate the spatial and temporal temperature distribution of CdS thin films when irradiated with a 532 nm pulsed laser in a glass/SnO₂:F/CdS structure. For better estimation, the laser operating parameters and the optical properties of the CdS were measured. Finally, the results were compared with those obtained experimentally.

Keywords:

laser annealing, thermal model, temperature estimation, CdS

Reference:

D. Bauerle, Laser Processing and Chemistry, Berlin: Springer, 2000.

Ris work was supported by:

Project IPN SIP-20250251 and BEIFI-IPN



RENEWABLE ENERGY / 298

DEVELOPMENT OF ELECTROCOAGULATION REACTOR FOR REMOVING CONTAMINANTS FROM GREYWATER

Autor: MIHAEL SHAMED ISLAS ORTIZ¹

Coautores: Issis Claudette Romero Ibarra¹; Jorge Fonseca Campos¹

¹ *Instituto Politécnico Nacional*

Autor responsable de la comunicación: mislaso1500@alumno.ipn.mx

Water scarcity in Mexico, worsened by inadequate infrastructure, prolonged droughts, and urban growth, demands innovative solutions for water treatment and reuse. This project proposes the design of an electrocoagulation reactor for domestic greywater treatment, with potential for industrial scalability.

The objective of this project is to develop an efficient and accessible technology that can significantly contribute to mitigating the water crisis in Mexico, while promoting the responsible and sustainable use of water.

The project is developed using the VDI 2206 methodology, a mechatronics-based engineering approach that addresses complex problems by dividing systems into subsystems and modules.

Electrocoagulation, which uses electric current without the need for chemical reagents, faces challenges such as high energy consumption and electrode passivation. To address these issues, three improvement strategies are proposed:

1. Physical redesign of the reactor
2. Modification of electrode geometry
3. Adjustments to the electrical power supply mode

Before constructing the electrocoagulation reactor, electrical and hydraulic simulations were conducted on an 850 mL batch-type reactor using the student version of Ansys software. The simulations showed significant improvements in the behavior of the electric field when cathode was perforated at 30%, enhancing coagulant formation. For the reactor design, improved agitation of metal salts was achieved by incorporating a torispherical bottom. Finally, to optimize energy consumption, the use of pulsed current with a 50/50 duty cycle is proposed.

This project presents strong potential as a scalable and adaptable technology, thanks to its modular design. Moreover, electrocoagulation stands out as a greener alternative compared to conventional treatment methods, as it does not require the addition of chemical reagents and generates less waste, which is also drier and easier to manage.

Keywords:

electrocoagulation, electrode passivation, grey water, CAD simulations, mechatronic design.

Reference:

Wang, R. S., Shan, L. L., Zhu, Z. B., Liu, Z. Q., Liao, Z. M., & Cui, Y. H. (2025). Current status of electrode corrosion passivation and its mitigation strategies in electrocoagulation. *Chemical Engineering and Processing-Process Intensification*, 110192.

His work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación de México, Instituto Politécnico Nacional, MATEA, Proyectos SIP-IPN 2275 y 20250118 (Materiales avanzados para transformación de compuestos orgánicos con aplicaciones en energía y medioambiente, CVN/CESA-002/2024 proyecto "Sustentabilidad hídrica en la Ciudad de México").



RENEWABLE ENERGY / 312

SYNTHESIS AND CHARACTERIZATION OF YTTRIUM-DOPED CERIUM OXIDE THIN FILMS WITH POTENTIAL APPLICATIONS IN SOLID OXIDE FUEL CELLS

Autores: Denisse Fabiola González Ramírez¹; Gustavo Lara Prudenciano²; Irving Azael I Lara Samperio²; José Francisco Malagón García³; Kevin Adair Atenco Rojas¹; Kevin Salazar Martínez²; Mario Fidel García Sánchez⁴

¹ UPIITA IPN

² Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas IPN. Av Instituto Politécnico Nacional 2580, La Laguna Ticoman, Gustavo A. Madero, 07340 Ciudad de México, CDMX

³ UPIITA - Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas IPN. Av Instituto Politécnico Nacional 2580, La Laguna Ticoman, Gustavo A. Madero, 07340 Ciudad de México, CDMX

⁴ Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas

Autor responsable de la comunicación: ksalazarm1501@alumno.ipn.mx

Hydrogen technologies have become relevant with the increased need for energy storage. In particular, solid oxide fuel cells (SOFC) are devices that convert chemical energy of hydrogen in electricity with high efficiency. Decreasing the work temperature of these devices is mandatory for the scalability of these devices, which demands more research in new materials. Due to their high oxygen ion conductivity, yttrium-doped cerium oxide (YDC) films are promising candidates as electrolytes in solid oxide fuel cells (SOFCs). In this work, YDC thin films were grown by spray pyrolysis. The growth temperature and yttrium doping concentration were varied to evaluate their effects on the structural, morphological and chemical properties of the films. The influence of a thermal annealing in the structural properties was evaluated. The crystal structure was analyzed by X-ray diffraction (XRD), the surface morphology was examined using scanning electron microscopy (SEM), and composition was quantified by energy-dispersive X-ray spectroscopy (EDS). To assess the ionic properties, the films were characterized by electrochemical impedance spectroscopy (EIS) to determine their ionic conductivity. The results showed that thermal treatment improved the crystallinity of the films. Additionally, both the growth temperature and doping level significantly influenced the structure, morphology, and ionic conductivity of the films, which is essential for optimizing their performance as electrolytes in SOFCs.

Keywords:

thin films, solid oxide fuel cells, yttrium-doped cerium oxide, electrolytes

Reference:

Li, Y., Zhang, L. & Chen, X. Adv. Energy Sustainability Res. 5, 11 (2024).

Ris work was supported by:

This work was supported by IPN under project SIP 20242336, as well as by SECIHTI



RENEWABLE ENERGY / 300

GRAPHENE AS A NOVEL ETL IN INVERTED ORGANIC SOLAR CELLS WITH NON-FULLERENE-BASED ACTIVE LAYER

Autor: Ian Carlos Flores Contreras¹

Coautores: Lluís F. Marsal ²; Magaly Ramírez Como ³; Nayeli Colin Becerril ⁴; Víctor Cabrera Arenas ⁵; yenny L Casallas-Moreno ⁶

¹ UPIITA-IPN

² Universidad de Rovira i Virgili

³ Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional

⁴ Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional

⁵ Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas

⁶ Conahcyt-UPITA-IPN

Autor responsable de la comunicación: ifloresc1800@alumno.ipn.mx

Organic solar cells (OSCs) based on non-fullerene acceptors (NFAs) have garnered considerable attention due to their low-cost processing, mechanical flexibility, and enhanced power conversion efficiencies—now reaching up to 19.2%, [1]. However, intrinsic instability arising from the sensitivity of organic semiconductors to environmental stresses such as light exposure and interfacial degradation limits their long-term performance. These challenges highlight the need for innovation in device architecture and transport layer engineering. In this work, we report a novel inverted OSC configuration employing a non-fullerene-based active layer composed of a PM6:Y7 donor-acceptor blend and a monolayer graphene film as the electron transport layer (ETL), replacing conventional metal oxide or polymeric ETLs. The active layer was deposited by spin coating, and the graphene was transferred onto pre-patterned ITO substrates via a wet-transfer method. The full device structure included MoO₃ as the hole transport layer and Ag as the top electrode. Under AM 1.5G illumination, the fabricated device achieved a power conversion efficiency (PCE) of 7.83%. The J-V characteristics revealed good fill factor and efficient charge extraction, while the EQE spectra demonstrated strong photoresponse across the visible range, supporting the optical compatibility and conductivity of the graphene ETL. To the best of our knowledge, this architecture has not been previously reported. These findings demonstrate that graphene can serve as a promising interfacial material to enhance both performance and stability in non-fullerene-based OSCs.

Keywords:

Organic solar cells, non-fullerene acceptors, graphene, ETL, inverted architecture

Reference:

Green, M., Dunlop, E., Hohl-Ebinger, J., Yoshita, M., Kopidakis, N., & Hao, X. (2024). Solar cell efficiency tables (version 65). Progress in photovoltaics: research and applications, 29(1), 3-15.

Ris work was supported by:

The doctoral program 002906 granted by CONAHCYT—now SECIHTI—CVU No. 932821, and the 2024 institutional program “Proyectos de Desarrollo Tecnológico o Innovación para alumnos del IPN” promoted by the Secretaría de Investigación y Posgrado (SIP) of the Instituto Politécnico Nacional.



RENEWABLE ENERGY / 325

FLASH AND REACTIVE FLASH SINTERING IN ELECTROCERAMICS MANUFACTURING

Autor: Jean-Claude M'PEKO¹

¹ *São Carlos Institute of Physics, University of São Paulo (USP), Brazil*

Autor responsable de la comunicación: peko@ifsc.usp.br

Conventional processing of functional materials in the form of electroceramics normally involves several steps that include calcination of the reagent-grade raw materials at a relatively-low temperature for synthesis of the end-product powder, followed by grinding to reduce particle size, compaction to get a reasonable green density and, finally, sintering at a high temperature for densification. Introduced in the literature in 2010 is a novel approach known as flash sintering, which is assisted by an electric field, and whose main characteristics is that high-density electroceramics can be produced from green compacts in mere seconds, at furnace temperatures well below those required in conventional sintering. This technique has become largely explored in materials processing, and much of the effort includes advancing, as much as possible, the debate on the underlying mechanism(s). This talk aims to present results observed not only in single-phase powders, with a review of the effects of electric field strength and current density, but also in multi-phase powders where flash synthesis plus sintering, called reactive flash sintering, can develop in a single running experiment. Particularities and generalities applying in both scenarios will be discussed, including the case of ionic conductor/insulator composites where percolation effects may become the determining key.

Keywords:

Flash sintering, Reactive flash sintering, Zirconia, Titania, Multi-phase powders

Ris work was supported by:

FAPESP, CAPES and CNPq



RENEWABLE ENERGY / 327

PHOTOCATALYTIC EVALUATION OF SUPPORTED ILMENITES FOR DEGRADATION OF ORGANIC DYES

Autor: Leslie Naian Ramos Domínguez¹

Coautores: Dulce Isaura Vallejo Rendón²; Felipe Caballero Briones¹

¹ Instituto Politécnico Nacional, Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada.

² Universidad Tecnológica de Altamira

Autor responsable de la comunicación: leslieramos757@gmail.com

Titanium dioxide (TiO₂) is widely used as a photocatalyst for degrading organic pollutants in water. To enhance its absorption in the visible spectrum and improve its applicability in water treatment, the incorporation of Fe into TiO₂ or the use of natural minerals such as ilmenite (Fe²⁺Ti⁴⁺O₃) has been explored. This study evaluated the photocatalytic activity of five natural ilmenite samples in a pilot-scale continuous flow reactor, using methylene blue (MB) and methyl orange (MO) as model pollutants. Experiments were conducted under UV-C and visible light, with an initial dye concentration of 6 mg/L over three 200-minute cycles, collecting samples at specific time intervals. The samples were characterized by X-ray fluorescence (XRF), diffuse reflectance spectroscopy (DRS), and X-ray diffraction (XRD). The band gap energies ranged from 2.18 to 2.83 eV. Fe/Ti molar ratios were 0.82:1, 0.89:1, 0.07:1, 0.48:1, and 0.65:1. Vanadium contents ranged from 1.13 to 2.10 wt.%, and manganese contents from 0.49 to 2.06 wt.%. Crystalline phases identified included rutile, pseudorutile, and ilmenite. Under UV-C irradiation, MB and MO degradation ranged from 48 to 90% and 26 to 74%, respectively. Under visible light, M3 and M5 achieved 61.10% and 57.73% MB degradation, in some cases outperforming TiO₂. No degradation of MO was observed under visible light, likely due to insufficient photon energy, although MB degradation may have occurred through a sensitization effect on TiO₂. Differences in photocatalytic performance between the dyes may be related to their molecular structure, Fe/Ti ratio, V and Mn content, and crystalline phases. This work demonstrates the feasibility of scaling up the process and using ilmenites as alternative, cost-effective materials for environmental photocatalytic applications.

Keywords:

Photocatalysis, Ilmenite, Degradation, Dyes.

Reference:

P. García-Muñoz, G. Pliego, J. A. Zazo, A. Bahamonde, and J. A. Casas, Ilmenite (FeTiO₃) as low cost catalyst for advanced oxidation processes, *J. Environ. Chem. Eng.* 4 (1) (2016) 542–548.
<https://doi.org/10.1016/j.jece.2015.11.037>

Ris work was supported by:

SIP-IPN "Atención a Emergencias Nacionales 2024.



GROWTH OF 1D ZINC OXIDE STRUCTURES BY THE VAPOR-LIQUID-SOLID TECHNIQUE: ROLE OF SUBSTRATE POSITION AND DISPLACEMENT

Autores: Berenice Palacios Martínez¹; José Francisco Malagón García²

Coautores: Ateet Dutt ³; Hector Daniel Vidales Astudillo ⁴; Mario Fidel García Sánchez ⁵

¹ Av. Universidad Tecnológica No. 1000, C.P. 42830, El Carmen, Tula de Allende, Hidalgo, México.

² Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas IPN. Av Instituto Politécnico Nacional 2580, La Laguna Ticoman, Gustavo A. Madero, 07340 Ciudad de México, CDMX

³ Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México, Materiales de Baja dimensionalidad, México

⁴ Facultad de Ciencias, UNAM

⁵ Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas

Autores responsables de la comunicación: 23300798@uttt.edu.mx, paco_pp@ciencias.unam.mx

In this work, one-dimensional (1D) zinc oxide (ZnO) nanostructures were synthesized using the Vapor-Liquid-Solid (VLS) technique. The effect of the substrate position (monocrystalline silicon) inside the tubular furnace on the structural, morphological, and optical properties of the nanostructures was investigated. By shifting the substrate away from the furnace center, significant variations were observed in crystal orientation (X-ray diffraction), surface morphology (scanning electron microscopy), and defect density (photoluminescence). Additionally, three distinct growth zones were identified: on the substrate, directly on the precursor, and as powders in the intermediate region. These conditions enabled the synthesis of nanostructures either fixed to the substrate or as free-standing powders. The ability to control both the growth location and the crystalline quality of the nanostructures allows for their optimized integration into functional devices. These structures show great potential in applications such as gas sensors, biosensors, and photocatalysts, where preferential orientation and defect concentration play a key role in performance. The results obtained provide valuable insights for tailoring ZnO nanostructure synthesis strategies to meet specific application requirements.

Keywords:

Zinc Oxide, Vapor-Liquid-Solid, Nanostructures, Photoluminescence, Crystal Orientation

Reference:

"Functionalization of 3-aminopropyltrimethoxysilane Self-Assembled Monolayers on ZnO/Au nanowires: Role of the Seed layer". DOI: <https://doi.org/10.1016/j.matlet.2021.129452>

Ris work was supported by:

This work was supported by IPN under project 20242336 and 20250260



RENEWABLE ENERGY / 373

HYDROGEN PRODUCTION VIA AQUEOUS GLYCEROL REFORMING ASSISTED BY ULTRASOUND USING A HETEROGENEOUS CATALYST.

Autor: Julio García Posadas¹

Coautor: Issis Claudette Romero Ibarra²

¹ *Instituto Politécnico Nacional*

² *IPN*

Autor responsable de la comunicación: jgarciap1507@alumno.ipn.mx

The continuous increase in pollutant emissions and rising energy consumption have led to a concerning climate outlook. In addition, extreme weather events and the development of new technologies are driving a further rise in global energy demand. This scenario calls for the diversification of the energy matrix and the development of renewable energy sources to mitigate the environmental impact of energy use.

Hydrogen has emerged as a promising solution due to its great potential for applications in electricity generation, transportation, and industry, offering an almost complete reduction in greenhouse gas emissions. However, its production and storage remain significant challenges. Many hydrogen production methods require high temperatures and/or pressures, as is the case with reforming, pyrolysis, and thermolysis. An alternative to overcome these limitations is hydrogen production from glycerol, owing to its broad potential and versatility. Therefore, this project aims to evaluate the performance of a bismuth-based layered oxide catalyst, combined with ultrasound waves that generate "hot spots," to reduce the severe conditions of conventional processes and enhance their selectivity.

Keywords:

Energy, hydrogen, Ultrasound, Oxide Catalyst

Reference:

Glycerol to value-added chemicals: State of the art and advances in reaction engineering and kinetic modelling

Work was supported by: Issis

Claudette Romero Ibarra



SOLUTION COMBUSTION SYNTHESIS OF BISMUTH FERRITE (BiFeO_3) AND ITS CATALYTIC EFFICIENCY IN THE SONOCHEMICAL DEGRADATION OF EMERGING ORGANIC CONTAMINANTS

Autor: Anel Robles¹

Coautores: Daniel Flores-Ramirez ²; Issis C. Romero-Ibarra ²; José Ortíz-Landeros ³; Lisseth Medina de la Rosa

¹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas-IPN*

² *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas*

³ *Escuela Superior de Ingeniería Química e Industrias Extractivas*

Autor responsable de la comunicación: anivo.roblesster@gmail.com

Water scarcity and contamination by persistent organic pollutants represent growing environmental challenges, particularly due to the increasing presence of emerging contaminants (ECs) such as pharmaceuticals, dyes, and microplastics. These compounds often evade removal in conventional wastewater treatment systems, necessitating the development of advanced and efficient remediation strategies. In this study, bismuth ferrite (BiFeO_3 , BFO) was synthesized via a solution combustion method using bismuth nitrate [$\text{Bi}(\text{NO}_3)_3 \cdot 5\text{H}_2\text{O}$], ferric nitrate [$\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$], nitric acid (HNO_3), and urea as fuel. Various fuel-to-oxidizer molar ratios were tested to optimize purity and catalytic performance [1]. The resulting powders were characterized using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), UV-Vis-NIR spectroscopy for band gap determination, and Brunauer-Emmett-Teller (BET) surface area analysis. The catalytic performance of the synthesized BFO was evaluated through the sonochemical-assisted degradation (SAD) of Rhodamine B (RhB), ibuprofen, and polyethylene-based microplastics under ultrasonic irradiation. Experimental parameters including catalyst dosage, contaminant concentration, and pH were optimized. The BFO catalyst, obtained in 2.5 hours at 550 °C, exhibited high phase purity and reduced crystallite size, which contributed to enhanced catalytic activity. Preliminary results demonstrate significant degradation efficiencies across all tested contaminants, attributed to the generation of reactive oxygen species under ultrasonic conditions and the favorable surface and electronic properties of BFO. These findings underscore the potential of solution combustion-synthesized BiFeO_3 as an efficient sonocatalyst for the degradation of emerging contaminants in aqueous systems [1,2].

Keywords:

BFO, sonochemistry, emerging contaminants, water remediation, solution combustion.

Reference:

R. Pattanaik, R. Kamal, D. Pradhan, S.K. Dash, Fabrication of green-synthesized lanthanum-doped bismuth ferrite perovskite type nanocomposite for photocatalytic removal of ibuprofen from aqueous solution, SN Appl. Sci. (2025). <https://doi.org/10.1007/s42452-025-07314-5>.

Ris work was supported by:

Sustentabilidad Hídrica en la Ciudad de México CVN/CESA-002/2024, SIP-2275, SIP-20231669 and BEIFI 2021-2024 scholarship.



RENEWABLE ENERGY / 439

CARBON-DOPED g-C₃N₄: A METAL-FREE CATALYST FOR HYDROGEN GENERATION

Autores: Montserrat Gallegos-Alegria¹; José Manuel Romo-Herrera²; Uriel Caudillo-Flores³

¹ Centro de Nanociencias y Nanotecnología (UNAM)/ Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE)

² Centro de Nanotecnología y Nanociencias (UNAM)

³ Centro de Nanociencias y Nanotecnología (UNAM)

Autor responsable de la comunicación: mgallegos@ens.cnyn.unam.mx

The global dependence on fossil fuels for energy production continues to drive significant environmental damage by releasing greenhouse gases such as carbon dioxide. Consequently, the scientific community is actively pursuing alternatives aimed at mitigating emissions generated during the combustion of fossil fuels, among which the utilization of green fuels, such as hydrogen, has emerged as a promising strategy. Current conventional hydrogen production methods involve carbon dioxide emissions, so they are betting on producing green hydrogen obtained through catalytic processes. However, one of the main obstacles to the development of this technology is that it requires platinum-based catalysts, which are a very scarce metal on the planet and, therefore, very expensive. This work explores using carbon-doped graphitic carbon nitride (C-C₃N₄) as a metal-free alternative for hydrogen evolution reactions. Graphitic carbon nitride possesses a moderate band gap (~2.7 eV), enabling visible light absorption, but its low conductivity and sluggish charge transfer limit its catalytic performance. To overcome these limitations, C-C₃N₄ was proposed to improve electrocatalytic performance and thus enhance photoelectrocatalytic properties for hydrogen production. The following procedure was used to obtain carbon-doped carbon nitride: Bulk carbon nitride was mixed with different amounts of glucose to obtain different samples with different C/N ratios and left stirring with water for 12 h. The mixtures were dried at 120 °C for 12 h and subsequently calcined at 500 °C for 2 hours. The resulting materials were characterized by different spectroscopies (UV-Vis, XPS, IR), X-ray diffraction, nitrogen physisorption, thermogravimetric analysis (TGA), and electrochemical measurements. Using the Tauc method, it was observed that as the ratio of carbon in the samples increases, the band gap decreases, and the surface area increases.

This study investigates the physicochemical, optical, and structural properties of C-C₃N₄ materials as a function of their C/N ratio, emphasizing their potential applicability as metal-free electrocatalysts in photoelectrocatalytic hydrogen evolution systems.

Keywords:

hydrogen, photocatalysis, electrocatalysis, carbon nitride

Reference:

Xiao, P., Jiang, D., Liu, T., Li, D., y Chen, M. 2018. Facile synthesis of carbon-doped g-C₃N₄ for enhanced photocatalytic hydrogen evolution under visible light. *Materials Letters*, 212, pp. 111–113. doi: 10.1016/j.matlet.2017.10.079

Ris work was supported by:

We appreciate the financial support of the DGAPA-UNAM through the PAPIIT project IN105719 and IN111223



SYNTHESIS AND CHARACTERIZATION OF SPHERICAL ZnO COATINGS FROM ZINC PRIMER FOR THE REMOVAL OF METHYLENE BLUE

Autor: Dulce Dariana Sánchez Montiel^{None}

Coautores: Marco Antonio Lopéz Camacho ¹; Monserrat Ballesteros Balbuena ¹; VICTOR HUGO CASTREJON SANCHEZ ²

¹ UAEMex

² Tecnológico de Estudios Superiores de Jocotitlán

Autor responsable de la comunicación: dulce.sanchez@tesjo.edu.mx

The following investigation reports on the production of ZnO from ceramic spheres coated with cold-galvanized paint with a 93% Zn content. Using the thermal oxidation method, we can appreciate how the material is formed using characterization techniques.

The techniques used to study the material before and after heat treatment were: Scanning Electron Microscopy, which allowed us to follow the evolution of the morphology as a function of heat treatments, in which sea urchins, microneedles, and microspikes were obtained; by μ Raman Spectroscopy and X-ray Diffraction, it is estimated that the phase present in the material is hexagonal, wurtzite-type, and the main crystalline planes are (100), (002), and (101); according to these results, the presence of black ZnO with a hexagonal crystalline structure was confirmed. The adsorption experiments carried out show us that it is possible to remove methylene blue, up to percentages as high as 74% of the original concentration of the dye.

Keywords:

ZnO, Primer de Zn, Azul de metileno

Reference:

Isai, KA, Shrivastava, VS. Degradación fotocatalítica de azul de metileno utilizando nanomateriales semiconductores de ZnO y 2% Fe-ZnO sintetizados por el método sol-gel: un estudio comparativo. SN Appl. Sci. 1, 1247 (2019). <https://doi.org/10.1007/s42452-019-1279-5>

Ris work was supported by:

Beca de Maestría SECIHTI



NUMERICAL SIMULATION OF A SOLAR CELL BASED ON A DOUBLE Sb₂Se₃/Sb₂S₃ ABSORBER LAYER AND AN ITO WINDOW LAYER WITH AN EFFICIENCY OF 28.72%

Autor: Enrique Rosendo Andrés¹

Coautores: Antonio Coyopol solís ¹; Crisóforo Morales Ruíz ¹; Godofredo García Salgado ¹; Leticia Treviño Yarcé ¹; María Josefina Robles Aguila ¹; Reina Galeazzi Isasmendi ¹; Román Romano Trujillo ¹

¹ Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: enrique.rosendo@correo.buap.mx

Simulation of solar cells based on cadmium sulfide (CdS) as window layer, antimony sulfide (Sb₂Se₃) like first absorber layer and antimony selenide (Sb₂S₃) like second absorber layer with the structure (ITO/CdS/Sb₂Se₃/Sb₂S₃/CM) using the Cell Capacitance Simulator solar-1D (SCAPS-1D) has been carried out. The effect of the thickness of the first and the second absorber layer was studied. The thickness of the Sb₂S₃ layer varied from 0.01 to 1.6 μm , it was found that PCE increases around 15% with increasing thickness. The thickness and concentration of carriers in the second absorber layer varied from 0.01 to 1.6 μm . It was observed that by increasing the thickness of the Sb₂Se₃ layer, PCE increased around 11.52%. The impact of the work function of several metals as back contacts for the solar cell was studied, considering metals with a work function between 3.65 and 6.0 eV. The results show that metals with a work function greater than 5.0 eV promote charge transport in the solar cell, yielding an efficiency close to 28.72%. Finally, a maximum power conversion efficiency (PCE) of 28.72 % is achieved with an open circuit voltage (Voc) of 0.88 V, short circuit current density (Jsc) of 45 mA/cm² and a fill factor (FF) of 85 %, obtained with a thickness of 1 μm for the Sb₂S₃ layer and 0.9 μm for the Sb₂Se₃ layer the thickness. And the proposed heterostructure is ITO/CdS/Sb₂Se₃/Sb₂S₃/CM. The above results provide design guidelines for a solar cell based on two absorber layers Sb₂S₃ and Sb₂Se₃ and window layer of CdS with high efficiency.

Keywords:

solar cell simulation, SCAPS-1D, antimony selenide, antimony sulfide

Reference:

Leticia Treviño Yarcé et al 2025 Mater. Res. Express 12 055904, DOI: 10.1088/2053-1591/adbab5

Ris work was supported by:

Benemérita Universidad Autónoma de Puebla



SEMICONDUCTORS

CHAIRMEN

Dr. Joaquín Alvarado Pulido (BUAP), joaquin.alvarado@correo.buap.mx

Dr. Irving Eduardo Cortes Mestizo (CIACYT-UASLP), irving.cortes@uaslp.mx

Research on semiconductors has been an extremely important research field for most of the past century and will continue to have a central role worldwide during the twenty first century. Current technology would not exist if silicon-based electronics had not been developed. This impressive progress has been extended to other semiconductors such as gallium arsenide, group-three nitrides and related materials. The pace at which technology advances is a direct consequence of the research efforts in growth, characterization, control of properties, development of novel devices, performance improvement, new materials such as alloys and solid solutions, theoretical approaches to predict and understand semiconductor properties, and so on. The Mexican Society for Science and Technology of Surfaces and Materials (SMCTSM) has had, since its beginnings, an important tradition among its members in pursuing research in the important field of semiconductors. This Symposium has been an important forum, for many years, for the generation, discussion and exchange of ideas where stimulating and fruitful collaborations have arisen among the participants. The themes covered in the symposium include:

- Growth: chemical and physical methods
- Single crystals
- Thin films: epitaxial and polycrystalline
- Surfaces
- Structural characterization
- Electronic properties: optical, thermal and electrical
- Lattice dynamics and phonon properties
- Homo and heterojunctions
- Devices
- Novel semiconductors: compounds, alloys and solid solutions
- Nanoscaled semiconductors
- Carbon: nanotubes, graphene, and fullerenes
- Theoretical models and calculations of semiconductor properties
- Novel characterization techniques
- Other (it is such a wide and beautiful area!)

We look forward to your participation in the Symposium of Semiconductors, whose success and high impact is guaranteed by the contribution of the SMCTSM members.



DEVELOPING Ga_2O_3 PHOTOELECTRODES FOR EFFICIENT PHOTOELECTROCHEMICAL CELLS

Autor: MARIANA TELLEZ GARCIA¹

Coautores: BLANCA SUSANA SOTO CRUZ ¹; JOSE JOAQUIN ALVARADO PULIDO ¹; LUIS ANTONIO ORTIZ FRADE ²

¹ Benemérita Universidad Autónoma de Puebla

² Centro de investigación y desarrollo tecnológico en electroquímica

Autor responsable de la comunicación: tg224470003@alm.buap.mx

This work reports the fabrication of gallium oxide (Ga_2O_3) thin films via Atomic Layer Deposition (ALD). We characterize their optical, electrical, morphological, and electrochemical properties to evaluate their application in photoelectrochemical cells (PECs). PECs have garnered interest in recent years, as they enable water decomposition to obtain clean fuel. This process utilizes a semiconductor photoelectrode, a counter electrode and reference electrode as well as a supporting electrolyte for ionic conduction. Solar energy drives the redox process of water and hydrogen evolution, generating a photocurrent. So far, Ga_2O_3 thin films with thicknesses of 20 and 40 nm have been successfully deposited across temperatures ranging from 100 to 300 °C in 50 °C intervals. These films have been characterized by cyclic voltammetry and electrochemical impedance spectroscopy to gather information on surface redox reactions, stability, current density, charge carrier density, electrolyte and electrode resistance under both dark and UV-illuminated conditions. A photoresponse was observed in the film grown at 250 °C.

Keywords:

Fotoelectroquímica, fotoelectrodo, semiconductor, redox, hidrogeno

Reference:

[1] H. Song, S. Luo, H. Huang, B. Deng y J. Ye, "Solar-Driven Hydrogen Production: Recent Advances, Challenges, and Future Perspectives," *ACS Energy Letters*, vol. 7, n.º 3, pp. 1043–1065, feb. 2022, doi: 10.1021/acsenenergylett.1c02591.

Ris work was supported by:

SECIHTI, BUAP



EFFECTS OF MAGNESIUM INCORPORATION ON PEALD-GROWN GaN RIN FILMS

Autor: Dylan Tepatzi¹

Coautores: César Augusto Ramírez Cisneros ²; Daladier Alonso Granada Ramirez ¹; Joaquin Alvarado ²; Mauricio Huixtlaca ³; Miguel Domínguez ²

¹ Benemerita Universidad Autónoma de Puebla-BUAP

² Benemérita Universidad Autónoma de Puebla

³ Benemérita Universidad Autónoma de Puebla - ICUAP

Autor responsable de la comunicación: dylan.tepatzix@alumno.buap.mx

Gallium nitride (GaN) thin films doped with varying concentrations of magnesium (Mg) were deposited using plasma-enhanced atomic layer deposition (PEALD) and analyzed to investigate the effects of Mg incorporation on their chemical composition and electrical behavior. X-ray photoelectron spectroscopy (XPS) was employed to confirm the presence and chemical state of Mg within the GaN matrix. Rutherford backscattering spectrometry (RBS) provided quantitative elemental analysis and depth profiling. Electrical properties were evaluated through capacitance-voltage (C-V) and current-voltage (I-V) measurements to determine doping efficiency and p-type conductivity. The results demonstrate a clear dependence of electrical performance on Mg concentration, revealing a critical threshold beyond which compensation effects and on conductivity are observed.

Keywords:

PEALD, Mg doping, Thin films

Reference:

A. J. M. Mackus et al., "Synthesis of doped, ternary, and quaternary materials by atomic layer deposition: A review," *Chem. Mater.*, vol. 31, no. 4, pp. 1142–1183, Feb. 2019

Ris work was supported by:

This work was supported by Proyecto-VIEP-ID100 and BUAP-CA-96 at BUAP. D. Tepatzi, doctoral student in Semiconductor Devices, thanks SECIHTI (formerly CONAHCyT) for scholarship #1041324 supporting his research.



THERMOMETRY AND ELECTROCHEMICAL CHARACTERIZATION OF CHALCOPYRITE SYNTHESIZED BY MICROWAVE IRRADIATION WITH Zn, Pb, AND Ni IMPURITIES

Autores: Gonzalo Viramontes Gamboa¹; Isai Raya Farías¹

Coautor: Laura Alicia Ibarra Bracamontes¹

¹ *Universidad Michoacana de San Nicolás de Hidalgo*

Autor responsable de la comunicación: isai.raya@umich.mx

This work introduces an integrated optical-electrochemical methodology for monitoring the rapid, self-propagating synthesis of chalcopyrite-type materials (CuFeS_2) in a conventional microwave oven under nitrogen. Stoichiometric powders of Cu, Fe and S were first reacted to obtain phase-pure chalcopyrite, verified by X-ray diffraction. In a second stage, Cu and Fe sites were partially substituted with Zn, Pb or Ni (0–22 wt %), and total precursor mass was varied from 2 g to 7 g.

Real-time UV-Vis emission spectra, collected through an optical-fiber-coupled spectrophotometer, revealed bright plasma bursts characteristic of microwave-assisted reactions. Applying Planck's radiation law and Wien's displacement law to these spectra yielded instantaneous emission temperatures between ~3550 K and >8000 K. Higher impurity loadings and larger batches produced sharper temperature spikes, indicating enhanced microwave absorption and heat localization.

To assess the practical impact of these thermal histories, we carried out cyclic voltammetry and potentiostatic dissolution tests in acidic ferric sulfate solutions. The impurity-doped samples exhibited markedly different leaching kinetics: Zn-substituted chalcopyrite accelerated Cu^{2+} release by up to 35 %, whereas Pb and Ni slowed the initial kinetics, suggesting passivating surface layers. Correlating the electrochemical data with in-situ temperature profiles highlights how dopant choice and precursor mass jointly tune both the synthesis energetics and subsequent hydrometallurgical behavior.

This non-invasive temperature-mapping approach, coupled with post-synthesis electrochemistry, provides valuable design rules for optimizing microwave-assisted routes to advanced semiconductor or catalytic chalcopyrite materials.

Keywords:

chalcopyrite, microwave irradiation, optical thermometry, electrochemistry, leaching kinetics

Reference:

Dr. Gonzalo Viramontes Gamboa, Facultad de Ciencias Físico Matemáticas, UMSNH
Email: doc.cs.ingenieria.fisica@umich.mx

Ris work was supported by:

ECIHTI (Secretaría de Innovación, Ciencia y Desarrollo Tecnológico del Estado de Michoacán) through a doctoral scholarship.



TUNABLE DENSITY-OF-STATES IN CHROMIUM OXIDE THIN FILMS VIA ROOM TEMPERATURE LASER ABLATION

Autor: Angel Regalado Contreras¹

Coautor: Wencel José de la Cruz Hernández²

¹ Centro de Nanociencias y Nanotecnología - UNAM

² Centro de Nanociencias y Nanotecnología-UNAM

Autor responsable de la comunicación: arcontreras@ens.cnyn.unam.mx

Chromium oxide thin films were deposited at room temperature, via reactive laser ablation under varying O₂ pressures and analyzed using in-situ X-ray Photoelectron Spectroscopy (XPS). Qualitative XPS identified Cr³⁺ and Cr⁴⁺ states, with 2p_{3/2} binding energies ranging between 576.8 and 582.5 eV. Cr 2p spectra exhibited spin-orbit splitting, with peak separations ranging from 9.2 to 9.5 eV. Quantitative analysis confirmed that lower O₂ pressures favored Cr₂O₃ growth, while higher pressures promoted CrO₂, following a limiting-reactant mechanism due to the inherent plasma plume-working pressure dynamics. Near-Fermi-level spectra revealed significant Density-Of-States modulation, with the Valence Band Maximum shifting from 1.25 to 3.3 eV. A direct correlation between O₂ pressure and electronic structure was established.

Keywords:

XPS, PLD, Chromium Oxide, Thin Films

Reference:

1] Z. Li et al., "Preparation and characterization of chromium oxide thin films: The response of morphology, crystal structure, and electrical properties to oxygen pressure under magnetron sputtering," *Vacuum*, vol. 228, p. 113518, Oct. 2024, doi: 10.1016/j.vacuum.2024.113518.

Ris work was supported by:

This work was supported in part by the DGAPA-PAPIIT grant number IT103125 and the SECIHTI grant number No. 194758, and the Project Laboratorio Nacional de Nanofabricación SECIHTI-UNAM.



PHOTOCONDUCTIVE SENSOR FOR UV RADIATION MONITORING IN ENVIRONMENTAL IoT

Autores: Raquel Ramírez Amador¹; Raziel Sánchez Guarneros²

Coautores: Carlos Bueno Avendaño ²; Haydee Patricia Martínez Hernández ²; Raúl Cortés Maldonado ²; Salvador Alcántara Iniesta ³

¹ *Tecnológico Nacional de México/Instituto Tecnológico de Apizaco*

² *INSTITUTO TECNOLÓGICO DE APIZACO*

³ *Benemérita Universidad Autónoma de Puebla (BUAP)*

Autor responsable de la comunicación: d13370389@apizaco.tecnm.mx

Zinc oxide (ZnO) is an n-type semiconductor material widely studied for its remarkable electronic, optical, and chemical properties. It has a direct band gap of 3.37V, making it highly sensitive to ultraviolet (UV) radiation. Its high electron mobility, optical transparency, and low temperature synthesis capability make it an ideal choice for optical sensors, piezoelectric devices, and flexible electronics applications. Its most notable advantages include improved photoconductivity, thermal and chemical stability, compatibility with substrates such as silicon, nontoxicity, and abundance.

The high sensitivity of ZnO in this material allows it to respond to variations in UV-visible radiation. This sensitivity is directly related to the degree of change in electrical resistance to incident light. Therefore, this work presents a UV/visible light sensor made of ZnO on silicon that can be used in environmental issues. For the development of the sensor, a silicon substrate was used on which a thin film of zinc oxide (ZnO) was deposited using the spray pyrolysis method, a cost-effective and reproducible technique for the formation of semiconductor coatings. The results show that the photoconductive structure has a resistance of 10 kΩ, indicating good sensitivity to changes in incident light.

The optical, electrical, and morphological characterization of the ZnO films is also presented. To evaluate the performance of this sensor, real-time monitoring of solar exposure conditions is performed from various devices, such as IoT platforms using WiFi or LoRa.

The authors thank Dr. Joaquín Alvarado Pulido and Dr. Salvador Alcántara Iniesta for lending us the facilities and semiconductor laboratory of the Ecocampus Valsequillo-CIDS-BUAP, as well as the Department of Electrical and Electronic Engineering, National Technological Institute of Mexico/Technological Institute of Apizaco for lending us their electronics laboratories, and Dr. Blanca Susana Soto Cruz without them this project would not have been completed.

Keywords:

semiconductor material, UV, ZnO, sensor, IoT.

Reference:

R. Dhirendra Prasad, "A Review on Modern Characterization Techniques for Analysis of Nanomaterials and Biomaterials", *ES Energy & Environment*, 2024, 23, 1087.

Ris work was supported by:

Dr. Joaquín Alvarado Pulido and Dr. Salvador Alcántara Iniesta for lending us the facilities and semiconductor laboratory of the Ecocampus Valsequillo-CIDS-BUAP, as well as the Department of Electrical and Electronic Engineering, National Technological Institute of Mexico/Technological Institute of Apizaco.



THERMODYNAMIC ANALYSIS OF INITIAL CONDITIONS FOR EPITAXIAL LAYERS FORMATION FROM TERNARY Ga-As-Sb LIQUID PHASES ON InP SUBSTRATE

Autores: Andrei Gorbachev¹; Francisco De Anda Salazar²

Coautor: Viatcheslav Michournyi ²

¹ *Universidad Autónoma de San Luis Potosí*

² *IICO UASLP*

Autor responsable de la comunicación: andre@cactus.iico.uaslp.mx

The GaAsSb ternary solid solution system is interesting for the formation of heterostructures for mid-infrared optoelectronic devices. On GaAs or GaSb substrates, the growth of planar GaAsSb epitaxial layers is accompanied by elastic energy release due to the mismatch of lattice parameters, that imposes restrictions on their thickness and composition. Another limiting factor is the presence of an extensive spinodal decomposition area in the considered system. This work presents the results of the analysis of thermodynamic initial conditions for the formation of epitaxial layers, on InP substrate, from ternary Ga-As-Sb liquid phases having liquidus temperatures of 550, 600 and 650 C. For estimations, we chose compositions of liquid phases that are in equilibrium with solid phases containing mole fractions of GaAs in the range of 0.3-0.7. In that case, the interfacial interaction between the substrate and the liquid phase is characterized by high thermodynamic stability, that is determined by the ratio of the thicknesses of the melting region, dm , and the deposited layer, dGr : $h = (dGr - dm) / dm$.

A small etching of the substrate in contact with the saturated liquid phase leads to its drastic supersaturation and, consequently, to the deposition of a significant amount of solid phase. Without considering the contribution of elastic energy, the analysis shows that thermodynamic conditions exist for the formation of two solid phases from one liquid phase, their corresponding compositions are determined by the existence of an immiscibility gap. If elastic energy is taken into account, thermodynamic conditions are such that only one solid phase can form with a composition near a GaAs molar fraction of 0.51, that is isoperiodic with the InP substrate, i.e., it causes a lattice latching effect, which is stronger at higher temperatures. The thermodynamic analysis was realized applying the CALPHAD method on the base of SGTE data.

Keywords:

LPE, CALPHAD, GaAsSb

Reference:

Andrei Gorbachev, Francisco De Anda Salazar, Juan Adrián Galván Montalvo, Viatcheslav Michournyi, Peculiarities of the thermodynamic conditions to grow InGaAs., MRS Advances, Volume 6, pages 1005– 1009, (2021) <https://doi.org/10.1557/s43580-021-00198-8>

Ris work was supported by:

This work was partially supported by CONACYT and PRODEP



HIGH-PERFORMANCE PHOTODETECTION OF UV-VISIBLE-NIR BY Ag-Mn₂O₃ HETEROJUNCTIONS

Autor: Carlos Rafael Michel¹

Coautor: Alma Hortensia Martínez-Preciado²

¹ *Departamento de Física, Universidad de Guadalajara CUCEI, Guadalajara, Jalisco, México*

² *Departamento de Ingeniería Química, Universidad de Guadalajara CUCEI, Guadalajara, Jalisco, México*

Autor responsable de la comunicación: carlos.muribe@academicos.udg.mx

Ag-Mn₂O₃ metal-semiconductor heterojunctions were synthesized by the coprecipitation method using the corresponding nitrates and formic acid. For comparative purposes, Mn₂O₃ was synthesized by the same process. XRD patterns collected at room temperature showed that single-phase Mn₂O₃ and Ag-Mn₂O₃ were obtained at 550°C, in air. X-ray photoelectron spectroscopy shows the presence of Mn³⁺ ions and metallic silver. Surface morphology (SEM images) of Ag-Mn₂O₃ exhibits particles of cuboid shape with abundant cavities and cracks evenly distributed. Nanowires with lengths up to 4 micrometers were also observed. The optical bandgap energy was determined through the Tauc method, obtaining 2.15 eV and 2 eV, for Mn₂O₃ and Ag-Mn₂O₃, respectively. Photocurrent measurements were carried out on sintered pellets of these materials using artificial light from LEDs of different wavelengths. The photosensor devices were placed inside fused quartz tubes to avoid contamination and hydration. The optical irradiance (E_e) of the LEDs was modulated by varying the input voltage, using a DC power source. Photocurrent variations ($\Delta I = I_f - I_o$) produced by the exposure of Mn₂O₃ to UV-A light and darkness showed an increase from 0.62 to 5.28 μA when E_e increased from 70 to 140 mW/cm^2 . For Ag-Mn₂O₃, ΔI changed from 24 to 245 μA , at the same E_e values, representing a 38- to 46-fold increase over those recorded for Mn₂O₃. When light of a larger wavelength was used, smaller ΔI values were measured. When sunlight was used, the resulting I vs. t graphs of Ag-Mn₂O₃ showed a good sensitivity to variations of E_e . The improvement in photocurrent of silver-doped manganese oxide can be attributed to a decrease in its bandgap energy, associated with the formation of metal-semiconductor heterojunctions and the lower work function of silver, with a greater number of free electrons.

Keywords:

metal-semiconductor, heterojunctions, manganese oxide, silver doping, photosensors

Reference:

Carlos R. Michel, Alma H. Martínez-Preciado, High-performance photodetection of UV-visible-NIR by Ag-Mn₂O₃ heterojunctions, *Materials Chemistry and Physics* 309 (2023) 128421. <https://doi.org/10.1016/j.matchemphys.2023.128421>

Ris work was supported by:

The General Academic Coordination of the Universidad de Guadalajara, through the PRO-SNI program



ELECTRICAL AND STRUCTURAL CHARACTERIZATION FOR THIRD GENERATION SOLAR CELL

Autores: Eulises Regalado-Pérez¹; Evelyn Díaz-Cruz¹; Joaquin Alvarado²; Julio Villanueva-Cab³

¹ *Instituto de Física – BUAP*

² *Instituto de Ciencias – BUAP*

³ *Instituto de Física – BUAP*

Autor responsable de la comunicación: julio.villanuevac@correo.buap.mx

Photovoltaic (PV) cells that convert sunlight directly into electricity are becoming increasingly important due to the world's renewable energy demand. It is well known that the moisture in ambient, temperature and light play important roles on the electrical behaviors of semiconducting thin films, thin film-based semiconductor homo- and heterostructures, and other optoelectronic devices. Therefore, it is very important to know the mechanism of interaction of the moisture, temperature and light with perovskites, for their application in the fabrication of carrier controlled electrical and optoelectronic devices. In this work, we provide experimental data correlating local atomistic structural changes due to these external stimuli through X-ray absorption spectroscopies along with photovoltaic characterizations (efficiency and stability) of third generation cells.

Keywords:

semiconductors, solar cells, characterization

Reference:

ACS Appl. Energy Mater. 2022, 5, 4, 4817–4828

Sustainable Energy Fuels, 2025, 9, 1225–1235

ACS Appl. Energy Mater. 2025, 8, 7, 4331–4344

His work was supported by:

CONACYT CF-2019-848260



SURFACE ENGINEERING OF HfO_2 BY SPIN COATING AND ALD: A COMPARATIVE APPROACH FOR MOS/MIM BIOSENSORS

Autor: Julieta Mariana Muñoz Morales¹

Coautores: Abdú Orduña Díaz ²; Joaquín Alvarado Pulido ¹; Miguel Ángel Domínguez Jiménez ¹; Miguel Ángel Méndez Rojas ³

¹ Center for Research in Semiconductor Devices, Institute of Sciences, Benemérita Universidad Autónoma de Puebla (BUAP)

² Center for Research in Applied Biotechnology, Instituto Politécnico Nacional

³ Department of Chemical and Biological Sciences, Universidad de las Américas Puebla

Autor responsable de la comunicación: mm224470092@alm.buap.mx

The functionalization of dielectric surfaces with specific biomolecules is a key component in the development of high-sensitivity capacitive biosensors. This work explores the use of hafnium oxide (HfO_2), a high-permittivity dielectric, as a platform for the immobilization of polyclonal antibodies targeting enteropathogenic *Escherichia coli* (EPEC). Thin films of HfO_2 were deposited on silicon and PET/ITO substrates using two techniques: spin coating and Atomic Layer Deposition (ALD), to evaluate their performance in MOS (Metal-Oxide-Semiconductor) and MIM (Metal-Insulator-Metal) device configurations. The presence of the HfO_2 layer was confirmed by FTIR-ATR spectroscopy through characteristic Hf-O vibrational bands, and by EDS analysis showing the expected elemental composition. Surface modification was achieved by silanization with APTMS (3-aminopropyltriethoxysilane), enabling covalent bonding of antibodies. FTIR spectra after functionalization showed signals related to amine groups ($-\text{NH}_2$), and the subsequent immobilization of antibodies was confirmed by the appearance of amide I ($\text{C}=\text{O}$ stretching) and amide II ($\text{N}-\text{H}$ bending) bands. Electrical characterization of MOS and MIM structures demonstrated changes in capacitance values after functionalization and antibody immobilization, suggesting successful modulation of the dielectric-electrolyte interface. Critical variables such as coating uniformity, biochemical bond stability, and electrical response after biofunctionalization were evaluated. This study aims to contribute to the design of more reproducible and reliable bioelectronic platforms, with potential applications in biomedical diagnostics and environmental monitoring.

Keywords:

hafnium oxide, ALD, spin-coating, antibody immobilization, MOS/MIM sensors

Reference:

R. Salinas, A. Orduña, O. Obregon and Miguel A. Dominguez, "Biosensors based on zinc oxide thin-film transistors using recyclable plastic substrates as an alternative for real-time pathogen detection", *Talanta*, 237, 122970 (2022).

Ris work was supported by:

BUAP-INRS bilateral project (SRE Mexico and MRIF-Quebec) and VIEP projects



MEMRISTIVE BEHAVIOR IN ULTRATHIN Ga_2O_3 FILMS DEPOSITED BY ALD ON TiN/Si

Autor: Jessica Abigail Fernández Morales¹

Coautores: Joaquin Alvarado ²; Miguel Domínguez ²; Miguel Ángel Méndez Rojas ³

¹ Centro de investigación en dispositivos Semiconductores, Instituto de Ciencias, benemérita universidad autónoma de Puebla (BUAP)

² Benemérita Universidad Autónoma de Puebla

³ Department of Chemical and Biological Sciences, Universidad de las Américas Puebla

Autor responsable de la comunicación: fm224470094@alm.buap.mx

Resistive switching in ultrathin metal oxide films represents a promising approach for the development of energy-efficient neuromorphic devices.

This work explores the memristive behavior of gallium oxide (Ga_2O_3) thin films deposited by Atomic Layer Deposition (ALD) on TiN/Si substrates. Films with thicknesses of 20 nm and 2 nm were fabricated to evaluate surface coverage and electrical response at different growth temperatures.

The 20 nm films were used to validate the ALD process and to establish optimal deposition conditions (250 °C), supported by SEM and EDS characterizations confirming the homogeneous incorporation of gallium and oxygen. Based on this validation, 2 nm films were deposited, which exhibited clear memristive behavior even in ultrathin configurations. I-V measurements revealed temperature-dependent hysteresis.

These results lay the groundwork for the future integration of interfacial layers to further modulate electrical performance. Overall, this study confirms the potential of ultrathin Ga_2O_3 films as functional materials for next-generation memristive devices, with the ability to emulate synaptic functions in neuromorphic computing systems.

Keywords:

Memristor, Ga_2O_3 , ALD, thin films, neuromorphic computing, resistive switching, hysteresis.

Reference:

Goul, R., Marshall, A., Seacat, S. et al. Atomic-scale tuning of ultrathin memristors. Commun Phys 5, 260 (2022). <https://doi.org/10.1038/s42005-022-01037-4>

Ris work was supported by:

BUAP, SECIHTI



IMPROVING THE FREQUENCY RESPONSE OF THE n-InGaP/p-GaAs/n-GaAs BIPOLAR JUNCTION TRANSISTOR.

Autor: JAIME MIMILA-ARROYO¹

¹ *Centro de Investigación y Estudios Avanzados del Instituto Politécnico Nacional*

Autor responsable de la comunicación: jmimila@cinvestav.mx

n-InGaP/p-GaAs/n-GaAs bipolar transistors (BJT) from two different vendors showed different frequency response at identical geometry and collector current densities. In this BJT the emitter was silicon doped In_{0.5}Ga_{0.5}P, the base, carbon doped GaAs and the emitter silicon doped GaAs. All the layers of the BJT of both vendors were grown by MOCVD using the same reactor type, but each one with its own epitaxial grow know-how and grower. In this BJT the frequency response is strongly dependent on the minority carriers base mobility, dependent as well on the carriers concentration, which in this case was in the low 10²⁰ holes/cm³ and point defects. A study was realized to understand the origine of the difference observed in the hole mobility in the base of this device between the two vendors and to find the way to improve the frequency response. The author of this presentation was part of the research team in charge of the study from the beginning to the end. The main stages of the study will be detailed as well as the main results that allowed to improve the performance of the transistor.

Keywords:

n-InGaP/p-GaAs/n-GaAs, BJT, Point defects, MOCVD



DEVELOPMENT OF A ZnO PHOTOELECTRODE FOR ITS USE IN PHOTOELECTROCHEMICAL CELLS

Autor: Iliana María Ramírez Bretón¹

¹ *Instituto de Ciencias de la Universidad Autónoma de Puebla, Benemérita Universidad Autónoma de Puebla*

Autor responsable de la comunicación: rb224470004@alm.buap.mx

Hydrogen generation through photoelectrochemical water splitting is a promising alternative in the field of renewable energy. This work presents the fabrication of ZnO photoelectrodes using the ultrasonic spray pyrolysis technique, a low-cost method that offers ease of implementation and the ability to control parameters such as film thickness and growth rate.

Electrochemical studies were carried out using cyclic voltammetry under dark and UV-illuminated conditions, as well as electrochemical impedance spectroscopy. Preliminary voltammetry results show an increase in current density under UV irradiation, particularly in ZnO electrodes doped with fluorine. Impedance spectroscopy results will also be presented, aimed at exploring the effect of doping on the electrochemical behavior of the electrodes.

The results obtained allow for the evaluation of the preliminary performance of these photoelectrodes and guide future optimizations for their application in photoelectrochemical cells.

Keywords:

ZnO photoelectrode, Photoelectrochemical cells, Ultrasonic spray pyrolysis, Hydrogen generation

Reference:

S. N. Grushevskaya, I. Belyanskaya, and O. A. Kozaderov, Approaches for modifying oxide-semiconductor materials to increase the efficiency of photocatalytic water splitting, *Materials* 15(14) (2022) 4915.
<https://doi.org/10.3390/ma151>

Ris work was supported by:

SECIHTI and BUAP



MEMRISTIVE APPLICATIONS OF MESOPOROUS SILICA COMPOSITES WITH ZNO NANOPARTICLES

Autor: Juan Manuel González Delgadillo¹

Coautores: Yesmin Panecatí Bernal²; Salvador Alcántara Iniesta¹; Miguel Ángel Méndez Rojas³; José Joaquín Alvarado Pulido¹

¹ Instituto de Ciencias Benemérita Universidad Autónoma de Puebla

² Tecnologías de la Información e Innovación Digital. Universidad Tecnológica de Tecamachalco

³ Departamento de Ciencias Químico-Biológicas, Universidad de las Américas Puebla

Autor responsable de la comunicación: gd223570531@alm.buap.mx

The development of efficient and low-power non-volatile memory is essential for emerging technologies such as neuromorphic computing. This work investigates a hybrid composite based on mesoporous silica functionalized with ZnO nanoparticles (Mesoporous Silica@ZnO NPs) for application in memristive devices. The high surface area and tunable porosity of the silica matrix, combined with the semiconducting and resistive switching properties of ZnO, enable a promising platform for memory and synaptic device architectures.

The composite was synthesized via hydrothermal process and nanoparticle impregnation and deposited on Silicon/TiN substrate. SEM, EDS, FTIR, and UV-VIS analyses confirmed uniform ZnO distribution and suitable nanostructure. Electrical testing showed repeatable bipolar resistive switching, with distinct SET/RESET transitions and stable hysteresis, supporting both digital memory and analog switching for artificial synapses.

Future work focuses on optimizing interface properties and device performance to enable multilevel memory states and improve endurance, essential for neuromorphic and edge AI applications.

Keywords:

Composite, Memristor, ZnO, Mesoporous Silica, Semiconductor

Reference:

G Milano, L Boarino¹, I Valov, and C Ricciardi, "Memristive devices based on single ZnO nanowires— from material synthesis to neuromorphic functionalities," *Semiconductor Science and Technology*, vol. 37, no. 3, p. 034002, January 2022.

Ris work was supported by:

SECIHTI



ASSESSING WATER QUALITY: A TiO_2 NANOPARTICLES WITH MESOPOROUS SILICA APPROACH FOR DISSOLVED NITROGEN DETECTION

Autor: Areli Pamela González Delgadillo¹

Coautores: Yesmin Panecatí Bernal ²; Salvador Alcántara Iniesta ¹; Miguel Ángel Méndez Rojas ³; José Joaquín Alvarado Pulido ¹

¹ *Instituto de Ciencias Benemérita Universidad Autónoma de Puebla*

² *Tecnologías de la Información e Innovación Digital. Universidad Tecnológica de Tecamachalco*

³ *Departamento de Ciencias Químico-Biológicas, Universidad de las Américas Puebla*

Autor responsable de la comunicación: gd224570626@alm.buap.mx

The growing demand for reliable water quality monitoring calls for sensitive and cost-effective detection methods for pollutants such as nitrites and nitrates. This study investigates a hybrid sensing material composed of mesoporous silica integrated with TiO_2 nanoparticles, aiming to enhance surface interaction and charge transfer processes relevant to chemical sensing.

The composite was synthesized via hydrothermal process and nanoparticle incorporation, and subjected to structural, morphological, and optical characterization (SEM, EDS, UV-Vis) to assess its suitability for sensing. The hybrid material was then integrated into a sensor platform, and its electrical response was evaluated under varying concentrations of nitrite and nitrate in aqueous solutions.

Preliminary results demonstrate an improved sensitivity compared to TiO_2 alone, attributed to the high surface area and porous architecture of the mesoporous silica, which facilitates analyte adsorption and interaction with the active sites of TiO_2 .

Keywords:

TiO_2 , Nanoparticles, water quality, sensing material, Mesoporous Silica

Reference:

Samuel, Z., Jokazi, M., Nwahara, N. et al. Nitrite electrochemical sensing using Cu centred porphyrin functionalized TiO_2 nanoparticles modified glassy carbon electrode. *J Appl Electrochem* 55, 1341–1356 (2025).

Ris work was supported by:

SECIHTI



SPECTROSCOPIC ELLIPSOMETRY IN THE CHARACTERIZATION OF METAL-OXIDE SEMICONDUCTOR INTERFACES AND ITS APPLICATION TO DEVICE FABRICATION.

Autor: José Gabriel Roberto Hernández Arteaga¹

¹ *Coordinación para la Innovación y la Aplicación de la Ciencia y la Tecnología*

Autor responsable de la comunicación: roberto.hernandez@uaslp.mx

Cobalt oxide (Co₃O₄) and Gd doped cerium oxide (CeO₂) thin films were synthesized by a spin coating process to obtain a p-n junction. The surface of both films was characterized by spectroscopic ellipsometry (SE) and spectroscopic imaging ellipsometry (SIE). The uniformity of the ellipsometric angles was analyzed by a principal component analysis (PCA). The variability of the spectra composing the SIE images led to an estimated error of 10.5% on the determined thickness and optical parameters. The measured energy band gap of Co₃O₄ films with optimized deposition conditions was 1.79 eV. The heterostructure TCO/CeO₂:Gd/Co₃O₄ formed a n-p junction exhibiting diode behavior, with a rectification factor of 1.57, shunt conductance of $G=1.75 \text{ mS cm}^{-2}$ and series resistance of $R=46.54 \text{ } \Omega \text{ cm}^2$, showing the feasibility of this heterojunction for diode devices.

Keywords:

Spectroscopic ellipsometry, Cobalt oxide (Co₃O₄), cerium oxide (CeO₂)



ADVANCEMENTS IN CATALYTIC SYSTEMS FOR ENVIRONMENTAL REMEDIATION: FROM POLYCYCLIC AROMATIC HYDROCARBON DEGRADATION TO ELECTROCHEMICAL CO₂ TRANSFORMATION

Autor: Luis Ortiz-Frade¹

Coautores: Anahí Barrios Velasco ²; Gilberto Rocha-Ortiz ¹; Marisela Cruz-Ramírez ³; Omar Monsalvo-Zuñiga

¹

¹ CIDETEQ

² Instituto Tecnológico Superior de Ciudad Hidalgo

³ UAQ

Autor responsable de la comunicación: laofrade@gmail.com

Environmental contamination from polycyclic aromatic hydrocarbons (PAHs), such as anthracene, and the increasing atmospheric concentrations of carbon dioxide (CO₂) necessitate innovative remediation strategies. Photocatalysis and electrocatalysis, utilizing semiconductor nanomaterials and coordination compounds, offer promising routes for degrading recalcitrant pollutants and converting CO₂ into valuable products. This work explores the design and evaluation of advanced catalytic systems, including n-ZnO/p-MnO nanocomposites for degrading PAHs and hybrid systems of nanometric copper(I) oxide (Cu₂O) with cobalt coordination complexes for electrochemical CO₂ transformation. Nanocomposites were synthesized via one-pot alkaline hydrolysis and characterized using techniques such as UV-Vis, HR-TEM, XRD, XPS, and electrochemical methods. Photocatalytic degradation of anthracene was studied in ethanol:water and acetone:water solutions under UV irradiation. Separately, two cobalt coordination complexes, [Co(tpa)Cl]Cl and [Co(bipy)₃]²⁺, and nanometric Cu₂O were synthesized, characterized by FT-IR, Raman, UV-Vis, SEM/EDS, and X-ray diffraction. Their electrochemical response, both individually and integrated as FTO/Cu₂O with cobalt complexes, was evaluated via cyclic voltammetry in N₂ and CO₂ saturated media. For anthracene degradation, n-ZnO/p-MnO nanocomposites, particularly n-ZnO/p-MnO(Mn=2.25%), significantly enhanced photocatalytic activity, attributed to the p-n junction and improved electron transport. Solvent selection was critical; ethanol:water promoted benzoic acid formation with ZnO, while acetone:water led primarily to 9,10-anthraquinone via photolysis, with minimal semiconductor involvement. In CO₂ transformation studies, the synthesized cobalt complexes and Cu₂O demonstrated defined redox behaviors. Hybrid systems of FTO/Cu₂O with the cobalt complexes exhibited enhanced cathodic currents in the presence of CO₂, providing clear evidence of molecular catalysis. Proposed mechanisms highlight electron transfer, ligand effects, and CO₂ activation for products like CO and carbonate. These findings underscore the versatility of tailored nanomaterials and coordination compounds in driving efficient environmental remediation processes, validating their potential for applications in photocatalysis, electrochemical CO₂ reduction, and artificial photosynthesis.

Keywords:

n-ZnO/p-MnO nanocomposites, PAHs, photocatalytic activity, electrochemical CO₂ reduction, coordination compounds.

Reference:

Blanca L. Martínez-Vargas, Marisela Cruz-Ramírez, Jesús A. Díaz-Real, J.L. Rodríguez-López, Francisco Javier Bacame-Valenzuela, Raúl Ortega-Borges, Yolanda Reyes-Vidal, Luis Ortiz-Frade, Synthesis and characterization of n-ZnO/p-MnO nanocomposites for the photocatalytic degradation of anthracene, J. Photochem. Photobiol. A Chem. 369 (2019) 85–96. <https://doi.org/10.1016/j.jphotochem.2018.10.010>.

Ris work was supported by:

SECIHTY CB-2009-130500 and CBF2023-2024-3108



SEMICONDUCTORS / 93

COMPARATIVE ANALYSIS OF THE RECYCLING METHODS USED IN C-SI PHOTOVOLTAIC MODULES

Autor: Mariana Cabrera Hernández¹

Coautores: Sandra Jiménez Xochimitl¹; Raquel Ramírez Amador²; Raúl Cortés Maldonado³; Osvaldo López Hernández¹; Haydee Patricia Martínez Hernández³; Carlos Bueno Avendaño³

¹ FCE - BUAP

² Tecnológico Nacional de México/Instituto Tecnológico de Apizaco

³ INSTITUTO TECNOLÓGICO DE APIZACO

Autor responsable de la comunicación: cabrerah.mariana@gmail.com

The recycling of end-of-life photovoltaic modules is an issue that has gained increasing importance worldwide due to the growing development of solar photovoltaic energy. Although first-generation photovoltaic modules (crystalline silicon) have an average lifespan of 25 years, it is important to pay attention to those photovoltaic installations that are reaching the end of their useful life and those showing early-stage failures, as these devices may contain both valuable and toxic elements. In this work, research was carried out on the recycling methods for crystalline silicon photovoltaic modules, as this is the predominant technology in the global market. Through detailed investigation, it was found that different methods and stages have been developed to separate the elements that make up photovoltaic modules, as well as to recycle each of their components throughout the various stages of the recycling process.

Keywords:

End-of-life photovoltaic modules; major and minor components; recycling methods.

Reference:

<https://publications.tno.nl/publication/34640523/crl8a6/TNO-2022-R10860.pdf>
<https://doi.org/10.1016/j.solmat.2022.111976> <https://doi.org/10.69766/IPDB8111>
<https://doi.org/10.1016/j.resconrec.2024.107887>

Ris work was supported by:

BUAP y TecNM/ITA Apizaco



DEVELOPMENT OF A PIEZOELECTRIC SENSOR USING A THIN FILM OF ZINC OXIDE ON SILICON WAFERS AND ITS INSTRUMENTATION FOR IOT APPLICATIONS

Autor: ALFREDO OSCAR MATLALCUATZI SANDOVAL^{None}

Coautores: Carlos Bueno Avendaño ; Raquel Ramírez Amador ; Salvador Alcántara Iniesta ; Héctor Juárez Santiesteban ; Raúl Cortes Maldonado ; Haydee Patricia Martínez Hernández ; Jaime Alberto Elizalde Olin

Autor responsable de la comunicación: d15370004@apizaco.tecnm.mx

Currently, the Internet of Things Technology (IoT) surrounds us and is part of our daily lives, from entertainment to the workplace. We use electronic devices and appliances that upload and download data from the Internet, with the purpose of automating processes or guaranteeing a better service. These devices are mostly manufactured from semiconductor materials such as silicon. For this reason, this work aims to present the development of a piezoelectric sensor, which is widely used in medicine and the metal-mechanical and automotive industries, among others, as pressure and vibration sensors. The proposed sensor is manufactured from a thin film of zinc oxide on a silicon wafer, using the spray pyrolysis (SP) technique. The sensor is then characterized for implementation in Internet of Things systems. To this end, several films with different thicknesses and resistivity ranges were deposited, which were analyzed using a SEM microscope, revealing a homogeneous morphology. Analysis was also performed using an I-V curve tracer and X-ray diffraction. Subsequently, the fabrication of the sensors on copper-coated Bakelite sheets is described, which were then subjected to comparative sensitivity versus sheet bending tests. Finally, the data obtained from the sensor characterization is presented, in addition to its implementation using a preamplifier stage and an ESP32 microcontroller, which is one of the most widely used for the design of IoT systems.

Keywords:

zinc oxide, pyrolysis, piezoelectric, IoT

Reference:

- [1] <https://www.eleconomista.com.mx/empresas/La-pandemia-significo-un-boom-de-ventas-para-la-industria-chips-20220819-0020.html>.
- [2] FUMEC. 2024. "Oportunidades para el Nearshoring de Semiconductores en México". Mapa de ruta, julio 2024.

Ris work was supported by:

Departamento de Eléctrica y Electrónica y División de Estudios de Posgrado e Investigación del Instituto Tecnológico de Apizaco. Centro de investigación en Dispositivos Semiconductores de la Benemérita Universidad Autónoma de Puebla. SECIHTI



MESOPOROUS SILICA/PEDOT:PSS-BASED BREATH BIOSENSOR

Autor: Mariana Morales Castillo¹

Coautores: Juan Manuel González Delgadillo ²; Yesmin Panecatl Bernal ³; Salvador Alcántara Iniesta ²; Miguel Ángel Méndez Rojas ⁴; José Joaquín Alvarado Pulido ²

¹ *Licenciatura en Biotecnología, Facultad de Biología, BUAP*

² *Instituto de Ciencias Benemérita Universidad Autónoma de Puebla*

³ *Tecnologías de la Información e Innovación Digital. Universidad Tecnológica de Tecamachalco*

⁴ *Departamento de Ciencias Químico-Biológicas, Universidad de las Americas Puebla*

Autor responsable de la comunicación: mc202348372@alm.buap.mx

Currently, there is significant scientific and clinical interest in the detection of volatile organic compounds (VOCs), as their presence in human breath provides non-invasive biomarkers for various physiological conditions, including diabetes, cancer, and respiratory disorders. In this work, we present the early development of a flexible, cost-efficient breath sensor designed for real-time VOC detection. The sensing layer is composed of a hybrid nanostructure based on mesoporous silica functionalized with poly(3,4-ethylenedioxythiophene):polystyrene sulfonate (PEDOT:PSS), which was deposited onto a flexible PET substrate coated with indium tin oxide (ITO) using the spin coating technique.

The incorporation of mesoporous silica enables high surface area and enhanced molecular adsorption, while PEDOT:PSS contributes to the electrical transduction of analyte interactions. Morphological and structural characterization (SEM, EDS, and XRD) confirmed the uniformity and functional integrity of the hybrid film. Electrical measurements under controlled VOC exposure reveal distinct changes in resistance, demonstrating clear sensitivity to several analytes, including ethanol, methanol, and acetone. Among these, a markedly higher selectivity and sensitivity towards acetone

—an established biomarker for diabetes—was observed, suggesting the potential of this device for medical diagnostics.

Future work will focus on long-term stability, dynamic range, and integration with wireless readout platforms for wearable health monitoring applications.

Keywords:

Biosensor, breath, PEDOT:PSS, mesoporous silica, VOCs

Reference:

Assunção da Silva, E., Duc, C., Redon, N. and Wojkiewicz, J.-L. (2021), Humidity Sensor Based on PEO/PEDOT:PSS Blends for Breath Monitoring. *Macromol. Mater. Eng.*, 306: 2100489. <https://doi.org/10.1002/mame.20210048>

Ris work was supported by:

Facultad de Biología BUAP



OPTICAL, STRUCTURAL AND ELECTRIC CHARACTERIZATION OF $(\text{Fe}_2\text{O}_3)_x (\text{ZnO})_{1-x}$ THIN FILMS DEPOSITED BY SPRAY PYROLYSIS

Autores: Carlos Torres-Frausto¹; Martin Zapata-Torres²; Leonel Sanchez-Garcia¹; Miguel Melendez-Lira^{None}

¹ *Departamento de Fisica, Cinvestav*

² *CICATA-IPN*

Autor responsable de la comunicación: cafrator@gmail.com

Iron-zinc oxide films were deposited on glass and silicon p-type at 450°C by spray pyrolysis using ultrasound and pneumatic to produce the spray. As precursors 1M aqueous solutions of hexa-hydrated iron chloride salts ($\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$) and anhydrous zinc chloride (ZnCl_2) were employed. Different concentrations of iron and zinc were obtained from the solutions, by varying the contents in percentages of volume prepared at increments of 10% each [1].

We report the results of the optical and structural properties obtained by Uv-Vis, Raman, Photoluminescence spectroscopies and X-ray diffraction. The samples grown on silicon presented rectifying properties and for some compositions spectral response.

Results are discussed in terms of the composition (x) of the $(\alpha\text{-Fe}_2\text{O}_3)_x (\text{ZnO})_{1-x}$ thin films.

Keywords:

Transparent semiconductors, Optical properties, thin films

Reference:

[1] Torres Frausto, C., et al. "Optical and structural properties of $\text{Fe}_2\text{O}_3\text{-ZnO}$ composite thick films obtained by ultrasonic spray pyrolysis." *Superficies y vacío* 36 (2023).

Ris work was supported by:

partially by CONAHcyT



OBTENTION OF OPTICAL CONSTANTS of $(\text{CdTe})_{1-x}(\text{In}_2\text{Te}_3)_x$ FILMS GROWN BY RF SPUTTERING AND STUDY OF THEIR ELECTRICAL PROPERTIES.

Autores: Carlos Torres-Frausto¹; Leonel Sanchez-Garcia¹; Miguel Melendez-Lira¹; Rafael Kitl-Hernandez¹

¹ *Departamento de Física, Cinvestav*

Autor responsable de la comunicación: rafakitlhdez@gmail.com

CdTe is a semiconductor widely employed in production of solar cells and gamma ray detectors. Alloying with elements like sulphur, manganese, zinc, mercury, indium allows tailoring many of its electronic properties because the existence of respective tellurates. In particular alloying CdTe with indium made possible to modify the band gap in the infrared range. the compounds In_2Te_3 and CdIn_2Te_4 are compounds related to CdTe with a crystallographic structure in which sites in the structure have been identified as ordered vacancies.

$(\text{CdTe})_{1-x}(\text{In}_2\text{Te}_3)_x$ thin films with a nominal composition in weight of $x=0$ and $x=1$ been deposited employing RF sputtering. The produced $(\text{CdTe})_{1-x}(\text{In}_2\text{Te}_3)_x$ thin films were uniform and characterized to obtain chemical composition and structural and electronic properties [1]. The optical constants were obtained by direct fitting to the transmission spectra [2]. $(\text{CdTe})_{1-x}(\text{In}_2\text{Te}_3)_x$ thin films with $x=0.3$ and $x=0.7$ were deposited on silicon to study their $I_{\text{vs}}V$ characteristics and spectral response.

Keywords:

ordered vacancies semiconductors, thin films, optical properties

Reference:

- [1]. Meléndez-Lira, Miguel, et al. Materials Research Express 11.4 (2024): 045901.
- [2]. Birgin, Ernesto G., et al. Journal of Computational Physics 151.2 (1999): 862-880.

Ris work was supported by:

partially by CONAHCyT



SEMICONDUCTORS / 396

LASER THERMAL DIFFERENTIAL REFLECTANCE FOR STUDING OPTICAL BANDGAPS IN SEMICONDUCTORS

Autores: Rueben Montoya Quiñonez¹; Cristo Manuel Yee Rendon²

Coautores: Edgar Agustin Contreras³; Juan Jazziel Favela Lopez ; Antonio Ramos Carrasco⁴; Máximo López López⁵; Héctor Félix Quintero⁶; Jorge Carlos Avila Gaxiola⁷; Jesús Roberto Millan Almaraz⁷; yenny L Casallas-Moreno⁸

¹ *Facultad de Ciencias Físico-Matemáticas, Universidad Autónoma de Sinaloa, Blvd. de las Américas S/N, Ciudad Universitaria, Culiacán Sinaloa 80010, México*

² *Universidad Autónoma de Sinaloa*

³ *Departamento de Física, Centro de Investigaciones y Estudios Avanzados de IPN*

⁴ *Universidad de Sonora*

⁵ *Departamento de Física, CINVESTAV-IPN, Apdo. Postal 14-740, 07000 México D.F., México*

⁶ *Facultad de Ciencias Físico-Matemáticas, Universidad Autónoma de Sinaloa*

⁷ *Universidad Autónoma de Sinaloa*

⁸ *Conahcyt-UPITA-IPN*

Autor responsable de la comunicación: rubenmontoya.fcfm@uas.edu.mx

One of the perhaps more important parameters for a semiconductors is its optical bandgap. For thin films growth over opaque substrates, transmittance is not an option and reflectance could lead to significant errors on the determination of edge of absorption. Modulated spectroscopy like electroreflectance and photoreflectance are prove to be useful for the bandgap determination they both relies on the modification of the reflectance produce by electric field. On the present work we report the possibility of induce a change in the reflectance by heating with a laser, by comparing the spectra with and without the laser heating as differential signal could be obtained and compared to the one obtained by more conventional techniques. We apply this technique to GaN and ZnO with vey good agreement.

Reference:

N.A.

Keywords:

Reflectance, GaN, ZnO

Ris work was supported by:

Beca Sehicti para estudios de posgrado



SEMICONDUCTORS / 399

FROM QUANTUM THEORY TO OXIDE-SEMICONDUCTOR CHEMISTRY: THE POWER OF X-RAY PHOTOELECTRON SPECTROSCOPY (XPS)

Autores: Angel Regalado Contreras¹; Wencel José de la Cruz Hernández²

¹ *Centro de Nanociencias y Nanotecnología - UNAM*

² *Centro de Nanociencias y Nanotecnología-UNAM*

Autor responsable de la comunicación: arcontreras@ens.cnyn.unam.mx

This work addresses some of the fundamental principles of the X-ray photoelectron spectroscopy (XPS) technique, from its origins to sophisticated applications in semiconductor characterization. Applications in metal oxide semiconductors such as ZnO, TiO_x, and FTO are briefly discussed, highlighting their use in tailoring specific properties through chemical identification, quantification, and correlation with electrical and electronic behavior, as well as their potential industrial applications.

Keywords:

XPS, Thin Films

Reference:

Moulder, J. F., Wanger, C. D., Riggs, W. M., Davis, L. E., Muilenberg, G. E. 1979. Handbook of X-ray Photoelectron Spectroscopy. Perkin-Elmer Corp., Physical Electronics Division, Eden Prairie, Minnesota, USA. doi:10.1002/sia.740030412

Work was supported by:

DGAPA-PAPIIT grant number IT103125 and the SECIHTI grant number No. 194758



SYNTHESIS AND PHYSICAL CHARACTERIZATION OF ZnCuO THIN FILMS

Autores: Gerardo Alonzo¹; Regina Romero Rodriguez²

¹ *Universidad Anahuac Mayab, Instituto Tecnológico Superior Progreso*

² *Universidad Anahuac Mayab*

Autor responsable de la comunicación: regina.romero@anahuac.mx

Zinc oxide (ZnO) thin films were successfully deposited onto 1 cm² Corning glass substrates using a homemade spray pyrolysis system composed of an airbrush and a hot plate. The precursor solution was prepared with zinc chloride (ZnCl₂) at different molar concentrations (0.1 M, 0.3 M, and 0.5 M) and deposited at a substrate temperature of 400 °C. Optical characterization was performed using UV-Vis spectroscopy to obtain transmittance and absorbance spectra, from which the optical band gap energy (E_g) was estimated using the Tauc method. A total of 12 samples were analyzed per concentration. The results revealed a clear increase in E_g with higher precursor concentrations: 3.40 eV (± 0.1964) for 0.1 M, 3.58 eV (± 0.2020) for 0.3 M, and 3.64 eV (± 0.0707) for 0.5 M. These findings suggest that ZnO films with tunable band gap energies can be achieved through controlled variation of precursor concentration, which is relevant for applications in optoelectronic devices, UV detectors, and transparent conductive oxides (TCOs).

Keywords:

spray pyrolysis, ZnO, thin films, concentrations, absorbance.

Reference:

Jafarova, V., & Orudzhev, G. (2020). Structural and electronic properties of ZnO: A first-principles density-functional theory study within LDA(GGA) and LDA(GGA)+U methods. *Solid State Communications*, 325, 114166. <https://doi.org/10.1016/j.ssc.2020.114166>

Ris work was supported by:

Universidad Anáhuac Mayab.



GREEN SYNTHESIS OF TUNGSTEN OXIDE (WO₃) WITH JUSTICIA SECUNDA VAHL EXTRACT

Autores: Orlando Zaca Moran¹; Oscar Secundino Sánchez²; Fernando Díaz-Monge³; Joel Diaz-Reyes¹

¹ Centro de Investigación en Biotecnología Aplicada, Instituto Politécnico Nacional

² Depto. de Física, CINVESTAV-Instituto Politécnico Nacional.

³ Tecnológico Nacional de México/ITS de Tlaxco

Autor responsable de la comunicación: orlandozaca@hotmail.com

WO_x nanoparticles were obtained by the green synthesis method using sodium tungstate dihydrate and *Justicia Secunda Vahl* extract. UV-Vis spectroscopy presented a band at 290 nm associated with WO_x, through the Tauc graphs a variation of the of the band gap is observed as a function of the molarity of sodium tungstate dihydrate from 3.89 to 2.72 eV. TEM microscopy showed spherical structures with particle sizes of 8.95 nm. FTIR spectroscopy showed W-O-W, O-W-O and W-O bonds. EDS spectroscopy showed a percentage of 57.7% for Oxygen and 42.3% for tungsten, these results highlight the reduction of sodium tungstate by the *Justicia Secunda Vahl* extract, as well as the first report by green synthesis of WO_x nanoparticles, without the implementation of techniques such as hydrothermal.

Keywords:

WO_x nanoparticles, *Justicia Secunda Vahl*, Green Synthesis of Tungsten Oxide

Reference:

Y. Wicaksana, S. Liu, J. Scott, R. Amal, Tungsten Trioxide as a Visible Light Photocatalyst for Volatile. Org. Carbon Remov. Mol. 19, 17747–17762 (2014)



SEMICONDUCTORS / 441

STRUCTURAL AND OPTICAL CHARACTERIZATION OF p-InGaAsSb/n-InGaAsSb/n-GaSb HETEROSTRUCTURES GROWN BY LIQUID PHASE EPITAXY FOR INFRARED APPLICATIONS

Autor: Gerardo Villa Martínez¹

Coautores: Julio Gregorio Mendoza Alvarez²; Manolo Ramírez López³; Patricia Rodríguez Fragozo²

¹ Sección de Estudios de Posgrado e Investigación-Escuela Superior de Ingeniería Mecánica y Eléctrica Unidad Ticomán, Instituto Politécnico Nacional

² Physics Department, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional

³ Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional. Nacional

Autor responsable de la comunicación: gvillam@ipn.mx

InGaAsSb-based heterostructures are promising for infrared optoelectronics due to their tunable bandgap and high carrier mobility. In this work, we present the growth and characterization of Zn-doped InGaAsSb/Te-doped InGaAsSb/Te-doped GaSb grown by liquid phase epitaxy (LPE). Structural characterization through multiple analytical techniques. X-ray diffraction analysis confirms high crystalline quality, while secondary ion mass spectrometry (SIMS) reveals successful Te incorporation as the n-type dopant. Low temperature photoluminescence (7 K) shows an emission peak at 633 meV in the near-infrared (NIR) range. Raman spectroscopy analysis of the plasmon-phonon coupling enabled the estimation of Zn doping concentration in the p-type layer. Current-voltage measurements at room temperature demonstrate diode-like behavior, confirming proper p-n junction formation. These results highlight controlled doping achievable in LPE-grown antimonide heterostructures and their potential for NIR optoelectronic applications.

Keywords:

InGaAsSb, liquid phase epitaxy (LPE), p-n junctions, Raman spectroscopy, infrared

Reference:

M. Ramírez-López, J.J. Cruz-Bueno, D. Flores-Ramírez, G. Villa-Martínez, R. Trejo-Hernández, L.M. Reséndiz-Mendoza, P. Rodríguez-Fragoso, Y.L. Casallas-Moreno. Physical mechanism of Zn and Te doping process of In_{0.145}Ga_{0.855}As_{0.892}Sb_{0.892} quaternary alloys, Mater. Sci. Semicond. Process 173 (2024) 108090.

<http://doi.org/10.1016/j.mssp.2023.108090>

Ris work was supported by:

SIP-IPN, CONAHCYT



SYNTHESIS AND STRUCTURAL CHARACTERIZATION OF METAL OXIDES FOR PHOTOELECTROCHEMICAL HYDROGEN GENERATION.

Autor: José Antonio Trejo Ruiz¹

Coautores: Andrés Godínez García ¹; Iván Enrique Martínez Merlín ¹; Miriam Marisol Tellez Cruz ²

¹ *Instituto Tecnológico de Tlalnepantla*

² *Instituto de Investigaciones en Materiales*

Autor responsable de la comunicación: tony_strat@outlook.com

Due to the high energy demand and the negative impact on the environment, the search for alternative energies has been promoted. In this context, hydrogen has emerged as a promising energy source, and photoelectrochemical cells have been proposed as a method for decomposing water and obtaining green hydrogen. The present work is based on Zinc Oxide (ZnO), which is a material that has proven to be efficient for the elaboration of semiconductors, since it has good optical and electrical properties, excellent mobility of charge carriers, electrons/hole which is crucial to minimize recombinations, has good chemical stability and low cost which makes it an optimal material for this research. The purpose of this work is to develop new materials that are capable of producing hydrogen in a sustainable and economical way by harnessing the sun's energy through photoelectrochemical water splitting. Using synthesis techniques which are economical, simple and industrially scalable, such as pyrolytic spray. This technique was used to develop ZnO thin films on glass substrates. The samples were obtained by optimizing synthesis parameters, temperature, flow, deposition time and spray distance. The obtained samples were characterized one by one by X-ray Diffraction (XRD) which allowed the identification of the hexagonal crystalline phase wurtzite type. On the other hand, ultraviolet-visible spectroscopy (Uv-Vis) tests were also performed, analyzing the behavior of the material under the light beam and whether it absorbed in the desired range of the spectrum. Based on the results obtained and their analysis, it was possible to obtain the optimum synthesis parameters, as well as the reproducibility in the experimentation of the samples.

Keywords:

Hidrogeno, Electroquímica, Fotocatálisis, Semiconductores, Oxido de Zinc.

Reference:

L. J. Minggu, W. R. Wan Daud, and M. B. Kassim, "An overview of photocells and photoreactors for photoelectrochemical water splitting," *Int. J. Hydrogen Energy*, vol. 35, no. 11, pp. 5233–5244, Jun. 2010, doi: 10.1016/j.ijhydene.2010.02.133.

Ris work was supported by:

Al Tecnológico de Tlalnepantla por su respaldo institucional. A la Dra. Miriam Marisol Tellez Cruz (IIM-UNAM) y al Mc. Ulises Eli Cercas Balderas (CINVESTAV) por su valiosa colaboración. A la SECIHTI por el apoyo otorgado para esta investigación.



TEMPERATURE GROWTH EFFECTS STUDY OF Ga_2O_3 AND ITS RESPONSE TO UV LIGHT

Autor: César Augusto Ramírez Cisneros¹

Coautores: Mauricio Huixtlaca Quintana ¹; Dylan Tepatzi Xahuentitla ¹; Salvador Alcántara Iniesta ²; Joaquín Alvarado ¹; Raquel Ramírez Amador ³

¹ Benemérita Universidad Autónoma de Puebla

² Benemérita Universidad Autónoma de Puebla (BUAP),

³ Tecnológico Nacional de México/Instituto Tecnológico de Apizaco

Autor responsable de la comunicación: rc224570099@alm.buap.mx

Gallium oxide has gained attention as a promising candidate for a wide variety of devices, for example solar cells, solar blind photodetectors, power electronics, smoke sensors, among others. Granted by its capabilities beyond conventional technology, a large bandgap (4.9) places next to a new generation of ultra-wide bandgap semiconductors, e.g. diamond, GaN or SiC, which show interesting inherent properties such as high tolerance to radiation, thermal stability and fast response. Thus, this work focuses on the growth of thin films, gallium oxide (₂₃) using Plasma Enhanced Atomic Layer Deposition (PEALD), where trimethylgallium (TMG) is used as ~~the~~ precursor, ₂ gas as an oxygen precursor and argon gas was used as the carrier. Looking to explore temperature growing influence over the material properties, additionally its response to UV light (254 ~~nm~~). Experiments go from 100° to 300°, and we present some of the characterizations done so far.

Keywords:

gallium oxide, photodetector, peald, uv, radiation

Reference:

Hui Hao et al. "Remote plasma-enhanced atomic layer deposition of gallium oxide thin films with NH₃ plasma pretreatment". In: Journal of Semiconductors 40.1 (Jan. 2019), p. 012806. doi: 10.1088/1674-4926/40/1/012806.

Ris work was supported by:

Instituto de Ciencias de la Benemérita Universidad Autónoma de Puebla



PLASMA-ENHANCED ALD GROWTH WINDOW AND COMPOSITION TUNING OF $\text{Al}_{1-x}\text{Sc}_x\text{N}$ FOR EMERGING NEUROMORPHIC APPLICATIONS

Autor: Mauricio Huixtlaca¹

Coautores: César Augusto Ramírez Cisneros²; Miguel Domínguez²; Dylan Tepatzi²; Joaquín Alvarado²

¹ Benemérita Universidad Autónoma de Puebla - ICUAP

² Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: mauricio.huixtlacaqui@alumno.buap.mx

This work explores the development of $\text{Al}_{1-x}\text{Sc}_x\text{N}$ thin films for neuromorphic and memristive devices, leveraging their combined piezoelectric and ferroelectric properties. The films are being deposited using plasma-enhanced Atomic Layer Deposition (PE-ALD), which enhances surface reactions and allows precise control over thickness and composition at the nanoscale. The initial stage focuses on identifying the ALD growth window by varying the deposition temperature (200,°C, 250,°C, 300,°C). In the following stage, the scandium concentration $\text{Al}_{1-x}\text{Sc}_x\text{N}$ will be adjusted to study its effect on the material's functional behavior. AlScN presents advantages over conventional materials such as HfO_2 , particularly in terms of electromechanical performance and its potential integration into flexible electronic systems.

Keywords:

AlN, ScN, Ferroelectric, Piezoelectric, PEALD

Reference:

Researcher in electronics focused on flexible sensors and nitride-based materials deposited by ALD, with interest in piezoelectric and neuromorphic device applications.

Ris work was supported by:

This work was supported by the Research Group on Technological Applications of Semiconductors, focusing on microelectronic process design, MEMS sensors, material synthesis, and device fabrication.



COMPARATIVE ANTIMICROBIAL EVALUATION OF GREEN-SYNTHESIZED ZnO NANOPARTICLES USING GINGER AND GARLIC EXTRACTS

Autor: Teresa Pacheco Álvarez¹

Coautores: Alma López García¹; Anabel Romero López¹; José Joaquín Alvarado Pulido¹; Luis Antonio Ortiz Frade²; María Josefina Robles Águila¹; Miguel Ángel Méndez Rojas³; Salvador Alcántara Iniesta¹; Yesmin Panecat Bernal⁴; Ángel Gabriel Mendoza Martínez¹

¹ Benemérita Universidad Autónoma de Puebla

² Centro de Investigación y Desarrollo Tecnológico en Electroquímica

³ Universidad de las Américas Puebla

⁴ Universidad Tecnológica de Tecamachalco

Autor responsable de la comunicación: pa223570530@alm.buap.mx

The term “nanoparticle” comes from the Greek word “nanos” which means a tiny size entity, and from the Latin word “particulum” which means particle. In the scientific world terminology, the term “nano” is applied to precisely indicate a 10⁻⁹ magnitude in the metric system [1]. Zinc Oxide (ZnO) is a well known semiconductor with a band gap energy of 3.2 eV, and has three possible structures: rocksalt, zincblende and wurtzite [2]. This work aimed to synthesize ZnO nanoparticles (NPs) using ginger and garlic extracts as reductor and stabilizer agents, with zinc acetate solution as the precursor. The obtained mixture was subsequently heated at 400 °C.

Spherical nanoparticles of different sizes were obtained and characterized using DLS, SEM, EDS and XPS. Their antimicrobial activity was then evaluated through the Minimum Inhibitory Concentration (MIC) test against clinically relevant bacteria and yeasts. Results showed comparable antimicrobial effects for both ginger- and garlic-ZnO NPs. Specifically, the MIC for *P. aeruginosa* and *S. aureus* bacteria was 2048 µg/µl, while for *E. coli*, the MIC was 512 µg/µl, indicating a stronger antibacterial effect. Finally, the MIC for the yeast *C. albicans* was 2048 µg/µl.

Keywords:

metallic nanoparticles, zinc oxide, natural extracts, antimicrobials.

Reference:

Medina Cruz, D., Mostafavi, E., Vernet Crua, A., Barabadi, H., Shah, V., Cholula-Díaz, J. L. Guisbiers, G., Webster, T. J. (2020). Green nanotechnology-based zinc oxide (ZnO) nanomaterials for biomedical applications: a review. *Journal of Physics: Materials*. doi:10.1088/2515-7639/ab8186

Ris work was supported by:

Becas Nacionales SECIHTI, CVU 1071700



Sr_xBa_{1-x}Nb₂O₆: A FIRST REPORT OF SYNTHESIS BY ULTRASONIC SPRAY PYROLYSIS

Autor: Adolfo David Quintero González¹

Coautores: JOSE ALBERTO LUNA LOPEZ¹; Zaira Jocelyn Hernandez Simon²; José Álvaro David Hernández De la Luz³; Eduardo Ernesto Flores Cuevas⁴; Gabriel Omar Mendoza Conde⁵; Jaqueline Vázquez Zúñiga¹

¹ CIDS-IC-BUAP

² Centro de Investigaciones en Dispositivos Semiconductores, Benemérita Universidad Autónoma de Puebla

³ Centro de Investigación en Dispositivos Semiconductores - Instituto de Ciencias de la Benemérita Universidad Autónoma de Puebla

⁴ Centro de Investigaciones y Estudios Avanzados del Instituto Politécnico Nacional (CINVESTAV-IPN)

⁵ Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: imezaira@gmail.com

Ferroelectric materials are materials that exhibit spontaneous electrical polarization and are currently the basis for the production of devices such as capacitors, transducers, thermographic sensors, etc. Strontium barium niobate (Sr_xBa_{1-x}Nb₂O₆, or SBN) is a ferroelectric material that has been the focus of extensive research due to its ferroelectric, electro-optic, and pyroelectric properties. Notably, SBN exhibits rapid response times, a property that suggests a wide range of potential technological applications. A variety of techniques have been employed to synthesize this material, including pulsed laser deposition, RF sputtering, laser ablation, and hydrothermal synthesis. However, to date, there has been no report of its preparation by the ultrasonic spray pyrolysis technique. The ultrasonic spray pyrolysis deposition technique exhibits several merits, including cost-effectiveness, ease of deposition, and scalability. Consequently, the materials produced by this technique are competitive with those reported using much more complex synthesis methods. For the above reasons, the present work reports the process used to achieve the deposition of SBN using an ultrasonic spray pyrolysis system. In order to verify the obtention of SBN, the material characterization technique Grazing Incidence X-ray Diffraction (GIXRD) was employed, as well as the Raman technique. And to ascertain the stoichiometry of the material, the X-ray Photoelectron Spectroscopy (XPS) technique was utilized. The analysis yielded findings of interest regarding the potential for modifying the properties of the obtained material according to parameters such as the volumetric ratio of the precursor solutions utilized, as well as the duration and temperature of the thermal annealing.

Keywords:

SBN, Spray Pyrolysis, GIXRD, Raman, XPS.

Ris work was supported by:

Zaira Hernández acknowledges support from SECITI Postdoc program [CVU number: 774431]. The authors acknowledge to CINVESTAV-Merida and CIDS-BUAP laboratories for their help in the sample's characterizations.



ESTIMATION OF THE INFLUENCE OF GaAs, GaSb AND InP SUBSTRATES ON THE BOUNDARIES OF STABLE COMPOSITIONS OF GaAsSb TERNARY SOLID SOLUTIONS IN EPITAXIAL LAYERS OF VARIOUS THICKNESSES

Autores: Andrei Gorbachev¹; Francisco De Anda Salazar²

Coautor: Viatcheslav Michournyi ²

¹ *Universidad Autónoma de San Luis Potosí*

² *IICO UASLP*

Autor responsable de la comunicación: andre@cactus.iico.uaslp.mx

Various III-V solid solution systems are characterized by the existence of a spinodal decomposition area, which imposes limitations on the formation of epitaxial layers, in particular on their composition and thicknesses. In this work, we have performed a comparative analysis of the change in the stability region boundaries of GaAsSb solid ternary solutions formed on GaAs, GaSb and InP substrates in the temperature range from 400 to 650 C. The calculations have been completed using the CALPHAD method and the SGTE data. Disregarding the elastic energy generated by the lattice mismatch between forming solid solutions and substrate, the estimations show a continuous spinodal decomposition area, between near pure GaAs and GaSb compositions, that expands with decreasing temperatures. Given the elastic energy contribution to the solid solution energy, extensive regions of stable compositions are always observed in thin epitaxial layers with thicknesses on the order of a few monolayers. On GaAs and GaSb substrates these regions shrink rapidly, as the layer grows, to compositions corresponding to free elastic energy solid solutions. On the InP substrate, at large thicknesses, within the spinodal decomposition area, the interval of stable compositions is conserved around the isoperiodic composition with the substrate (GaAs_{0.51}Sb_{0.49}), and for the 150 nm epitaxial layer lies between 0.41-0.61 molar fractions of GaAs. The results obtained may be of interest for the growth of thick layers in heterostructures to obtain photodetectors for the mid-infrared wavelength range.

Keywords:

CALPHAD, spinodal decomposition, GaAsSb

Reference:

Castillo E. G., Castillo A. K., Michournyi V. A., De Anda F., and Gorbachev A, Estimation of the instable composition areas., IOP Conf. Series: Journal of Physics: Conf. Series 792 (2017) 012011, doi:10.1088/1742-6596/792/1/012011

Ris work was supported by:

This work was partially supported by CONACYT and PRODEP



ZnO NANOCOMPOSITE WITH CARBON QUANTUM DOTS: A PHOTOCATALYTIC SOLUTION FOR ANTIBIOTIC REMOVAL FROM WATER.

Autores: José Joaquín Alvarado Pulido¹; José Juan Martín Mozo Vargas¹; Miguel Ángel Méndez Rojas²; Natalia Mejía Castillo¹; Yesmin Panecatl Bernal³

¹ Benemérita Universidad Autónoma de Puebla

² Universidad de las Americas Puebla

³ Universidad Tecnológica de Tecamachalco

Autor responsable de la comunicación: mc224470095@alm.buap.mx

In September 2024, the World Health Organization (WHO) warned that the release of antibiotics into the environment from pharmaceutical manufacturing contributes to antimicrobial resistance, a growing threat to global health. In Mexico, this problem is exacerbated by the limited capacity of treatment plants to remove emerging contaminants such as antibiotics, as conventional methods are not designed for this purpose.

This work proposes the development of a photocatalytic nanocomposite of zinc oxide (ZnO) and carbon quantum dots (CQDs), synthesized using green chemistry with garlic extract. Given the growing presence of antibiotics in water bodies and the inefficiency of conventional treatments, the aim is to optimize this material for the photocatalytic degradation of pollutants, taking advantage of the synergy between ZnO and CQPs to improve visible light absorption, reduce photocorrosion, and move toward sustainable solutions in water purification.

The composite was characterized using SEM, EDS, FTIR, and UV-Vis. Its photocatalytic activity was evaluated in the degradation of the antibiotic ofloxacin under UV irradiation. The results show high degradation efficiency, positioning the material as a promising and sustainable alternative for the treatment of water contaminated with antibiotics.

Keywords:

ZnO, PCC, Nanocomposite, Water Pollution, Antibiotics, Photocatalysis, Green Synthesis

Reference:

«Organización Mundial de la Salud,» 19 septiembre 2024. [En línea]. Available: <https://www.who.int/es/news/item/19-09-2024-who-at-unga-call-for-urgent-high-level-action-to-address-global-scourge-of-antimicrobial-resistance>. [Último acceso: Junio 2025].

Ris work was supported by:

Secretaría de ciencia, humanidades, tecnología e Innovación



SYNTHESIS AND PRELIMINARY OPTICAL CHARACTERIZATION OF SNO THIN FILMS DEPOSITED BY SPRAY PYROLYSIS

Autor: Catalina De la Riva Chávez¹

Coautor: Gerardo Alonzo²

¹ *Universidad Anahuac Mayab*

² *Universidad Anahuac Mayab, Instituto Tecnológico Superior Progreso*

Autor responsable de la comunicación: catadelariva.02@gmail.com

Transparent conductive oxides (TCOs) are critical in optoelectronic applications due to their ability to combine high optical transparency and electrical conductivity. This work presents the preliminary synthesis and optical evaluation of tin oxide (SnO) thin films deposited via spray pyrolysis, as a precursor stage for fluorine-doped SnO (FTO). Tin(II) chloride (SnCl₂) was used as the starting precursor and dissolved in an ethanol-water mixture with added hydrochloric acid (HCl) to suppress hydrolysis and ensure solution stability. Glass substrates were manually cut, cleaned, and placed on a hot plate at 400–450 °C during deposition. The spray system was calibrated to ensure uniform and repeatable coverage. Optical characterization was performed using UV-Vis spectroscopy in the 300–900 nm range to determine transmittance, absorbance, and optical band gap (E_g). Preliminary results show that solution composition and molar concentration significantly affect film uniformity and transparency. These findings lay the foundation for subsequent doping optimization with fluorine to improve conductivity. This approach supports the development of efficient, low-cost, and environmentally sustainable TCO layers for future solar energy devices.

Keywords:

Spray pyrolysis, tin oxide, SnCl₂, thin films, UV-Vis spectroscopy

Reference:

Sellam, M., Rasheed, M., Azizii, S., & Saidani, T. (2024). Improving photocatalytic performance: Creation and assessment of nanostructured SnO₂ thin films, pure and with nickel doping, using spray pyrolysis. *Ceramics International*, 50(12), 20917–20935. <https://doi.org/10.1016/j.ceramint.2024.03.094>

Ris work was supported by:

Universidad Anáhuac Mayab.



ZINC OXIDE FILMS OBTAINED BY ULTRASONIC SPRAY PYROLYSIS FOR THE EVALUATION OF THEIR PIEZOELECTRIC POTENTIAL

Autores: Jesus Roberto Vazquez Guzman; José Joaquín Alvarado Pulido¹; Salvador Alcántara Iniesta¹

¹ *Benemérita Universidad Autónoma de Puebla*

Autor responsable de la comunicación: vg224470096@alm.buap.mx

Zinc oxide (ZnO) is a semiconductor material of great interest due to its outstanding piezoelectric, optical, and electrical properties, making it a key candidate for the development of sensors, microelectromechanical devices, and energy harvesting systems. In this research, ZnO thin films are synthesized using the Ultrasonic Spray Pyrolysis (USP) technique, a low-cost and highly versatile method that allows precise control over parameters such as substrate temperature, precursor concentration, and atomization rate.

The main objective is to optimize the piezoelectric properties of the obtained films for their application in trampoline-type devices, designed to detect mechanical stimuli and convert mechanical energy into electrical energy. Structural characterizations are carried out through X-ray diffraction and profilometry, along with functional tests aimed at evaluating their piezoelectric performance. Preliminary results reveal a strong dependence between growth conditions and the functional response of the material, highlighting the importance of deposition process control. This work provides experimental evidence of the potential of ZnO as an active material in emerging technologies, aiming toward sustainable applications in microelectronics and renewable energy generation.

Keywords:

ZnO, Ultrasonic Spray Pyrolysis, Thin films, Piezoelectric properties, Mechanical energy

Reference:

J.R. Ramos-Serrano, S. Alcántara-Iniesta, M. Acosta-Osorno, M.E. Calixto, Growth of highly c-axis oriented ZnO thin films by spray pyrolysis for piezoelectric applications, *Materials Science in Semiconductor Processing* 138 (2022) 106324. <https://doi.org/10.1016/j.mssp.2021.106324>

Ris work was supported by:

Secretaría de ciencia, humanidades, tecnología e innovación



DEVELOPMENT AND INTEGRATION OF A SCHOTTKY-BASED PHOTODETECTOR WITH EMBEDDED MULTI-STACKED (In,Ga)As/InAs QUANTUM DOTS

Autores: Jesús Samuel González Sámano¹; Irving E. Cortes-Mestizo²

Coautores: Arely Puente Rivera ¹; JESUS ROLANDO PINSON ORTEGA ³; Marcos Ivan Bustos Ibarra ⁴; Maria Fernanda Mora Herrera ⁵; Victor Hugo Mendez Garcia ⁶; Leticia Ithsmel Espinosa Vega ⁷; Guadalupe del Carmen Yépez Barradas ¹; Ángel Iván Méndez García ⁷; Daniel Lopez Vilchis ⁶

¹ *Facultad de Ciencias, Universidad Autónoma de San Luis Potosí*

² *SECIHTI-UASLP*

³ *Center for the Innovation and Application of Science and technology, Universidad Autónoma de San Luis Potosí (UASLP), Av. Sierra Leona #550, Col. Lomas 2a Sección, 78210, San Luis Potosí, México.*

⁴ *CIACyT, UASLP*

⁵ *Facultad de Ciencias, Universidad Autonoma de San Luis Potosí.*

⁶ *Universidad Autonoma de San Luis Potosi*

⁷ *Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí*

Autor responsable de la comunicación: jesus1gos23@gmail.com

The detectivity limit of semiconductor photodetectors is determined by factors such as bandgap energy, generation-recombination mechanisms, and the intrinsic noise characteristics of the material. In photodetectors based on Schottky junctions or p-n structures, these properties introduce limitations in photon absorption, particularly in the infrared region. To extend spectral sensitivity and enhance photon-to-charge conversion efficiency (especially in the infrared range) advanced semiconductor nanostructures incorporating low-dimensional systems have been investigated [1]. For example, embedding quantum dots into photodetectors enables absorption of sub-bandgap photons, due to the formation of discrete energy levels within the nanostructures. In this work, two configurations of Schottky-junction photodetectors with self-assembled InAs quantum dots are explored. The heterostructures were grown by molecular beam epitaxy (MBE) on (100)-oriented p-type GaAs substrates. In Sample A (B), 10 periods of InAs quantum dots were deposited and capped with GaAs (InGaAs), followed by a 50 nm-thick p-type GaAs (InGaAs) layer. Front Schottky and rear ohmic contacts were defined via photolithography and deposited by physical vapor deposition (PVD) on the top and bottom surfaces, respectively. The photodetector assembly was completed using wire bonding and custom 3D-printed packaging. The device was integrated into a transimpedance amplifier circuit to convert photocurrent to voltage. Electrical characterization under illumination was performed via current-voltage (I-V) measurements. The results demonstrate that the device based on Sample A exhibits superior optoelectronic performance compared to the InGaAs-based configuration in Sample B.

Keywords:

photodetectors, nanostructures, semiconductors, heterostructures, Schottky junctions.

Reference:

Ezzedini et al. Nanoscale Research Letters (2017) <https://doi.org/10.1186/s11671-017-2218-2>

Ris work was supported by:

The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, and financial support from COPOCyT Fideicomiso 23871, SECIHTI CF-2023-I-1300, and Investigadoras e Investigadores por México.



GROWTH AND ANALYSIS OF MULTI-STACKED INAS QUANTUM DOTS using GaAs AND InGaAs AS MATRIX SEMICONDUCTOR LAYERS

Autores: Jesús Samuel González Sámano¹; Irving E. Cortes-Mestizo²

Coautores: Alexis Fernández Fernández ¹; Ángel Iván Méndez García ³; Arely Puente Rivera ¹; Daniel Lopez Vilchis ⁴; Guadalupe Yépez Barradas ¹; JESUS ROLANDO PINSON ORTEGA ⁵; Marcos Ivan Bustos Ibarra ⁶; Maria Fernanda Mora Herrera ⁷; Victor Hugo Mendez Garcia ⁴; Leticia Ithsmel Espinosa Vega ³

¹ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí

² SECIHTI-UASLP

³ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí

⁴ Universidad Autónoma de San Luis Potosí

⁵ Center for the Innovation and Application of Science and technology, Universidad Autónoma de San Luis Potosí (UASLP), Av. Sierra Leona #550, Col. Lomas 2a Sección, 78210, San Luis Potosí, México.

⁶ CIACyT, UASLP

⁷ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

Autor responsable de la comunicación: jesus1gos23@gmail.com

One alternative to enhance photon absorption at energies lower than the host semiconductor bandgap is the use of the intermediate band (IB) concept, implemented through quantum dots (QDs), thus avoiding complex tandem heterostructures. The quantized energy levels introduced by QDs extend the photon absorption range of the device, leading to improved energy conversion efficiency. However, implementing QDs in IB structures requires a high density of vertically stacked layers embedded in a semiconductor matrix. The performance of such systems typically degrades with an increasing number of QD layers due to strain accumulation caused by the lattice mismatch between the QDs and the surrounding matrix [1]. Excessive strain leads to dislocations and defects that degrade the optoelectronic properties and complicate the growth process. In this study, an epitaxial growth strategy is proposed to fabricate samples with ten periods of multi-stacked InAs QDs, addressing strain-induced limitations. The heterostructures were grown by molecular beam epitaxy (MBE) on (100)-oriented p-type GaAs substrates. In Sample A(B), ten InAs QD layers were deposited and capped with GaAs (InGaAs), followed by a 50 nm-thick p-type GaAs (InGaAs) layer. RHEED measurements were used to analyze QD nucleation in each layer. In Sample A(B), the critical thickness remained constant (decreased) as the number of periods increased. High-resolution X-ray diffraction (HRXRD) confirmed the crystalline quality and composition, with satellite peaks indicating the formation of a periodic stacked structure. Photoreflectance spectroscopy was employed to analyze the band structure, confirming the presence of discrete energy levels associated with the embedded quantum dots.

Keywords:

quantum dots, multi-stacked, heterostructures, molecular beam epitaxy, semiconductor.

Reference:

Kim, J.O., Sengupta, S., Barve, A.V., Sharma, Y.D., Adhikary, S., Lee, S.J., Noh, S.K., Allen, M.S., Allen, J.W., Chakrabarti, S., & Krishna, S. (2013). Multi-stack InAs/InGaAs Sub-monolayer Quantum Dots Infrared Photodetectors. *Applied Physics Letters*, 102, 011131. <https://doi.org/10.1063/1.4774383>

Ris work was supported by:

The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, and financial support from COPOCyT Fideicomiso 23871, SECIHTI CF-2023-I-1300, and Investigadoras e Investigadores por México.



NUMERICAL AND EXPERIMENTAL EVALUATION OF SEMICONDUCTING OXIDES AS ANTI-REFLECTIVE COATINGS FOR GaAs SOLAR CELLS

Autores: Arely Puente Rivera¹; Irving E. Cortes-Mestizo²

Coautores: Jesús Samuel González Sámano ¹; Ángel Iván Méndez García ³; Marcos Ivan Bustos Ibarra ⁴; Iván Alejandro Jasso Granja ; Maria Fernanda Mora Herrera ⁵; Victor Hugo Mendez Garcia ⁶; Leticia Ithsmel Espinosa Vega ³; Edgar López Luna ⁷; Edgar Briones ⁸

¹ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí

² SECIHTI-UASLP

³ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí

⁴ CIACYT, UASLP

⁵ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

⁶ Universidad Autónoma de San Luis Potosí

⁷ CIACYT-UASLP

⁸ Departamento de Matemáticas y física, Instituto Tecnológico y de Estudios Superiores de Occidente (ITESO), Universidad Jesuita de Guadalajara

Autor responsable de la comunicación: a358874@alumnos.uaslp.mx

One of the most challenging issues in the development of solar cells is the reduction of both electrical and optical losses. The reflection of incident light in photovoltaic systems is undesirable because it decreases their conversion efficiency. Reflected light does not contribute to the generation of hole-electron pairs, with blue wavelengths being particularly unexploited. In a GaAs-based solar cell, the spectral range from 420 to 480 nm exhibits a reflectivity value around 0.5, meaning that half of these photons are not absorbed. Nevertheless, these photons have enough energy to excite carriers from the valence band to the conduction band, representing a significant source of electrical current generation. Recently, the use of transparent oxides to create anti-reflective coatings (ARC) has been explored, as they do not absorb visible light and their thickness can be designed to reduce reflectivity at specific wavelengths [1]. In this study, nanolayers of In_2O_3 , HfO_2 , Ga_2O_3 , and TiO_2 semiconducting oxides were employed as ARC on p-i-n GaAs solar cells. First, technology computer-aided design (TCAD) was used to simulate and design the ARC system. The numerical study indicated that, for the wavelength range under study, reflectivity could be reduced to less than 0.05 with a 54 nm-thick ARC, resulting in a 40% increase in short-circuit current density. To compare the numerical results with real devices, the solar cells and ARC system were fabricated. The p-i-n GaAs solar cells were grown by molecular beam epitaxy (MBE) on (100)-oriented substrates. For current-voltage characterization, ohmic contacts were made using indium (n-type front surface) and silver (p-type bottom side), both deposited by physical vapor deposition (PVD). Next, the 54 nm-thick In_2O_3 ARC was deposited by atomic layer deposition (ALD). Light measurements were performed using an AM1.5 solar simulator at 450 W/m^2 . Reflectance and photoreflectance confirmed the reduction in blue-range reflectivity, validating the designed ARC. This work shows a strategy that combines MBE, ALD, and simulation to reduce optical losses in III-V solar cells.

Keywords:

Semiconducting Oxides, Antireflective, III-V Solar Cells, TCAD Simulation, ALD-MBE growth.

Reference:

Hala J. El-Khozondar, Rifa J. El-Khozondar, Rafat Al Afif, Christoph Pfeifer, Modified solar cells with antireflection coatings, International Journal of Thermofluids, Volume 11, 2021, 100103, ISSN 2666-2027, <https://doi.org/10.1016/j.ijft>

Ris work was supported by:

The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, and financial support from COPOCYT Fideicomiso 23871, SECIHTI CF-2023-I-1300, Fondo DGA-ITESO 2024 and Investigadoras e Investigadores por México.



SEMICONDUCTORS / 151

EXPLORATION OF InAs QD NUCLEATION ON III-N-V SEMICONDUCTORS MATERIALS FOR STRAIN BALANCE APPLICATIONS

Autores: Irving E. Cortes-Mestizo¹; Ángel Iván Méndez García²

Coautores: Arely Puente Rivera³; Daniel Lopez Vilchis⁴; Guadalupe del Carmen Yépez Barradas³; JESUS ROLANDO PINSON ORTEGA⁵; Jesús Samuel González Sámano³; Leticia Ithsmel Espinosa Vega²; Marcos Ivan Bustos Ibarra⁶; Maria Fernanda Mora Herrera⁷; Victor Hugo Mendez Garcia⁴

¹ SECIHTI-UASLP

² Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí

³ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí

⁴ Universidad Autónoma de San Luis Potosí

⁵ Center for the Innovation and Application of Science and technology, Universidad Autónoma de San Luis Potosí (UASLP), Av. Sierra Leona #550, Col. Lomas 2a Sección, 78210, San Luis Potosí, México.

⁶ CIACYT, UASLP

⁷ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

Autor responsable de la comunicación: a299810@alumnos.uaslp.mx

Unlike conventional silicon-based solar cells, III-N-V materials such as GaAs, GaNAs, and InAs exhibit outstanding properties for photovoltaic applications, including higher absorption coefficients, precise bandgap tunability, and enhanced conversion efficiencies under concentrated illumination.

However, the high cost and growth complexity of these materials limit their commercial deployment. This has raised interest in advanced structures such as quantum dots (QDs), which enhance device performance by extending the spectral response, increasing absorption, and improving efficiency [1]. In this study, the strain balance method is explored for the growth of InAs QDs on GaNAs layers. The objective was to assess the growth behavior under low arsenic flux conditions and evaluate the feasibility of achieving high-quality nucleation on GaNAs. Structural simulations were carried out using the NextNano software prior to fabrication, enabling optimization of the system under strain-balanced conditions. The simulations indicated that increasing the GaNAs layer thickness results in proportionally thicker QDs, maintaining strain balance in the heterostructure. The QDs were grown using molecular beam epitaxy (MBE) with reduced arsenic flux, allowing the formation of exposed quantum dots without encapsulation and thus facilitating surface characterization. During growth, reflection high-energy electron diffraction (RHEED) was employed to monitor the evolution of surface morphology in real-time. Analysis of RHEED intensity patterns confirmed the successful nucleation of InAs QDs under strain-balanced conditions, demonstrating the viability of this approach for implementing multi-stacked QD architectures in future device fabrication.

Keywords:

Strain-balance, Quantum Dots, Molecular Beam Epitaxy, III-N-V Semiconductors, Photovoltaic Devices.

Reference:

Kim, M. R., & Ma, D. (2015). Quantum-dot-based solar cells: recent advances, strategies, and challenges. The journal of physical chemistry letters, 6(1), 85-99.

Ris work was supported by:

The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, and financial support from COPoCyT Fideicomiso 23871, SECIHTI CF-2023-I-1300, and Investigadoras e Investigadores por México.



APPLICATION OF STRAIN MINIMIZATION METHOD FOR THE DESIGN OF 1D III-V PHOTOVOLTAIC HETEROSTRUCTURES

Autores: Marcos Ivan Bustos Ibarra¹; Irving E. Cortes-Mestizo²

Coautores: Alexis Fernández Fernández³; Ángel Iván Méndez García⁴; Arely Puente Rivera³; Daniel Lopez Vilchis⁵; Guadalupe del Carmen Yépez Barradas³; JESUS ROLANDO PINSON ORTEGA⁶; Jesús Samuel Sámano González⁷; Maria Fernanda Mora Herrera⁷; Victor Hugo Mendez Garcia⁵; Leticia Ithsmel Espinosa Vega⁴

¹ CIACyT, UASLP

² SECIHTI-UASLP

³ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí

⁴ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí

⁵ Universidad Autónoma de San Luis Potosí

⁶ Center for the Innovation and Application of Science and technology, Universidad Autónoma de San Luis Potosí (UASLP), Av. Sierra Leona #550, Col. Lomas 2a Sección, 78210, San Luis Potosí, México.

⁷ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

Autor responsable de la comunicación: marbus_01@outlook.com

The Sun offers an immense, clean, and renewable energy source, making the development of technologies to harness it essential for the global energy transition. Since the discovery of the photovoltaic effect, significant efforts have been made to convert sunlight into electricity efficiently. However, one of the main challenges in thin-film solar cells remains overcoming the Shockley–Queisser efficiency limit. The use of low-dimensional systems in short-period superlattices (SPSLs) to enhance carrier generation via intermediate bands represents a promising strategy to improve the conversion efficiency of solar cells. Nevertheless, the synthesis of SPSLs presents considerable challenges due to lattice mismatch between constituent materials, leading to strain accumulation. In this work, the two-dimensional elastic energy minimization framework in Nextnano is employed to analyses and design 1D-based III-V SPSLs heterostructures. A GaAs (311)A substrate is considered. Quantum wires (QWi) composed of (a) InAs, (b) InGaAs, and (c) AlAs with diameters of 3.3 nm and 2.1 nm, respectively are analyzed [1]. A short period superlattice (SPSL) consisting of 10 periods of quantum wires embedded in a GaAs matrix is evaluated. This analysis provides detailed information on the strain distribution throughout the heterostructure, including evaluations of hydrostatic in-plane, and out-of-plane components. The influence of mechanical stress on the band structure and eigenvalues of the one-dimensional nanostructures is also assessed. Notably, the strain-induced alterations lead to modifications in the quantized energy levels, thereby shifting the absorption spectrum of the system. The results of this numerical analysis yielded valuable insights that support the advancement of solar cells based on one-dimensional SLSP systems, particularly by enabling the formation of intermediate energy bands to enhance photovoltaic efficiency.

Keywords:

Quantum wires, SPSLs, Solar cell, Nextnano

Reference:

Wen, H., Wang, Z. M., & Salamo, G. J. (2004). Atom-resolved scanning tunneling microscopy of (In,Ga)As quantum wires on GaAs(311)A. *Applied Physics Letters*, 84(10), 1756-1758. <https://doi.org/10.1063/1.1664018>

Ris work was supported by:

The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, and financial support from COPOCyT Fideicomiso 23871, SECIHTI CF-2023-I-1300, and Investigadoras e Investigadores por México.



ANALYSIS OF PHOTOVOLTAIC PROPERTIES IN III-V QUANTUM WIRE SHORT- PERIOD SUPERLATTICE SOLAR CELLS USING SILVACO ATLAS

Autores: Marcos Ivan Bustos Ibarra¹; Irving E. Cortes-Mestizo²

Coautores: Alexis Fernández Fernández ³; Ángel Iván Méndez García ⁴; Arely Puente Rivera ³; Guadalupe del Carmen Yépez Barradas ³; Daniel Lopez Vilchis ⁵; JESUS ROLANDO PINSON ORTEGA ⁶; Jesús Samuel Sámano González ⁷; Leticia Ithsmel Espinosa Vega ⁴; Maria Fernanda Mora Herrera ⁷; Victor Hugo Mendez Garcia ⁵

¹ CIACyT, UASLP

² SECIHTI-UASLP

³ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí

⁴ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí

⁵ Universidad Autonoma de San Luis Potosi

⁶ Center for the Innovation and Application of Science and technology, Universidad Autónoma de San Luis Potosí (UASLP), Av. Sierra Leona #550, Col. Lomas 2a Sección, 78210, San Luis Potosí, México.

⁷ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

Autor responsable de la comunicación: marbus_01@outlook.com

A short-period superlattice (SPSL) is composed of a periodic arrangement of ultra-thin layers, typically ranging from 2 to 10 monolayers. SPSLs offer several advantages when they are integrated into solar cells such as enhanced light absorption, improved carrier mobility, and greater electronic control. However, achieving SPSLs with optical and electrical properties suitable for efficient photovoltaic performance remains an ongoing research challenge. In this study, we numerically investigate an SPSL structure consisting of 10 vertically stacked periods of quantum wires embedded within a GaAs-based solar cell. The numerical model was first developed by solving the one-dimensional Schrödinger equation to determine the eigenstate energies associated with quantum confinement in the quantum wires. Once the eigenvalues along the nanostructure were obtained, a photogeneration model was implemented to simulate the carrier generation process. Additionally, a drift-diffusion Poisson model was integrated to evaluate the charge transport properties of the structures under study. Finally, IV and EQE curves are determined [1]. The results indicate that integrating a quantum wire SPSL enhances the spectral response in the near-infrared region, while also altering the internal electric field and carrier recombination dynamics. This study demonstrates the promise of quantum wire superlattice engineering as an effective strategy for performance enhancement in III-V solar cells and establishes a simulation-based framework to guide future experimental realizations.

Keywords:

Quantum wires, SPSLs, Solar cell, Silvaco ATLAS

Reference:

Hebali, M., Bennaoum, M., Azzeddine, H. A., Ibari, B., Benzohra, M., & Chalabi, D. (2020). Characteristics and Electrical Parameters of Silicon Nanowires (SiNWs) Solar Nanocells. Journal Of Nano- And Electronic Physics, 12(6), 06033-06034. [https://doi.org/10.21272/jnep.12\(6\).06033](https://doi.org/10.21272/jnep.12(6).06033)

Ris work was supported by:

The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, and financial support from COPOCyT Fideicomiso 23871, SECIHTI CF-2023-I-1300, and Investigadoras e Investigadores por México.



MNS/CDS DEPOSITED BY SILAR FOR APPLICATION IN AN ULTRAVIOLET SENSOR

Autores: Antonio Del Rio De Santiago¹; Estefania castañeda alonso²; Héctor A Guerrero-Osuna²; Leticia Perez-Arrieta²; Rocio Garcia Rocha^{None}; Jesus Octavio Sígala Valdez²

¹ *Posgrado en Ingeniería y Tecnología Aplicada, Universidad Autónoma de Zacatecas. Ramón López Velarde 801. C.P. 98000, Zacatecas, Zac., México.*

² *universidad Autonoma de Zacatecas*

This work presents the synthesis and characterization of an ultraviolet (UV) sensor based on a type- II MnS/CdS heterojunction deposited on an ITO (Indium Tin Oxide) transparent conductive oxide (TCO) substrate using the Successive Ionic Layer Adsorption and Reaction (SILAR) method. The fabrication process involved depositing thin films by maintaining a constant number of MnS deposition cycles. Subsequently, CdS layers were deposited with varying numbers of cycles: 45, 55, and 65. The device was structured in a superstrate configuration, which facilitates favorable band alignment between MnS and CdS. This alignment enhances the separation and transport of photoinduced charge carriers, thereby improving the device's photoelectric response under UV light exposure. The formation of the MnS/CdS heterojunction significantly contributes to the generation of free carriers when illuminated with ultraviolet radiation. The synthesized thin films were characterized using various techniques, including UV-visible spectroscopy to examine their optical properties, scanning electron microscopy (SEM) to analyze surface morphology, and the Kelvin probe method to assess their electrical properties. Under UV illumination, electrical measurements indicated a substantial increase in photocurrent, representing improved charge generation and transport due to the heterojunction structure. These results demonstrate that the MnS/CdS heterostructure functions effectively within the UV light spectrum range. Its fabrication process is relatively simple and cost-effective, making it an attractive option for developing next-generation optoelectronic devices. This study emphasizes the potential of integrating MnS/CdS heterojunctions into UV-sensitive systems, suggesting promising applications in environmental monitoring, wearable sensors, and other optoelectronic technologies that require UV detection.

Keywords:

Heterojunction, ultraviolet light, SILAR

Reference:

B.R Sankapal, R.S Mane, C.D Lokhande,
Deposition of CdS thin films by the successive ionic layer adsorption and reaction (SILAR) method, Materials Research Bulletin,
Volume 35, Issue 2,
2000,
Pages 177-184,
ISSN 0025-5408,
[https://doi.org/10.1016/S0025-5408\(00\)00210-5](https://doi.org/10.1016/S0025-5408(00)00210-5).

Ris work was supported by:

Universidad Autonoma de Zacatecas



FORBIDDEN ENERGY GAP DETERMINATION BY PHOTOACOUSTIC SPECTROSCOPY IN N-TYPE POROUS SILICON: POROSITY PERCENTAGE DEPENDENCE

Autores: A Rojas Marroquin¹; Brece Soto Hernández²; Cesar Mora Ley¹; JESUS CLAUDIO SANCHEZ NAJERA²; José Antonio Calderón Arenas¹; L Luviano³; M Aguilar Frutis¹; Rubén Sánchez Sánchez¹; Uriel Nogal Luis¹

¹ *CICATA LEGARIA IPN*

² *CECYT 2 IPN*

³ *Universidad Tecnológica Fidel Velázquez*

Autores responsables de la comunicación: brucee.soto@gmail.com, jsanchezn@ipn.mx

An analysis of photoacoustic spectroscopy spectra in n-type porous silicon samples has been conducted to determine the effect of porosity percentage on their energy gap. Porous silicon (PS) samples were prepared through electrochemical anodization for durations of 5, 10, 15, 20, and 30 minutes. A crystalline silicon (CS) wafer, oriented in the (100) direction, was used. This wafer was phosphorus-doped, n-type, with a thickness of $500 \pm 15 \mu\text{m}$ and a resistivity of $1\text{-}5 \Omega\text{cm}$. A constant current density of 40 mA/cm^2 and a 40% hydrofluoric acid (HF) solution were employed in all cases. For measuring the photoacoustic spectra, we used a photoacoustic spectroscopy system consisting of a tungsten lamp (Spectra-Physics 66921) with a power output of 700 W. The lamp emits continuous light, which passes through an optical system that focuses the beam at the entrance of a monochromator (Spectra-Physics 74000). The emerging monochromatic light is then modulated in intensity using a mechanical chopper (Oriel 75159) at a selected frequency. The modulated monochromatic light is collected by an optical quartz fiber and focused onto the photoacoustic cell. Measurements were taken in the wavelength range from 250 to 800 nm. Energy gap values were obtained from the photoacoustic spectra using the Tauc plot method. In each sample, porosity was determined by gravimetry, and the thickness of the porous layer was measured with electron microscopy. The percentage of porosity changes significantly with anodization time, showing an approximately linear increase as a function of the thickness fraction of the porous layer. The energy gap increases with the porosity percentage, which indicates the quantum confinement effect of charge carriers.

Keywords:

Porous silicon; photoacoustic spectroscopy; Tauc plot method.

Reference:

Nogal, U., (Master Thesis) Estudio de las Propiedades Ópticas y Térmicas en Silicio Poroso Elaborado Mediante Ataque Electroquímico, México, (2012). M. J. Sailor, 2011. Porous Silicon in Practice: Preparation, Characterization and Applications, Wiley Vch Verlag GmbH

Ris work was supported by:

Secretaría de Investigación y Posgrado del Instituto Politécnico Nacional (IPN), México; Comisión de Fomento de Actividades Académicas del IPN, México; Secretaría de Ciencia, Humanidades, Tecnología e Innovación, México.



IMPROVING OF THE ELECTRICAL AND OPTICAL PROPERTIES OF ZnO FILMS DOPING WITH FLUOR

Autor: Xochitl Aleyda Morán Martínez¹

Coautores: José Alberto Luna López ¹; Zaira Jocelyn Hernández Simon ¹; Gabriel Omar Mendoza Conde ¹; José Alvaro David Hernández de la Luz ¹; Antonio Coyopotl Solis ¹

¹ Benemérita Universidad Autónoma de Puebla

Autores responsables de la comunicación: col538335@colaborador.buap.mx, jose.luna@correo.buap.mx

Zinc oxide is widely used as TCO in the fabrication of optoelectronic devices. The optoelectronic properties of zinc oxide can be improved by means of the doping process. The fluorine has been reported to be excellent as doping for zinc oxide. The electrical and optical properties can be changed varying the fluorine doping concentration. In this work, zinc oxide thin films doped and undoped were deposited by spray pyrolysis on glass substrate and silicon type n. The fluorine doping concentration was % v/v=0.48, the films were obtained for a deposit time of 2, 4 and 6 minutes. The improvement of the transmittance was verified by UV-Vis in the doping films, the bandgap obtained was from 2.98-3 eV. By profilometry, the thickness of the films was obtained from 70-170 nm. The PL spectrums revealed a large increase in intensity with respect to undoped ZnO film. The FTIR results show the main absorption band for Zn-O ($450-510\text{ cm}^{-1}$) for undoped and doped, as well as the Zn-F (418 cm^{-1}) for doped films. The electrical characterization was by Hall Effect, the bulk concentration, mobility and resistivity were obtained. The bulk concentration was from 10^{13} to 10^{19} for undoped and doped films, respectively. Also, the mobility is greater doped films deposited to 2 and 4 minutes with respect to undoped films. The electrical effect of the doping was observed with a low resistivity ($6.13\text{ }\Omega\cdot\text{cm}$) for doped film against ($6.10\times 10^4\text{ }\Omega\cdot\text{cm}$) for undoped zinc oxide film. The I-V characterization exhibited a change on the conductance (slope) in the doped films; this result confirms the improvement of the electrical properties.

Keywords:

zinc oxide, doped with fluorine, spray pyrolysis, low resistivity, transmittance

Reference:

Yakuphanoglu, F., Caglar, Y., Ilcan, S., & Caglar, M. (2007). The effects of fluorine on the structural, surface morphology and optical properties of ZnO thin films. *Physica. B, Condensed Matter*, 394(1), 86–92. <https://doi.org/10.1016/j.physb.2007.02.014>.

Ris work was supported by:

SECIHTI BASIC SCIENCE G-952-2025 and VIEP PROJECT-518-2025



STRUCTURAL AND MORPHOLOGICAL CHARACTERIZATION OF INDIUM SELENIDE SYNTHESIZED VIA MECHANICAL ALLOYING IN A COMMERCIAL MILL

Autor: Josue Fernando Teoyotl Sosa¹

Coautores: José Álvaro David Hernández de la Luz ¹; Osvaldo López Hernández ¹; Gabriel Juárez Díaz ¹; Primavera López Salazar ¹

¹ Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: josue.teoyotls@alumno.buap.mx

Recently, metal chalcogenide semiconductors have shown high efficiency as thermoelectric materials. Among them, indium selenide (In_2Se_3) is notable for its structural complexity, featuring coexisting phases, with the α - and β - In_2Se_3 phases being stable layered crystalline structures at room temperature. For thermoelectric applications, obtaining bulk or powder forms is crucial. Mechanical alloying offers a cost-effective method to synthesize uniform nanoscale powders. This study aimed to identify the optimal synthesis conditions for In_2Se_3 by varying milling time while maintaining a 10:1 ball-to-powder ratio. We synthesized the material from indium beads and selenium powders in an argon-filled glove box, ensuring In_2Se_3 stoichiometry. After pre-milling in an onyx mortar, the powder was mechanically alloyed in a commercial Spectromill, with samples collected at 30, 60, and 90 minutes. Samples were characterized using X-ray diffraction (XRD), and the 1-hour sample underwent scanning electron microscopy (SEM) analysis. At 0.5 hours of milling, XRD revealed characteristic peaks of the β - In_2Se_3 phase (rhombohedral), alongside a peak for tetragonal indium around 32.8° . However, after 1 and 1.5 hours of milling, only the β - In_2Se_3 phase was present in the diffractograms, indicating complete reaction. SEM images (500x) showed particles up to 50 microns. At higher magnifications (2000x and 5000x), agglomerates of particles ranging from a few hundred nanometers to 5 microns were observed. Our results conclude that 1 hour is the optimal milling time for synthesizing In_2Se_3 using the commercial Spectromill.

Keywords:

Indium selenide, XRD, SEM, Mechanical Alloying, Comercial Mill

Reference:

O. López, M. et al. "Synthesis of indium selenide (In_2Se_3) by prior mechanical pulverization and mechanical alloying for thermoelectric applications" *Mater Res Express*, 4, (2017), doi: 10.1088/2053-1591/aa5ecb

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECIHTI) by doctoral fellowship 1025239.



OPTICAL PROPERTIES OF LOW-THICKNESS SILICON OXYCARBIDE (SiC_xO_y) FILMS PRODUCED USING THE HORIZONTAL HFCVD DEPOSITION TECHNIQUE.

Autor: Imelda Antonia Pedraza Chan^{None}

Coautores: Antonio Coyopol Solís ¹; Alfredo Morales Sánchez ²; Godofredo García Salgado ¹; Miguel Gracia y Jimenéz ³; Crisóforo Morales-Ruíz ¹; Román Romano Trujillo ¹; Enrique Rosendo Andrés ¹

¹ CIDS-Benemérita Universidad Autónoma de Puebla

² Instituto Nacional de Astrofísica, Óptica y Electrónica (INAOE)

³ BUAP-IFUAP

Autores responsables de la comunicación: antonio.coyopol@correo.buap.mx, imelda.pedraza@alumno.buap.mx

Silicon oxycarbide (SiC_xO_y) materials have been extensively studied, owing to their compatibility with technologies currently used in the Si semiconductor industry, as low-k dielectrics, passivation layers, and etch-stop layers [1]. This paper reports on the synthesis of low-thickness silicon oxycarbide (SiC_xO_y) films using the hot-filament chemical vapor deposition (HFCVD) technique. A two-stage methodology was used to reduce the thickness of the silicon oxycarbide films from micrometric to nanometric scales. This methodology consists of a thermal pretreatment of the substrate at around 450°C, where the filament operates below 2000°C, followed by a controlled increase in the filament current from 1 to 2 amps to promote adhesion and growth of the deposit. Where the other parameters were fixed, setting the source-filament distance parameters at 2 mm. The thickness of the films was reduced from microns to nanometers, as determined by profilometry. According to Fourier transform infrared spectroscopy (FTIR), the characteristic vibrational modes of Si-O-Si and Si-C, Si-CH₃ are observed. On the other hand, photoluminescence was performed and its response in the visible spectrum was observed mainly in the green-blue or from 3.06 eV at 2.47 eV. According to the photoluminescence (PL) results, it is positioned in the visible range, attributable to its amorphous structure and the formation of defects associated with oxygen vacancies (NOVs) and ODC I and II). Subsequently, it was implemented in the Metal-Insulator-Semiconductor (MIS) structure using an ITO layer as the top contact and aluminum (Al) as the bottom contact. Its current-voltage (I-V) curves and formation mechanisms were evaluated.

Keywords:

HFCVD, Silicon Oxycarbide

Ris work was supported by:

Beca nacional de estudio de Posgrado

Reference:

[1] Ford, B.; Tabassum, N.; Nikas, V.; Gallis, S. Strong Photoluminescence Enhancement of Silicon Oxycarbide through Defect Engineering. *Materials* 2017, 10, 446. <https://doi.org/10.3390/ma10040446>



INVESTIGATION OF THE STRUCTURE AND SURFACE BAND BENDING OF Si-DOPED GaNAs GROWN BY MBE

Autores: Alexis Fernández Fernández¹; Victor Hugo Mendez García²

Coautores: Alfredo Belio Manzano ³; Leticia Ithsmel Espinosa Vega ³; María Fernanda Mora Herrera ³; Daniel López Vilchis ³; Irving E. Cortes-Mestizo ⁴; Cristo Manuel Yee Rendon ⁵; Héctor Félix-Quintero ⁶

¹ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

² Universidad Autónoma de San Luis Potosí

³ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología, Universidad Autónoma de San Luis Potosí

⁴ SECIHTI-UASLP

⁵ Universidad Autónoma de Sinaloa

⁶ Facultad de Ciencias Físico-Matemáticas, Universidad Autónoma de Sinaloa

Autor responsable de la comunicación: a340076@alumnos.uaslp.mx

Doping GaNAs offers unique advantages over GaAs, particularly for infrared optoelectronic applications. One key benefit is the ability to extend the emission wavelength into the near-infrared region without resorting to more complex ternary or quaternary compounds. By incorporating nitrogen, GaNAs enables longer wavelength operation (typically in the 1.0 to 1.3 μm range) making it highly suitable for fiberoptic communication and multijunction solar cells. This capability surpasses the intrinsic bandgap limitations of GaAs while maintaining lattice compatibility. Moreover, nitrogen incorporation introduces localized states that enhance carrier capture and confinement. When appropriately doped, GaNAs exhibits improved efficiency in quantum wells (QWs) and quantum dots (QDs) due to reduced carrier leakage and stronger spatial localization. Doping GaNAs also plays a significant role in controlling surface band bending. The strong perturbation of the conduction band due to nitrogen increases the sensitivity of internal electric fields to doping profiles. This enables precise engineering of surface fields, which is crucial for ultrafast carrier separation and acceleration. In this work, with the aim to modify the surface band bending we explore the delta doping of GaNAs with silicon. The samples were characterized by Raman, ellipsometry and photoreflectance spectroscopies (PR). PR showed 3 distinctive features associated with the E-, E- $+\Delta_0$ and E+ transitions when using the 405nm modulation laser source. For doped samples E- $\approx$ 1.22 and E+ $\approx$ 1.87 eV, indicating that %N=1.4%. After annealing (RTA) the transitions were clearly highlighted, indicative of a notorious increase on quality. The E₀ GaAs bandgap transition appear when modulating with the 635nm modulation wavelength, and close to this region Franz-Keldysh oscillations were observed after annealing, whose origin consequently can be assigned to deeper interfaces far from the Si-doped region. Finally, the lattice disorder and strain were evaluated by Raman spectroscopy. It is found that the RTA conducts to partially relief the stress.

Keywords:

Molecular Beam Epitaxy, doping, RTA, surface band bending.

Ris work was supported by:

The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, SECIHTI CF-2023-I-1300, COPOCyT Fideicomiso 23871, and Investigadoras e Investigadores por Mexico



INTEGRATED TEMPERATURE SENSOR: DESIGN AND AUTOMATION

Autores: Haydee Patricia Martínez Hernández¹; Manolo Mazariegos Buenrostro¹; Raúl Cortéz Maldonado¹

Coautores: Jorge Rogelio Alva Castillo ¹; Luis Angel Macias Rodriguez ¹; Uriel Josafat Vega Sánchez ¹; Victor Hugo Rodriguez Gonzáles ¹; Zuriel Demián Montiel Flores ¹

¹ *Instituto Tecnológico de Apizaco*

Autores responsables de la comunicación: haydee.mh@apizaco.tecnm.mx, mmazariegosbuenrostro@gmail.com, raul.cm@apizaco.tecnm.mx

The design of microchips for temperature sensing has become essential in industrial, medical, and research fields, where high precision and miniaturization are increasingly in demand. This work presents the development of a six-pad temperature sensor microchip, created using a fully digital and open-source workflow based on KLayout and KiCad, with automation integrated through Python macros.

The main objective was to demonstrate how combining open-source tools with programming can accelerate and improve the design process for integrated circuits, enabling efficient generation of complex and repetitive layouts. The methodology involved schematic creation and pad arrangement in KiCad, followed by physical layout implementation in KLayout. Python scripts were used to automate the creation of geometric structures and electrical connections, minimizing errors and significantly reducing development time.

The result is a compact and functional sensor whose structure and connectivity meet industry standards and can be easily adapted to new applications. Automation allowed for rapid design iterations, making real-time adjustments and optimizations possible.

This approach not only lowers the entry barrier for microchip design but also encourages innovation, interdisciplinary collaboration, and hands-on learning within the academic and professional community.

Keywords:

Temperature, sensor, microchip, RTD, KLayout, KiCad, Python, sensor, layout, chip.

Reference:

Lee, S.-Y., Kim, J.-D., Kim, Y.-S., Song, H.-J., & Park, C.-Y. (2023). Direct fabrication of a copper RTD over a ceramic coated stainless steel tube by combination of magnetron sputtering and sol-gel techniques. *Sensors*, 23(12), 5442-5452. <https://doi.org/10.3390/sensors23125442> cryogenicsociety-archive.org+13mdpi.com+13mdpi.com+

His work was supported by:

Y. Jiménez Flores, M. Balvanera Ortuño López, J.J. Alcantar Peña, I. Chávez Urbiola y R. Sánchez Fraga, Sesión Informativa –Multiproyecto para la Microfabricación de Chips TecNM, CIDESI –TecNM Instituto Tecnológico de Querétaro, marzo 2025.
<https://drive.google.com/drive/folders/13zWNnG8RH49cQnNcEkvRh496RkB9WTwF>



SENSOR DESIGN AND SIMULATION IN KLAYOUT

Autores: Carlos Bueno Avendaño¹; Raquel Ramírez Amador²; Valeria Juarez Granados²

Coautores: Bryan Israel Baez Flores²; Diego Raul Cuatecontzi Xelano²; Juan Felipe Rodriguez Velasco²

¹ INSTITUTO TECNOLÓGICO DE APIZACO

² Tecnológico Nacional de México/Instituto Tecnológico de Apizaco

Autores responsables de la comunicación: carlos.ba@apizaco.tecnm.mx, raque1577@yahoo.com.mx, valeriaj-gra@gmail.com

Klayout is a tool for designing and editing circuits, specifically in layers, since its main function lies in the detailed manipulation of logical layers, polygons, boxes, paths, and hierarchical cells, which allow us to represent the different materials and components of the circuit (in this case, sensors). Therefore, four types of sensors were developed:

- For the RTD (Resistance Temperature Detector): Klayout was used to draw resistive paths on metallic layers, simulating materials such as nickel. Using tools such as “boxes” or “instance,” precise trajectories were defined to control thermal resistance variations.
- In the design of the EMG sensor, fine contact paths and defined pads on certain layers were used.
- The gas detector benefited from multilayer modeling in KLayout, where exposed regions for contact with the environment were designed using materials sensitive to changes in conductivity.
- For the ammonia detector, the geometric precision offered by KLayout allowed us to efficiently define cavities and electrodes tailored to the specific materials that react with this gas.

For each sensor, the specified layers were used, as well as the tools provided by CIDESE technology, since KLayout not only allowed us to design but also geometrically validate each design according to the specifications provided.

Reference:

Dandl, K., Tóth, K., & Bitzenbauer, P. (2024). From simulation to experiment: Using KiCad to design electric circuits in the physics classroom. *Eurasia Journal of Mathematics, Science and Technology Education*, 20(10), em2510.

Ris work was supported by:

TECNM/ ITApizaco

Keywords:

Sensors kia, RTD, simulation, Klayout



CHARACTERIZATION OF MAPbI₃ PEROVSKITE POWDERS OBTAINED BY MECHANICAL MILLING

Autor: Javier Arturo Reyes Azcarate¹

Coautores: 1 Marisol Hernández ²; 2 Abraham Pacio ³; 3 Luis Alberto Ocampo Hernández ⁴; 4 Mauricio Pacio ²; 5 Avelino Cortés ²

¹ Centro de Investigaciones en Dispositivos Semiconductores, Benemérita Universidad Autónoma de Puebla

² Center for Research in Semiconductor Devices, Benemérita Universidad Autónoma de Puebla

³ Division of Basic Sciences and Engineering, Universidad Autónoma Metropolitana-Azcapotzalco

⁴ Faculty of Electronics Sciences, Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: ra224570627@alm.buap.mx

Perovskite is a material that has gained popularity due to its ability to be used in the fabrication of various devices, such as LEDs, solar cells, sensors, and others. Consequently, there has been a growing need to synthesize perovskite without using solvents, as they are widely applied in nearly all traditional perovskite sintering processes. A promising alternative is the mechanosynthesis fabrication method, which allows the production of materials with good phase purity [1]. In this work, MAPbI₃ perovskite was synthesized using a 1:1 molar ratio of MAI and PbI₂ at 1 mmol. The entire grinding process was carried out at room temperature and under ambient conditions. X-ray diffraction (XRD) analysis confirmed that the MAPbI₃ perovskite crystallized in the tetragonal phase, and some secondary phases corresponding to PbI₂ were also detected. The crystallite size was estimated using the Debye-Scherrer equation. Ultraviolet-visible (UV-Vis) spectroscopy revealed an optical band gap of approximately 1.48 eV, which is consistent with the reported values for MAPbI₃. Minimal defects were detected, and the synthesized powder exhibited good optical quality. This study demonstrated that mechanosynthesis is a suitable and effective route for solvent-free synthesis of MAPbI₃ perovskite, achieving good phase purity and desirable material quality as confirmed by the characterization techniques used.

Keywords:

Mechanosynthesis, phase, band, stoichiometry, and milling

Reference:

[1] M. Pal, P. Singh, and R. Bharti, Mechanosynthesis of the hybrid perovskite CH₃NH₃PbI₃, Mater. Chem. Phys. 239 (2020) 122007. <https://doi.org/10.1016/j.matchemphys.2019.122007>

Ris work was supported by:

VIEP-BUAP Projects



InAs QUANTUM DOTS SUPERLATTICES EMBEDDED IN ASYMMETRIC BARRIERS AlGaAs/GaAs GROWN BY MBE

Autores: Daniel López Vilchis¹; Leticia Ithsmel Espinosa Vega²

Coautores: Maria Fernanda Mora Herrera ³; Guadalupe del Carmen Yepez Barradas ⁴; Jesús Samuel Sámano González ⁵; Arely Puente Rivera ⁶; David Vazquez Cortes ⁷; Angel Rodriguez ¹; Irving Eduardo Cortes Mestizo ⁸; Victor Hugo Mendez Garcia ¹

¹ Universidad Autónoma de San Luis Potosí

² Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí

³ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

⁴ Universidad Autónoma de San Luis Potosí

⁵ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

⁶ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí

⁷ Mechanics and Materials Unit, Okinawa Institute of Science and Technology Graduate University (OIST)

⁸ ciacyt Uaslp

Autor responsable de la comunicación: a322730@alumnos.uaslp.mx

Quantum semiconductor materials have become the cornerstone for the development of next-generation quantum technologies with applications ranging from photonics, encryption and computing up to biotechnology and medicine thanks to their enhanced optical properties, allowing scientists to tailor absorption, reflection and transmission in a wide range of the UV-Vis-NIR spectra. Devices bearing these properties such as inter-band solar cells and high energetic lasers have proven advantageous due to the formation of discrete energy subbands. For the successful integration of QDs in such devices the multilayered growth or stacking must be studied, and so their encapsulation. The use of ternary alloys for capping affects directly energy subbands and quantum states and so contributes to carrier confinement and optical response at high energy levels. In previous works our research has focused on tailoring the morphological aspects of quantum dots while encapsulating them in asymmetric barriers to prevent parasite effects due to composition and randomization of quantum dot size and shape. In this work, we present with the aid of characterization techniques the analysis of multistacked AlGaAs/InAs/GaAs heterostructure, known as QDs superlattices. The samples were grown by molecular beam epitaxy (MBE), in contrast to previous research groups developing lasers emitting at the 980nm range our samples are embedded in a highly containing aluminum barrier up to $x=0.8$ efficient in protecting the quantum dots size and protecting the nanostructures from intermixing effects.

Corresponding Author: Leticia Ithsmel Espinosa Vega leticia.espinosa@uaslp.mx

Keywords:

Quantum Dots, nanostructures, III-V Materials, Superlattices.

Ris work was supported by:

This work was supported by: The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, and financial support from COPOCYT Fideicomiso 23871, SECIHTI CF-2023-I-1300, and Investigadoras e Investigadores por México.



FUNCTIONALIZE POROUS SILICON (PSi) WITH PHTHALOCYANINES AS A POSSIBLE APPLICATION FOR GaS SENSING

Autor: Remedios Belen Suarez Flores¹

Coautores: Antonio Coyopol Solis ¹; Crisóforo Morales Ruíz ¹; Enrique Rosendo Andrés ¹; Godofredo García Salgado ¹; José Luis Sosa Sánchez ¹; Miguel Gracia y Jimenéz ²; Reina Galeazzi Isasmendi ¹; Roman Romano Trujillo¹

¹ BUAP CIDS-ICUAP

² BUAP-IFUAP

Autor responsable de la comunicación: belensuarezflores@gmail.com

Ab

stract Since the discovery of nanostructured materials, porous silicon (PSi) has taken an outstanding role in research for gas sensing applications, thanks to its large specific surface area, diversity in structural modification and high reactivity. Current lines of research have focused on improving the well-known "3S": sensitivity, selectivity and stability by means of various technologies and techniques. Recent publications mention that metal phthalocyanines (MPc) improve electrochemical performance, stability and sensitivity in gas sensors. For this reason, the objective is to functionalize porous silicon (PSi) with phthalocyanines as a possible application for gas sensing. Crystalline silicon (100) p-type doped with boron (resistivity of 0.01-0.02 Ω cm), manganese perfluorinated phthalocyanine (F16 MnXPc), iron perfluorinated phthalocyanine (F16 FePc) and niobium phthalocyanine (NbPc) were used. The anodization process was carried out for 44.45 minutes, with a current density of 39.19mA/cm and 60V. The samples have a porosity of 60 % and layer thicknesses of 100 μ m, in each anodization process phthalocyanine previously dissolved in ethanol in an ultrasonic bath for 10 minutes was added directly to the electrolyte deposited in the cell. When performing the study by specular reflectance, the Q band was found in the absorption spectrum at wavelengths between 600 and 800 nm, as in this case the MPc is in solid state and not in solution, the Q band was widened and ran at 800 nm, this occurs by excitonic splitting (Davydov) due to interactions between flat and stacked conjugated molecules. Although studies are still lacking in seeing what kind of functionalization was achieved, it is extremely important to highlight that the presence of the three MPcs was found by the in-situ introduction method on PSi.

Keywords:

Functionalize, porous silicon, specular reflectance

Reference:

Boyang Zong, S. W. Smart Gas Sensors: Recent Developments and Future Prospective. Nano-Micro Letters, (2024) 5-8. <https://link.springer.com/article/10.1007/s40820-024-01543-w>.

Fabio Lupo, C. T. In situ metalation of free base phthalocyanine covalently bonded to silicon surfaces.

BEILSTEIN JOURNAL OF NANOTECHNOLOGY, (2014) 2223-2224. <https://www.sciencedirect.com/org/science/article/pii/S21>

Ris work was supported by:

CIDS-ICUAP



STRUCTURE OF HEAVILY Mn-DOPED GaAs

Autor: Alexis Ayala Limón¹

Coautores: Yoselin Angelica Bautista Pineda¹; Isaac Martínez Veilis²; Máximo López López³; Carlos Ernesto Ávila Crisóstomo⁴; Diego Giovanni González Vallejo¹

¹ Escuela Superior de Ingeniería Mecánica y Eléctrica, Instituto Politécnico Nacional

² Facultad de Ciencias Químicas, Universidad Juárez del Estado de Durango.

³ Departamento de Física, CINVESTAV

⁴ Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional

Autor responsable de la comunicación: aayalal1600@alumno.ipn.mx

Gallium arsenide doped with manganese (GaAs:Mn) is a dilute magnetic semiconductor (DMS) of great interest, as it combines the excellent optoelectronic properties of GaAs with the high magnetic moment introduced by Mn. Its Curie temperature (T_C) is the highest recorded among DMS based on III-V semiconductors. Since its properties strongly depend on the growth technique and conditions, this study focuses on the structural and optical properties of five GaAs:Mn thin films grown by low-temperature molecular beam epitaxy (LT-MBE) using different manganese cell temperatures (T_{Mn}), which implies different dopant concentrations. Raman spectroscopy and X-ray diffraction (XRD) were employed. Raman spectroscopy showed that the LO mode shifts to lower wavenumbers as the Mn concentration increases, enabling its estimation and revealing an exponential relationship with T_{Mn} . The analysis of the full width at half maximum (FWHM) in Raman spectra as a function of the manganese cell temperature reveals that an increase in this temperature leads to enhanced structural disorder in GaAs:Mn, particularly in the LO mode. Temperatures between 685 °C and 730 °C favor better preservation of the material's crystallinity, whereas at 745 °C, an amorphous nature is confirmed by XRD results. XRD analysis revealed cubic phases (GaAs and GaAs:Mn) at low T_{Mn} values (685–700 °C), indicating substitutional incorporation of Mn, and the appearance of hexagonal MnAs crystallites at higher T_{Mn} values (715–745 °C).

Keywords:

DMS (Dilute Magnetic Semiconductor), doping, crystallinity, Raman, XRD (X-ray Diffraction).

Reference:

Martínez Isaac. Estudio del material GaMnAs crecido por epitaxia de haces moleculares. PhD thesis, CINVESTAV, IPN, unidad zacatenco, 2010.

Ris work was supported by:

Instituto Politécnico Nacional, Grant No. SIP-20253696 and CONAHCYT-Frontier Science 2023 CF-2023- I-1117



STRUCTURE AND OPTICAL PROPERTIES OF HEAVILY Mn-DOPED GaAs

Autor: Yoselin Angelica Bautista Pineda¹

Coautores: Alexis Ayala Limon¹; Carlos Ernesto Ávila Crisóstomo²; Diego Giovanni González Vallejo¹; Isaac Martínez Veilis³; Maximo López López⁴

¹ *Escuela Superior de Ingeniería Mecánica y Eléctrica, Instituto Politécnico Nacional*

² *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas, Instituto Politécnico Nacional*

³ *Facultad de Ciencias Químicas, Universidad Juárez del Estado de Durango*

⁴ *Departamento de Física, Cinvestav*

Autor responsable de la comunicación: ybautistap2000@alumno.ipn.mx

Manganese-doped gallium arsenide (GaAs:Mn) stands out as a promising dilute magnetic semiconductor (DMS) thanks to the excellent optoelectronic properties of GaAs combined with the high magnetic moment induced by Mn and its notably high Curie temperature. Our work involved both optical characterization of GaAs:Mn using Photoluminescence (PL) spectroscopy and the development of a computational simulation in MATLAB. The MATLAB simulation was divided into two main programs: one for structural properties and another for optical properties. PL measurements at 15 K revealed three distinct peaks: two at 1.49 and 1.51 eV, attributed to carbon impurities and free excitons, respectively, and a third at 1.47 eV, associated with substitutional Mn, which is attenuated with MnAs formation. The consistent energy positions of these peaks across varying Mn concentrations suggest that the observed optical transitions are not strongly dependent on doping. For the structural properties' simulation, a graphical interface allowed users to visualize the 3D structure of GaAs:Mn and analyze doping effects, showing the lattice constant increases with Mn concentration in accordance with Vegard's law. For optical properties, the interface enables inputting the material's operating temperature to calculate the band gap $E_g(T)$ for GaAs and GaAs:Mn (at $x = 0.0045$) using the Varshni equation, also generating graphs that illustrate the band gap's variation with temperature.

Keywords:

GaAs:Mn, structural properties, optical properties, temperature, Mn concentration

Reference:

Martínez Isaac. Estudio del material GaMnAs crecido por epitaxia de haces moleculares. PhD thesis, CINVESTAV, IPN, unidad zacatenco, 2010.

Ris work was supported by:

Instituto Politécnico Nacional, Grant No. SIP-20253696 and CONAHCYT-Frontier Science 2023 CF-2023- I-1117



PATTERN FORMATION ON SILICON SURFACES BY MeV Cu ION IRRADIATION

Autor: Miguel Angel García Cruz¹

Coautores: Cristián Felipe Cruz García ²; Jorge Rickards ²; Luis Ricardo de la Vega ³; Erick Javier López Sánchez ³; Jaqueline Cañetas Ortega ²; Juan Gabriel Morales Morales ²; Luis Rodríguez Fernández ²

¹ *Facultad de Ciencias, Universidad Nacional Autónoma de México*

² *Instituto de Física, Universidad Nacional Autónoma de México*

³ *Academia de Matemáticas, Universidad Autónoma de la Ciudad de México*

Autor responsable de la comunicación: magarcia@ciencias.unam.mx

Although ion implantation was known primarily for doping materials and the fabrication of semiconductors, this technique can be used for surface nanopatterning on a wide variety of materials, such as polymers, insulators and metals. Surface functionalization may be achieved through ion irradiation, where it is well known to generate complex morphologies and topographies in the nano and micrometer scales [1]. This work presents the changes of the surface morphology of crystalline (100) silicon p-type boron doped by 1.5 MeV Cu⁺ ion implantation at an impinging angle of 70° with respect to the surface normal. Irradiation was performed at room temperature with a current of 200 nA over 0.2 cm² surface areas correspond to approximately an ion flux of 6.24×10¹² ions s⁻¹ cm⁻². Morphological changes were studied with surface analysis techniques SEM and AFM. A comparison with a simple model for surface ripple formation is presented. Possible applications of those surface modifications are the grating formation and anisotropic surface electrical conductivity.

Keywords:

Silicon, ion implantation, surface morphology, surface patterns, semiconductor

Reference:

[1] M.A. García et al. Nuclear Inst. and Methods in Physics Research, B 550 (2024) 165304.
doi.org/10.1016/j.nimb.2024.165304

Ris work was supported by:

UNAM-DGAPA under contract IN110425.



REMOVAL OF SOLUBLE ORGANIC MATTER FROM MUNICIPAL WASTEWATER BY HETEROGENEOUS PHOTOCATALYSIS WITH ZnO/ZEOLITE IN A COMPACT TREATMENT SYSTEM

Autores: Celestino Odín Rodríguez Nava¹; David Alfonso Ramírez Ortega¹; Olivia Calixto Fernandez¹; Ángel de Jesús Morales Ramírez¹

¹ *Instituto Politécnico Nacional*

Autor responsable de la comunicación: crodriguezna@ipn.mx

In this study, the effect of pH 4, 7, and 9 on the removal efficiency of organic matter present in real municipal wastewater (MWW) was evaluated using a heterogeneous photocatalysis system with ZnO supported on natural zeolite (ZnO/zeolite) as an alternative to treatment with suspended nanoparticles. Additionally, the ZnO/zeolite photocatalyst was characterized by FTIR, XRD, and UV- vis diffuse reflectance spectroscopy. The system at pH 9 showed the best performance, achieving 75% removal of organic matter after 100 hours of reaction, with an initial concentration of 290 mg/L. Surface interactions between ZnO and zeolite were confirmed, along with a reduction in crystallinity and photocatalytic activity. Furthermore, it was identified that physisorption of soluble organic matter prevailed during experimentation at pH 4. This work provides key elements for optimizing photocatalytic treatment in real municipal wastewater.

Keywords:

heterogeneous photocatalysis, municipal wastewater, ZnO, zeolite, advanced oxidation processes

Reference:

D. Naghipour, K.Taghavi, D. Hasanzadeh, S. D. Ashrafi, and M. Moslemzadeh, Remove safranin dye from the aqueous solution using ZnO stabilized on zeolite in the presence of ultraviolet light. *Desalination and Water Treatment*, 304 (2023) 238-246. <https://doi.org/10.5004/dwt.2023.29803>

Ris work was supported by:

Instituto Politécnico Nacional



EFFICIENT ANCHORING OF NANOSTRUCTURED CADMIUM SELENIDE ON DIFFERENT KINDS OF CARBON NANOTUBES

Autor: Yesmin Panecatí Bernal¹

Coautores: Joaquín Alvarado Pulido²; Fernando J. Rodríguez-Macias³; Rodolfo Lima-Juárez⁴; Juan Carlos García-Gallegos⁵; Melissa Chávez-Portillo⁶; Miguel-Ángel Méndez-Rojas⁷

¹ *Universidad Tecnológica de Tecamachalco*

² *Centro de Investigación en Dispositivos Semiconductores, Instituto de Ciencias, Benemérita Universidad Autónoma de Puebla, Puebla, 72570 Puebla, México.*

³ *Tecnológico de Monterrey, Escuela de Ingeniería y Ciencias, Ave. Eugenio Garza Sada 2501, Monterrey, N.L., 64849, México.*

⁴ *Universidad Politécnica de Tlaxcala, Av. Universidad Politécnica 1, San Pedro Xalcatlico, Tepeyanco, 90180 Tlaxcala, México.*

⁵ *Bioingeniería, Facultad de Ingeniería, Universidad Autónoma de Baja California, Blvd. Benito Juárez S/N CP 21280, Mexicali, BC 21280, México.*

⁶ *Ingeniería en Biotecnología, Universidad Politécnica Metropolitana de Puebla, Calle Popocatepetl sin, Colonia 3 Cerritos, Pueblo 72480, México*

⁷ *Departamento de Ciencias Químico-Biológicas, Universidad de las Américas Puebla, Ex-Hda. Sta. Catarina Mártir s/n, San Andrés Cholula, 72810 Puebla, México*

Autor responsable de la comunicación: panecatibernal@gmail.com

We report a method for the efficient anchoring of cadmium selenide (CdSe) nanoparticles on the surface of different types of multi-walled carbon nanotubes (purified, N-doped, O-doped and exfoliated). Characterization using different types of electron microscopies (SEM, STEM, and TEM), energy dispersive spectroscopy (EDS) and x-ray diffraction showed well anchored CdSe nanoparticles (NP) on the nanotube surfaces, NP shapes and sizes varied with temperature and other synthesis conditions and formed with good yields. The method here reported does not require previous activation of the carbon nanotube surface by chemical functionalization, nor the use of organic solvents, and the reaction proceeded in aqueous solutions, making this process simpler and more environmentally friendly than others.

CdSe/CNTs composites have a wide range of applications, including sensors, photocatalysis and environmental remediation, photosensors and photodetectors, solar cells, and biomedical imaging.

Keywords:

carbon nanotube, cadmium selenide, anchoring

Reference:

Karimi, B., Arabi, A.M., Najafi, F. et al. CNT–CdSe QDs nanocomposites: synthesis and photoluminescence studies. *J Mater Sci: Mater Electron* 29, 13499–13507 (2018). <https://doi.org/10.1007/s10854-018-9475-4>



PHOTOCATALYTIC DEGRADATION OF BLUE METHYLENE by Mn₃O₄

Autor: Melissa Chavez Portillo¹

Coautores: Hector Juarez Santiesteban²; Joaquin Alvarado Pulido³; Marco Antonio Vicencio Garrido⁴

¹ *Universidad Politécnica Metropolitana de Puebla*

² *Benemérita Universidad Autónoma de Puebla*

³ *Benemérita Universidad Autónoma de Puebla*

⁴ *Instituto Tecnológico de Puebla*

Autor responsable de la comunicación: melissa.chavez@metropoli.edu.mx

The textile industry discharges large volumes of dye-laden effluents, and if inadequately treatment, these wastewaters can cause severe damage to ecosystems and biosphere. To mitigate such environmental impact, photocatalysis activated by light irradiation using semiconductor materials has emerged as a promising remediation strategy. This study investigates the influence of the crystalline structure, morphology, and photocatalytic performance of manganese oxide (Mn₃O₄). MnO₂ powders were synthesized via chemical bath deposition which is a low cost technique. The resulting phase and structural characteristics were confirmed by X-ray diffraction (XRD) revealing the tetragonal conforming crystal in the 20-30 nm interval size. UV-Vis absorption spectroscopy was employed to analyze the optical properties and estimate the bandgap (E_g) which is ~2 eV. Photocatalytic degradation experiments using methylene blue revealed that parameters such as bandgap energy, particle morphology, crystal structure, and reaction kinetics play a crucial role in the efficiency of the degradation process. These findings underscore the importance of nanoarchitecture in optimizing the photocatalytic performance of oxide-based materials for wastewater treatment applications.

Keywords:

Mn₃O₄, CBD technique, Photocatalysis

Reference:

- [1] Scientific Reports volume 11, Article number: 2597 (2021), doi.org/10.1038/s41598-021-81974-2
- [2] 2020, VOL. 14, NO. 1, 1580–1589, doi.org/10.1080/16583655.2020.1846966

Ris work was supported by:

Benemerita Universidad Autonoma de Puebla



DEACTIVATION OF MICROORGANISMS CONTAINED IN ATMOSPHERIC BIOAEROSOLS BY HETEROGENEOUS PHOTOCATALYSIS WITH ZnO/ZEOLITE.

Autores: ANDREA DANIELA NEGRETE MUÑOZ^{None}; Celestino Odín Rodríguez Nava¹; Ángel de Jesús Morales Ramírez¹

¹ *Instituto Politécnico Nacional*

Autores responsables de la comunicación: adnmunoz@live.com, crodriguezna@ipn.mx

Human bioaerosols are considered biological contaminants that contribute to indoor air quality. They are also the most important mechanism of disease transmission, due to their small size, which allows longer residence time at the height at which they are expelled, reaching greater distances and generating a larger radius conducive to contagion. AOPs are positioned as a viable mechanism to achieve viral and bacterial inactivation in enclosed spaces, and to guarantee spaces free of pathogen transmission in spaces with high occupancy. The purpose of the project was to design a treatment train to evaluate the effectiveness of the inactivation of an indicator organism present in a bioaerosol (*Latobacillus casei*), by means of a ZnO/Zeolite photoreactor, establishing the ideal operating parameters that allow the highest inactivation efficiency. The procedure was carried out by passing a known sample of *Lactobacillus casei* through an aerosolization chamber and then into a spiral quartz photoreactor with ZnO/Zeolite, which was irradiated with a 6W UV lamp, connected to a suction pump that allowed regulating the residence time. In the photocatalysis test, an efficiency of 87.93 % was obtained, with a residence time of 0.47 s. During the inactivation evaluation, impaction was identified as the physical mechanism for eliminating the microorganism. The results lay the foundations for modifying the system and continuing with the experimentation.

Keywords:

AOP, bioaerosols, pathogens, photoreactor

Reference:

Doss, N., Carré, G., Keller, V., André, P., & Keller, N. (2018). Photocatalytic Decontamination of Airborne T2 Bacteriophage Viruses in a Small-Size TiO₂/B-SiC Alveolar Foam LED Reactor. *Water, Air, and Soil Pollution*, 229(2). <https://doi.org/10.1007/s11270-017-3676-y>

Ris work was supported by:

Escuela Nacional de Ciencias biológicas, Instituto Politécnico Nacional, SIP 20232807



FABRICATION AND CHARACTERIZATION OF III-V AND GRAPHENE/III-V DEVICES

Autor: Angel Leonardo Martinez Lopez¹

Coautores: Jose Alberto Piedra Lorenzana ²; Julio Gregorio Mendoza Alvarez ³; Máximo López López ⁴; Yasuhiko Ishikawa ⁵; Yenny Lucero Casallas Moreno ⁶

¹ Programa de doctorado en nanociencias y nanotecnología

² Department of Electrical and Electronic Information Engineering Toyohashi University of Technology

³ Departamento de Física-Cinvestav

⁴ Departamento de Física, CINVESTAV-IPN, Apdo. Postal 14-740, 07000 México D.F., México

⁵ Department of Electrical and Electronic Information Engineering, Toyohashi University of Technology

⁶ Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas (UPIITA-IPN)

Autor responsable de la comunicación: anlemtzlop@gmail.com

This work presents the fabrication and electrical characterization of III-V semiconductor devices developed through two complementary approaches. In the first part, p-i-n GaAs structures were grown by Molecular Beam Epitaxy (MBE) on GaAs(001) substrates. These epitaxial layers were processed into diode devices using photolithography, metal contact deposition by thermal evaporation, and thermal annealing. Current-voltage (I-V) measurements confirmed rectifying behavior with low leakage currents, demonstrating the suitability of these structures for optoelectronic applications. In the second part, monolayer graphene was transferred onto Si(111) substrates with n-type and p-type doping, as well as onto GaAs(001) (using a similar transfer technique to that reported in [1]), to engineer the metal-semiconductor interface. Devices fabricated on GaAs(001) exhibited linear I-V characteristics consistent with ohmic transport, whereas devices on Si(111) demonstrated moderate Schottky responses. These contrasting behaviors highlight the tunability of graphene-based contacts, influenced by substrate doping, work function alignment, and interface quality. Together, these two experimental approaches provide valuable insights into the fabrication routes and contact engineering strategies that can be selected depending on the targeted substrate and device architecture, serving as a basis for future integration of III-V semiconductors and graphene in advanced electronic and optoelectronic systems.

Keywords:

III-V, Graphene, Semiconductor Devices, MBE, Photolithography

Reference:

[1] Martínez López, A. L. et al. (2024). Impact of graphene as 2D interlayer on GaAs growth by CSVT. Mater. Sci. Semicond. Process., 168, 108605. <https://doi.org/10.1016/j.mssp.2024.108605>

Ris work was supported by:

SECIHTY scholar-ship, the authors sincerely thank the IPN and SECIHTI for their financial support in this work. We particularly thank SIP 20253723, SIP 20254808, PRORED 20254785, and the Frontier Science projects SECIHTI CF-2023-I-1117 and SECIHTI CBF-2025-I-3719.



ROBOTIC DEVICE FOR MEASURING RESISTIVITY IN SEMICONDUCTOR MATERIALS SENSITIVE TO PENETRATION

Autores: Alondra Maybeth Vaquera Domínguez¹; Antonio Del Rio De Santiago²; Leticia Perez-Arrieta¹; Ma. Del Rosario Martínez Blanco¹; Mireya Moreno Lucio¹; Víctor Hugo Méndez García³; Jesus Octavio Sígala Valdez¹

¹ *universidad Autonoma de Zacatecas*

² *Posgrado en Ingeniería y Tecnología Aplicada, Universidad Autónoma de Zacatecas. Ramón López Velarde 801. C.P. 98000, Zacatecas, Zac., México.*

³ *ciacyt Uaslp*

Electrical properties are fundamental in determining the functionality of semiconductor materials, as they enable classification as conductors, semiconductors, or insulators. Among these properties, resistivity is a key parameter. For the electrical characterization of these materials, sheet resistance is commonly measured. This intrinsic property does not depend on the sample's geometry, providing a more representative evaluation of the electrical behavior of thin films. However, obtaining accurate resistivity measurements in laboratory conditions is challenging due to the small surface area of the samples (typically on the order of cm^2) and the high resistance of thin films, which limit the applicability of conventional instruments such as multimeters. Additionally, electrical noise in the measurement systems can compromise data reliability. The four-point probe technique, also known as the Kelvin method, effectively minimizes contact resistance errors by using four aligned electrodes to measure the voltage drop across the sample. Nevertheless, many commercial systems overlook the influence of probe pressure, a factor that can significantly affect measurements, particularly in multilayer structures. This work presents the development of a low-cost robotic platform for resistivity measurement, which incorporates a data acquisition system, current and voltage sensors, a MicroSD module, an LCD, and a strain gauge to monitor the applied pressure. The system enables real-time correlation between contact pressure and electrical response, significantly enhancing the accuracy and reproducibility of measurements in the electrical characterization of thin-film semiconductors

Keywords:

resistivity, semiconductor, kelvin method

Reference:

Orva, D.M.; Hosseini, S.S.; Collins, F.; Adams, S.D.; Gates, W.P.; Kouzani, A.Z. Miniature Resistance Measurement Device for Structural Health Monitoring of Reinforced Concrete Infrastructure. *Sensors* 2020, 20, 4313. <https://doi.org/10.3390/s20154313>

Ris work was supported by:

Universidad Autonoma de Zacatecas



AUTOMATION OF A ROBOTIC DEVICE FOR CHEMICAL DEPOSITION USING THE SILAR METHOD

Autores: Antonio Del Rio De Santiago¹; Herber Martell Puente²; Irving Eduardo Cortes Mestizo³; Leticia Perez-Arrieta²; Luis O Solis Sánchez²; Ma. Del Rosario Martinez-Blanco²; Jesus Octavio Sigala Valdez²

¹ *Posgrado en Ingeniería y Tecnología Aplicada, Universidad Autónoma de Zacatecas. Ramón López Velarde 801. C.P. 98000, Zacatecas, Zac., México.*

² *universidad Autonoma de Zacatecas*

³ *ciacyt Uaslp*

Fossil fuels are a finite resource that contributes to global warming. There are alternative renewable energy sources, which represent a significant area of opportunity. As a result, Researchers and organizations are dedicating significant efforts and resources to the study of renewable energies. Based on this, the development and implementation of an automated robotic system is proposed in this work to carry out the deposition of thin films using the SILAR technique (Successive Ionic Layer Adsorption and Reaction), a low-cost and highly reproducible method used in the synthesis of semiconductor materials with applications in solar energy, sensors, and optoelectronics.

The proposal addresses the need for accessible and precise equipment in research laboratories. A mechanical-electronic system was designed and controlled by a custom-developed printed circuit board specifically for this application. The system enables the automated execution of immersion, rinsing, and transfer sequences, ensuring uniformity and minimizing human error.

In addition to the mechanical and electronic design, an intuitive graphical interface was integrated to configure the process parameters, along with a heating module and temperature sensors for thermal control during the deposition process. The device features a clamping mechanism that is adaptable to substrates of varying dimensions.

The experimental results include an analysis of the device's motion, as well as dimensional comparisons with the commercial HO-TH-03B device from the Holmarc® brand. Additionally, we synthesized thin films of manganese sulfide, and our analysis demonstrated the system's effectiveness for film growth. The device meets the criteria for precision, efficiency, and cost, positioning it as a viable alternative for educational institutions and research centers. This proposal contributes to strengthening national scientific infrastructure and promotes the development of homegrown technology in the field of advanced materials and clean energy.

Keywords:

automation, thin films, manganese sulfide, robotics, renewable resources.

Reference:

Sigala-Valdez, Jesús Octavio, et al. "Effect of the tri-sodium citrate as a complexing agent in the deposition of ZnS by SILAR." *Heliyon* 9.7 (2023): e17971.

Ris work was supported by:

Universidad Autonoma de Zacatecas



DEVELOPMENT AND CHARACTERIZATION OF A LOW-COST SYSTEM FOR RIN FILM DEPOSITION VIA SPIN COATING

Autores: Antonio Del Rio De Santiago¹; Celina L. Castaneda-Miranda²; Héctor A Guerrero-Osuna²; Irving Eduardo Cortes Mestizo³; Rocio Garcia⁴; Yoshua Juarez Elias²

¹ *Posgrado en Ingeniería y Tecnología Aplicada, Universidad Autónoma de Zacatecas. Ramón López Velarde 801. C.P. 98000, Zacatecas, Zac., México.*

² *universidad Autonoma de Zacatecas*

³ *ciacyt Uaslp*

⁴ *C*

In this work, we present the design, implementation, and characterization of a low-cost system for growing thin films using the spin coating technique. The device is built around an ESP32 DevKit v4 board, which serves as the central control unit, a Nextion touchscreen interface for user interaction, and a brushless motor driver programmed via the Arduino IDE. This integration enables precise

control of key process parameters—specifically rotation speed and spin time—through an intuitive, configurable menu. The system is based on the Maasi open-source software plans. However, significant modifications were made to both the firmware—customizing the motor driver control routines—and the hardware, including adaptations to the brushless motor controller circuitry and the step-down voltage regulator.

We conducted functional characterization of the system by depositing cadmium sulfide (CdS) thin films from precursor solutions documented in the literature. Experiments varied operational parameters, with rotation speeds ranging from 1,500 to 2,500 RPM and deposition times from 45 to 60 seconds, to assess their effects on film quality and uniformity. Although the system demonstrated stable and controlled operation, the ultimate uniformity and quality of the coatings depended heavily on the chemical preparation of the precursor solutions. This area is still being optimized

Keywords:

Thin Film Deposition, spin coating technique, depositing cadmium sulfide

Reference:

Design, Fabrication, and Optical Characterization of a Low-Cost and Open-Source Spin Coater Mohammad Sadegh-cheri
Journal of Chemical Education 2019 96 (6), 1268-1272 DOI:
10.1021/acs.jchemed.9b00013

Ris work was supported by:

Universidad Autonoma de Zacatecas



EARLY-STAGE BIOMARKER FOR IDIOPATHIC PULMONARY FIBROSIS USING PHOSPHATIDYLETHANOLAMINE-BIOCONJUGATED InP@ZnS QUANTUM DOTS

Autor: Daladier Alonso Granada Ramirez¹

Coautores: Alexa Limón-Bonilla ²; Beatriz Tlatelpa-Romero ¹; J.G. Mendoza-Alvarez^{4 3}; Joaquin Alvarado ⁴; Juan Pedro Luna-Arias ⁵; Luis-Guillermo Lara-cisneros ³

¹ *investigador Postdoctoral*

² *estudiante*

³ *profesor investigador*

⁴ *Benemérita Universidad Autónoma de Puebla*

⁵ *Departamento Biología Celular, Cinvestav*

Autor responsable de la comunicación: dalagranada@gmail.com

Early detection of idiopathic pulmonary fibrosis (IPF) remains a clinical challenge. In this work, we report the development of a fluorescent biomarker based on phosphatidylethanolamine-bioconjugated InP@ZnS quantum dots (QDs, 2–8 nm) designed for selective labeling of lung fibroblasts. Structural and optical characterization by HRTEM and UV-Vis spectroscopy confirmed a tunable bandgap (1.7–2.8 eV), while photoluminescence revealed visible-range emission (~2.2 eV), attributed to excitonic transitions in the InP core. The ZnS shell enhanced optical stability and quantum yield, critical for in vitro applications. Using confocal microscopy and the ZOE system, we demonstrated specific QD uptake in primary fibroblasts, where lipid bioconjugation improved membrane affinity. This system enables visualization of early IPF-associated morphological changes with higher sensitivity than conventional dyes, leveraging the QDs' high signal-to-noise ratio and photobleaching resistance. Our findings suggest that this platform could streamline early IPF diagnosis, reducing reliance on invasive techniques. Future studies will focus on validating specificity in 3D fibrotic tissue models and optimizing functionalization for in vivo applications. This work exemplifies how nanotechnology can address limitations in chronic disease diagnostics

Keywords:

Quantum dots, idiopathic pulmonary fibrosis, Early biomarker, InP, InP@ZnS

Reference:

1- Granada-Ramírez, D. A., et.al. (2019). Effect of the indium myristate precursor concentration on the structural, optical, chemical surface, and electronic properties of InP quantum dots passivated with ZnS. *Journal of Materials Science: Materials in Electronics*, 30(7), 4885-4894.

Ris work was supported by:

La Secretaría de Ciencia, Humanidades, Tecnología e Innovación (Secihti), benemerita universidad autonoma de puebla, centro de investigacion y de estudios avanzados del I.P.N



Mn²⁺-DOPED TiO₂-SiO₂ AEROGELS SYNTHESIZED THE SOL-GEL METHOD COMBINED WITH A SOLVOTHERMAL TREATMENT

Autores: Amanda Rodríguez Álvarez¹; Carlos Antonio Pineda Arellano¹; Daysi Elusaí Millán Ocampo^{None}; Erika Rodríguez Sevilla¹; MELISSA DE JESÚS RODRÍGUEZ FLORES¹

¹ Centro de Investigaciones Óptica

Autor responsable de la comunicación: melissaflores669@gmail.com

TiO₂ is a widely known photocatalyst, however, it presents certain limitations, such as a high electron-hole recombination rate and a large band gap. To address these limitations and improve its efficiency in photocatalytic processes, strategies such as doping (with metallic or non-metallic elements) and coupling with other semiconductors have been proposed. Another effective approach involves increasing the specific active surface area of the material, where aerogels represent a promising option due to their high surface area, capable of providing numerous active sites. In this work Mn²⁺-doped SiO₂-TiO₂ aerogels were synthesized using the sol-gel method, assisted by a solvothermal treatment and dried under ambient pressure. The materials were characterized by XRD, UV-Vis, SEM, and BET analysis, with the objective of investigating the influence of Mn²⁺ doping and calcination temperature on the structural and morphological characteristics of the aerogels. The BET surface areas exhibited by these materials range from 317 to 793 m²/g, with pore radii between 5.16 and 7.49 nm, corresponding to calcination temperatures of 850 °C and 550 °C, respectively. It was observed that the surface area, as well as the optical, structural and morphological characteristics, vary with increasing calcination temperature.

Keywords:

Drying at ambient temperature, High BET áreas, Mn²⁺-doped SiO₂-TiO₂ aerogel

Reference:

.

Ris work was supported by:

Project Secihti CBF2023-2024-2997: "Estudio sobre materiales aislantes térmicos de frontera, como alternativa para mitigar las pérdidas energéticas en sistemas termosolares.



ANISOTROPIC OPTICAL RESPONSE AND MORPHOLOGY OF p-TYPE DOPED GaAs(631) AND (100) FILMS GROWN BY MBE.

Autores: María Fernanda Mora Herrera¹; Victor Hugo Mendez Garcia²

Coautores: Daniel Lopez Vilchis²; Alexis Fernández Fernández³; Guadalupe del Carmen Yopez Barradas³; Jesús Samuel Sámano González³; Ángel Iván Méndez García⁴; Irving E. Cortes-Mestizo⁵; Leticia Ithsmel Espinosa Vega⁴; Jaime Ruiz García⁶; José Luis Cuellar Camacho⁷

¹ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología, Universidad Autónoma de San Luis Potosí

² Universidad Autonoma de San Luis Potosi

³ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

⁴ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí

⁵ SECIHTI-UASLP

⁶ Instituto de Física, Universidad Autónoma de San Luis Potosí, S.L.P., México.

⁷ Universidad Autonoma de Zacatecas, Zacatecas, México.

Autor responsable de la comunicación: a330845@alumnos.uaslp.mx

In recent years, extensive research has focused on the incorporation of beryllium as a p-type dopant in III-V semiconductors, particularly GaAs, due to its high activation efficiency and low diffusion coefficient. The study of Be-doped GaAs structures has become increasingly relevant for the development of advanced optoelectronic devices, where precise control of the dopant and its effects on structural, optical, and electrical properties is critical. Recent investigations have explored how beryllium affects the carrier dynamics and even the surface morphology, especially on high-index substrates such as GaAs(631), which offer favorable conditions for anisotropic growth and nanostructure self-organization. Be-doped GaAs epitaxial thin films were grown on (631)- and (100)-oriented GaAs substrates by molecular beam epitaxy (MBE), varying the Be-effusion cell temperature. Atomic force microscopy characterization revealed the formation of periodic surface undulations along the $[113]$ crystallographic direction, which is preserved despite the doping level. Two-dimensional autocorrelation function analysis was performed to evaluate the lateral correlation length of the unidimensional arrays, demonstrating long-range ordering on the surface. Room temperature spectroscopic ellipsometry measurements were also performed to study the optical properties of thin films. The imaginary part of the pseudodielectric function in the photon energy range of 0.5–5.0 eV exhibited four peaks at approximately 1.4, 2.9, 3.1, and 4.4 eV, corresponding to the critical points E_0 , E_1 , $E_1 + \Delta_1$, and E_2 respectively. In the E_1 and $E_1 + \Delta_1$ region, a slight redshift and broadening of the critical points were observed, attributed to the increased doping concentration. The samples were also characterized by Raman scattering, revealing the characteristic GaAs transverse optical (TO) and longitudinal optical (LO) phonon modes at 268 cm^{-1} and 292 cm^{-1} , respectively. A broadening and decrease in the intensity of the LO mode with increasing doping concentration were also observed, attributed to the LO phonon-plasmon coupling.

Keywords:

Molecular Beam Epitaxy, thin films, nanostructure, Quantum wires, doping

Ris work was supported by:

This work was supported by: The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, and financial support from COPOCyT Fideicomiso 23871, SECIHTI CF-2023-I-1300, and Investigadoras e Investigadores por México.



STRAIN REDUCTION IN MULTI-STACKING QUANTUM WELLS OF III-N-V MATERIALS USING STRAIN-BALANCE METHOD FOR PHOTOVOLTAIC HETEROSTRUCTURES

Autores: Irving E. Cortes-Mestizo¹; Ángel Iván Méndez García²

Coautores: Daniel Lopez Vilchis³; JESUS ROLANDO PINSON ORTEGA⁴; Jesús Samuel González Sámano⁵; Leticia Ithsmel Espinosa Vega⁶; Marcos Ivan Bustos Ibarra⁶; Maria Fernanda Mora Herrera⁷; Victor Hugo Mendez Garcia³

¹ SECIHTI-UASLP

² Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí

³ Universidad Autónoma de San Luis Potosí

⁴ Center for the Innovation and Application of Science and technology, Universidad Autónoma de San Luis Potosí (UASLP), Av. Sierra Leona #550, Col. Lomas 2a Sección, 78210, San Luis Potosí, México.

⁵ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí

⁶ CIACyT, UASLP

⁷ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

Autor responsable de la comunicación: a299810@alumnos.uaslp.mx

Conventional solar cell architectures exhibit efficiency limitations due to their restricted ability to absorb a broad range of the solar spectrum. One alternative to extend the absorption range is the inclusion of nanostructures, where confined states can capture photons with lower energy than the bandgap of the host semiconductor material. In this context, III-V/III-N-V quantum wells (QWs) embedded in GaAs-based solar cells demonstrate great potential for achieving high-efficiency optoelectronic devices. However, efficiency is reduced by strain and stress effects generated by the lattice mismatch between the materials employed. Therefore, the development of advanced structural engineering techniques to minimize accumulated stress across the structure is essential for enhancing device performance [1]. This work explores the concept of strain balance using both numerical and experimental approaches. First, simulations were performed with NextNano software. The strain minimization model enabled the analysis and optimization of the $\text{In}_x\text{Ga}_{1-x}\text{As}/\text{GaN}_y\text{As}_{1-y}/\text{In}_x\text{Ga}_{1-x}\text{As}$ QW sequence, where the molar fractions x and y in the ternary semiconductor compounds and the well and barrier layers were adjusted. On the experimental side, molecular beam epitaxy (MBE) was employed to grow three p-i-n GaAs solar cells with QWs: a reference sample ($x = 0$, $y = 0.01$), an unbalanced sample ($x = 0.3$, $y = 0.01$), and a strain-balanced sample ($x = 0.05$, $y = 0.01$), with well and barrier thicknesses of 3 and 2 nm, respectively. In situ monitoring was performed via reflection high-energy electron diffraction (RHEED) to assess the quality of the uninterrupted growth process. HRXRD was used to evaluate the In and N content, the presence of multiple QWs, and the crystalline quality. The appearance of satellite peaks confirmed the formation of nanostructures. Spectral features observed in photoreflectance measurements verified the presence of InGaAs and GaNAs QWs with confined energy levels.

Keywords:

Strain-balance, Quantum wells, Molecular Beam Epitaxy, III-N-V Semiconductors, Photovoltaic Devices.

Reference:

Ekings-Daukes, N. J., Adams, J., Ballard, et. al. (2009, February). Physics of quantum well solar cells. In *Physics and Simulation of Optoelectronic Devices XVII* (Vol. 7211, pp. 119-129). SPIE.

His work was supported by:

The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, and financial support from COPOCyT Fideicomiso 23871, SECIHTI CF-2023-I-1300, and Investigadoras e Investigadores por México.



MICROWAVE-ASSISTED SYNTHESIS OF g-C₃N₄/ZnS COMPOSITES FOR PHOTOCATALYTIC DICLOFENAC DEGRADATION

Autores: : Teresa Montalvo Herrera¹,

Coautores: Gloria Lourdes Dimas Rivera ¹., Juan Manuel Hernández López ¹.

¹ *Facultad de Ciencias Químicas, UANL*

Autor responsable de la comunicación: teresa.montalvohrr@uanl.edu.mx

Graphitic carbon nitride (g-C₃N₄) is a metal-free, n-type semiconductor with a band gap of 2.7 eV, enabling photocatalytic activity under visible light. Its low cost, chemical stability, and layered structure make it a promising material; however, its photocatalytic performance is limited by rapid charge carrier recombination. To overcome this limitation, this study aimed to enhance the photocatalytic efficiency of g-C₃N₄ through the formation of heterojunctions with zinc sulfide (ZnS), a strategy known to improve charge separation by introducing localized states within the band gap. g-C₃N₄/ZnS composites were synthesized via an in situ microwave-assisted method using different weight ratios (20/80, 50/50, and 80/20, denoted as gz20, gz50, and gz80, respectively) and evaluated for the photocatalytic degradation of diclofenac (35 ppm) under simulated solar light irradiation. The materials were characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), nitrogen physisorption (BET), diffuse reflectance spectroscopy (DRS), and photoluminescence (PL). XRD confirmed the presence of crystalline ZnS and successful composite formation. BET analysis indicated mesoporous structures (3–9 nm), with decreased surface area upon g-C₃N₄ addition. SEM revealed that ZnS particles were spherical (~0.8 μm), while g-C₃N₄ exhibited amorphous morphology (1.7–14.7 μm), both retained in the composites. Photocatalytic tests over 4 hours, with UV-Vis monitoring every 30 minutes, showed that the gz80 composite exhibited the highest degradation efficiency (50%), outperforming g-C₃N₄ (27%), ZnS (40%), gz20 (45%), and gz50 (37%). These results demonstrate that the g-C₃N₄/ZnS heterojunction, particularly in the 80/20 ratio, significantly enhances photocatalytic activity, highlighting its potential for the degradation of emerging contaminants under solar-simulated conditions.

Keywords:

g-C₃N₄, ZnS, composites, diclofenac degradation, microwave technique.

Reference:

Husein, S., Slamet, & Dewi, E. L. (2024). A review on graphite carbon nitride (g-C₃N₄)-based composite for antibiotics and dye degradation and hydrogen production. *Waste Disposal & Sustainable Energy*, 6(4), 603-635.

Ris work was supported by:
ProACTI 115-BYQ



TRIBOLOGY, SURFACES AND INTERFACES

CHAIRMEN

Dr. Edgar Enrique Camps Carvajal (ININ), enrique.camps@inin.gob.mx

Dr. Ernesto David García Bustos (SECIHTI-UPVM), edgarciab@secihti.mx

Tribology studies the friction and wear behavior of surfaces that are in contact and in relative motion. Materials, Lubricants and Coatings are commonly used to increase the durability and life of components in mechanical systems, as well to reduce the energy consumption through reducing friction.

This Symposium aims to cover the most relevant aspects of tribology by presenting papers focused on:

- Wear and friction studies of surfaces and bulk materials.
- Mechanical properties of coatings and thin films.
- Interaction between lubricants and coatings.
- Modeling of tribological phenomena.
- Industrial applications of coatings and thin films.
- Nanomaterials and nanoformulations for lubrication.
- Novel techniques to study wear and friction.
- Studies of tribochemical reactions (tribofilms).
- Diamond Like Coatings for Lubrication.
- Novel techniques to evaluate friction and wear.



TRIBOLOGY, SURFACES AND INTERFACES / 22

TRIBOLOGICAL PERFORMANCE OF Ti-AL-N COATINGS DEPOSITED BY VACUUM ARC

Autor: Misael Paz¹

Coautores: Ivan Camps ²; Julio Cruz ¹; Stephen Muhl ¹

¹ IIM, UNAM

² Tecnológico de Monterrey

Autor responsable de la comunicación: misapazv@gmail.com

We present the results of studies on Ti-Al-N coatings fabricated using an innovative Cylindrical Hot Refractory Anode Vacuum Arc (CHRAVA) system. The cathode design, consisting of a series of interchangeable rings, facilitated the easy adjustment of precursor compositions. Specifically, a complete cylinder was constructed using Ti rings, with Al rings strategically integrated in various sequences. Our analysis involved examining the coatings' structure, composition, and mechanical performance under wear conditions. X-ray diffraction identified a characteristic Ti-N structure, which evolved with the incorporation of Al. X-ray photoelectron spectroscopy further confirmed the presence of elements from the cathode rings and demonstrated an increase in Al content corresponding to the addition of Al rings. Additionally, tribological experiments on polished stainless-steel samples assessed the wear rate and coefficient of friction under different constant loads of 1, 2, and 5 N. The results were analyzed to understand the effect of increasing aluminum incorporation on the tribological performance of the coatings.

Keywords:

vacuum arc, coatings, Ti-Al-N, mechanical properties, tribology.

Work was supported by:

PAPIIT-AG101123



TRIBOLOGICAL CHARACTERIZATION OF CHITOSAN (Cts) COATINGS REINFORCED WITH HYDROXYAPATITE (Ha) ON CYLINDRICAL TITANIUM ALLOY (Ti64) SAMPLES

Autor: Daniel Andre Herrera Arellanes¹

Coautores: Ernesto David García Bustos²; Marco Antonio Doñu Ruíz¹; Noe López Perruquía¹; Wendy Esperanza Rico Cabrera³

¹ Universidad politécnica del valle de México

² Universidad Politécnica del Valle de México División de Ingeniería Industrial

³ Universidad Politécnica del Valle de México

Autores responsables de la comunicación: danyandre.ha@gmail.com, alezasunion000@gmail.com

Permanent orthopedic prostheses are primarily manufactured using metallic alloys such as Titanium (Ti64), Cobalt-Chromium-Molybdenum (CoCrMo), or 316L stainless steel, often featuring complex cylindrical geometries. Consequently, numerous studies focus on surface modification of these geometries to enhance properties such as wear resistance. Electrochemical deposition of chitosan (Cts) reinforced with functional materials like hydroxyapatite (Ha) on titanium alloy (Ti64) surfaces presents a promising strategy to improve the tribological performance of metallic prostheses. The electrochemical deposition process was carried out using an electrolyte composed of Cts, acetic acid, and Ha dispersed in denatured ethyl alcohol, stirred magnetically for 1 hour. Coating deposition was performed at varying voltages and times on Ti64 cylindrical substrates, resulting in films with differing thicknesses and morphologies. The impact of Cts-Ha coatings on wear resistance was evaluated through sliding wear tests using a pin-on-disk configuration, where a cylindrical Ti rod served as the counterface. Frictional force was recorded throughout the sliding process, and wear tracks were analyzed to assess the coatings' performance. This study demonstrates the potential of Cts-Ha composite coatings to enhance surface wear resistance, offering a surface engineering solution for the longevity and functionality of orthopedic implants.

Keywords:

Wear, PLD, HDPE, Microabrasion, Chitosan

Reference:

Che Isa, N. N., Mohd, Y., & Yury, N. (2012). Effect of chitosan on the formation of hydroxyapatite (HAP) coatings on titanium by electrodeposition technique. Conference: CHUSER. XRD y FTIR confirmaron fases orgánicas e inorgánicas.

Ris work was supported by:

This research was funded by Laboratorio de Estudios, Modificación y Aplicación de Superficies (LEMAS)-Universidad Politécnica del Valle de México in the project CIR/0022/2022 of the program "Investigadoras e Investigadores por México" of SECIHTI. Also Grupo Ciencia e Ingeniería de Materiales



ENHANCING ATMOSPHERIC WATER HARVESTING: THE ROLE OF NANOMATERIALS AND MICROSTRUCTURES ON COPPER SURFACE

Autores: Veronica Cristel Vázquez De la Cruz¹; Luis Fernando Benítez Rodríguez²; Julio Cesar Cruz Cardenas³; Stephen Muhl⁴; Marco Antonio Martinez Fuentes⁵; Ivan Camps⁶

¹ *Facultad de Ciencias, Universidad Nacional Autónoma de México, Ciudad de México, C. P. 04510, México.*

² *Universidad Nacional Autónoma de México*

³ *UNAM*

⁴ *Instituto de Investigaciones en Materiales, Uni Nacional Autonoma de Mexico*

⁵ *Instituto de Investigaciones en Materiales - UNAM*

⁶ *Tecnologico de Monterrey*

Autor responsable de la comunicación: cristelvazquez@ciencias.unam.mx

Facing a burgeoning global water crisis, the Earth's atmosphere stands as a surprisingly vast and virtually untapped reservoir of fresh water, holding an estimated 1.4×10^{19} liters. This research directly addresses this critical challenge by detailing the development of an advanced, automated system designed for the efficient collection of atmospheric water through condensation. At the center of the system lies a modified copper plate to enhanced water recovery. Its temperature is precisely regulated by a Peltier cell and an Arduino-based microcontroller, consistently maintaining conditions optimally close to the dew point.

To significantly boost the amount of condensed water, our investigation thoroughly explored the efficacy of a diverse range of surface modifications applied to the copper substrate. These variations included pristine, untreated copper; copper coated with a thin film of Multi-Wall Carbon Nanotubes (MWCNTs) with 25 to 50 walls synthesized by Chemical Vapor Deposition (CVD) and known for their thermal and surface properties; Nanostructured copper oxide (CuO) obtained through a 10-minute chemical etching process in a solution of DI water, NaClO_2 , Na_3PO_4 , and NaOH ; polished copper with a controlled average area roughness (S_a) of 70 nm; and sandblasted copper, treated with 53 μm diameter sand to induce a distinct micro-roughness.

Experimental trials were conducted in two distinct environmental conditions to thoroughly assess performance: an environment characterized by medium humidity (30-40%) and another simulating high humidity (80-90%), which means that the dew point varies between 0 °C and 20 °C. The findings from these experiments reveal a pronounced and undeniable variation in the total volume of water collected, which in the best results is estimated at 2.63 L per hour on a surface of 1 m² and also in the specific patterns of droplet formation across the different modified surfaces, which, depending on their nature, can move on the surface in less than 1 hour or continue growing for up to 3 hours before detaching. This striking variability unequivocally highlights the pivotal impact of key surface characteristics. These include the surface roughness, the dynamic variation of the contact angle with changing temperatures, and the inherent nano- or micro-scale structures engineered onto the copper. A discussion of how these specific surface properties influence and optimize the condensation process is presented in the project.

Keywords:

Water, condensation, dew point, dropwise, contact angle, humidity, ARDUINO, nanostructures

Reference:

Peng, Qi, et al. "Analysis of Droplet Dynamic Behavior and Condensation Heat Transfer Characteristics on Rectangular Microgrooved Surface with CuO Nanostructures." *International Journal of Heat and Mass Transfer*, vol. 130, 2019, pp. 1096-1107. ScienceDirect, doi:10.1016/j.ijheatmasstransfer.2018.11.012.

Ris work was supported by:

DGAPA-UNAM under contract IG101123 & SECIHTI.



WEAR RESISTANCE OF NITRIDED AISI 4140 STEEL BY TWO PROCEDURES

Autor: Virgilio Alberto Aquino Cruz

Coautores: Roberto Carlos Vega Morón ; Lizbeth Melo Máximo ; Dulce Melo Máximo ; José Solís Romero

Autor responsable de la comunicación: m24254001@tlalnepantla.tecnm.mx

This work investigates the effect of conducting salt bath nitriding on AISI 4140 steel using two procedures: Tenifer and Tenifer-QPQ, and analyzes and compares its wear resistance. First, 6 mm-thick samples were sectioned from a 38.1 mm diameter AISI 4140 steel bar. Later, superficial preparation included grinding the samples up to 1200 grit and then polishing them with 6 μm diamond suspension to achieve a mirror finish. Next, salt bath nitriding was conducted at 580 °C for 90 minutes by the aforementioned two processes. After that, a metallographic procedure was conducted using 4 % Nital etching agent for microstructure observation. The results revealed white layers of $10.3 \pm 1 \mu\text{m}$ (Tenifer) and $13.3 \pm 0.3 \mu\text{m}$ (Tenifer-QPQ), with diffusion zones around $125.3 \pm 5.1 \mu\text{m}$ and $134 \pm 7.6 \mu\text{m}$, respectively. An EDS line analysis revealed the presence of nitrogen on the sample surface, showing a decreasing concentration gradient from the white layer toward the substrate core for both treatments. Additionally, cross-section Vickers microhardness profiles were obtained, applying 10 gf (98.07 mN) along the layers. The white layer of Tenifer reached surface hardness around $1021 \pm 110 \text{ HV}0.01$ whereas the Tenifer-QPQ treatment presented values of around 780 HV0.01, gradually decreasing toward the substrate core. Furthermore, X-ray diffraction (XRD) tests allowed the identification of $\epsilon\text{-Fe}_{2-3}\text{N}$ and $\gamma'\text{-Fe}_4\text{N}$ phases. Furthermore, wear resistance assessment was performed through pin-on-disk tests using a 5 mm diameter alumina ball, under different loads and distance[1]. The coefficient of friction values and wear rates were analyzed, and the worn tracks were inspected by scanning electronic microscopy. Summarizing, the nitriding treatment by these two procedures generated a nitrogen-rich layer, which increased its superficial hardness. These layers improved the wear resistance of the steel.

Keywords:

nitriding, tenifer, wear resistance, surface engineering

Reference:

[1] R. A. García-León, J. Martínez-Trinidad, I. Campos-Silva, U. Figueroa-López, and A. Guevara-Morales, "Wear maps of borided AISI 316L steel under ball-on-flat dry sliding conditions," Mater Lett, vol. 282, Jan. 2021, doi: 10.1016/j.matlet.2020.128842.

Ris work was supported by:

Tecnológico Nacional de México. Instituto Tecnológico de Tlalnepantla. Secretaría de Ciencia, Humanidades, Tecnología e Innovación (Secihti). Instituto Tecnológico y de Estudios Superiores de Monterrey: Campus Estado de México, Campus Santa Fe



CHARACTERIZATION OF COPPER BORIDE SURFACES

Autor: Alan Rodrigo Rocha Escamilla¹

Coautores: David Barrientos Rodriguez ¹; Ernesto David García Bustos ²; Marco Antonio Doñu Ruiz ³; NOE LOPEZ PERRUSQUIA ⁴; TOMAS DE LA MORA RAMIREZ ⁵; Lizbeth Melo Máximo ; Jorge Alberto Granados Olvera

¹ *Universidad Tecnológica Fidel Velázquez*

² *CONAHCYT-UPVM*

³ *Universidad Politécnica del Valle de Mexico*

⁴ *Universidad Politécnica del Valle de México*

⁵ *TECNOLÓGICO DE ESTUDIOS SUPERIORES DE JOCOTITLÁN*

Autor responsable de la comunicación: rochaescamillaa@gmail.com

The modification of the surface characteristics it is a common process to increase the efficiency of materials for different applications. The process of boride by dehydrated pasta it is used to increase the Surface hardness of metallic materials. This job shows the change in Surface characteristics of a commercial copper alloy through the process of boride. This process was carried out on Cu substrates of 2x2x0.1 cm at temperatures 900, 950, 1000, 1100° C using the boride process by dehydrated paste with times of 1, 3, 6 hrs. The modified surfaces were characterized structurally, morphologically and elementally, using the techniques of X-ray diffraction, optical and electron microscopy, as well as energy dispersive spectroscopy (EDS). The change in surface energy was determined using the contact angle technique and the electrical resistance measurement was performed using the two points method, which were coated with Au, applying a load of 1.8 N. Both characterizations showed that the surface at 950° with 3 hours of treatment presented the highest contact angle and lowest electrical resistance.

Keywords:

process, surface, boride, temperatures

Reference:

Weng, XJ., Bai, J., Hou, J. et al. Experimental evidence of surface copper boride. Nano Res. 16, 9602– 9607 (2023).

Ris work was supported by:

This research was funded by Laboratorio de Estudios, Modificación y Aplicación de Superficies (LEMAS)- Universidad Politécnica del Valle de México in the project CIR/0022/2022 of the program “Investigadoras e Investigadores por México” of SECIHTI. Also Grupo Ciencia e Ingeniería de Materiales



ANALYZE OF ELECTRICAL RESISTANCE AND MICRO-ABRASION WEAR RATE OF COPPER BORIDE SURFACES (Cu-B).

Autor: DAVID BARRIENTOS RODRIGUEZ¹

Coautores: Alan Rodrigo Rocha escamilla ²; Ernesto David García Bustos ³; Jorge Alberto Granados Olvera ; Lizbeth Melo Máximo ; Marco Antonio Doñu Ruiz ⁴; NOE LOPEZ PERRUSQUIA ⁵; TOMAS DE LA MORA RAMIREZ ⁶

¹ *Universidad Tecnológica Fidel Velazquez*

² *Universidad Tecnológica Fidel Velázquez*

³ *CONAHCyT-UPVM*

⁴ *Universidad Politécnica del Valle de Mexico*

⁵ *Universidad Politécnica del Valle de México*

⁶ *TECNOLÓGICO DE ESTUDIOS SUPERIORES DE JOCOTITLÁN*

Autor responsable de la comunicación: 23313023@utfv.edu.mx

The variation in electrical conductivity of surfaces is vital for the efficiency of systems, so the study and control of wear on such surfaces is necessary to predict their proper functioning. This study focuses on analyzing the modification of the properties of a copper alloy when subjected to the boriding process using dehydrated paste, since copper is known for its excellent thermal and electrical conductivity (Wen Jing Zhang, 2024). Through the boriding process, it is combined to form a metalloid with unique properties with the intention of increasing wear resistance. The boriding process was carried out at 900, 950, 1000, and 1100 °C with residence times of 1, 3, and 6 hours, on copper specimens with 95% purity and dimensions of 2 x 2 x 0.1 cm. The borided specimens were subjected to an ultrasonic bath for 5 minutes to remove surface residues and were left to dry completely at room temperature. Mechanical properties were measured using Vickers micro-indentation and Rockwell-C indentation to determine the hardness of the layer as well as its adhesion. The sliding tests were conducted using loads of 50, 100, and 200 grams. The counter-body used was an AISI 52100 steel ball with a rotation time of 5 minutes at 120 RPM per test. The wear tracks were analyzed using optical microscopy, with which the wear rate of the samples was determined.

Keywords:

process, surface, boride, temperatures

Reference:

Weng, XJ., Bai, J., Hou, J. et al. Experimental evidence of surface copper boride. Nano Res. 16, 9602– 9607 (2023)

Ris work was supported by:

This research was funded by Laboratorio de Estudios, Modificación y Aplicación de Superficies (LEMAS)- Universidad Politécnica del Valle de México in the project CIR/0022/2022 of the program “Investigadoras e Investigadores por México” of SECIHTI. Also Grupo Ciencia e Ingeniería de Materiales



BORING TOOLS FOR TEMPERED GLASS

Autor: David Sánchez Huitrón¹

Coautores: Andres López Velázquez²; Enrique Baston Castillo¹; Jorge Víctor Cortes Suárez³; Marco Antonio Doñu Ruiz¹; Milton Carlos Elías Espinoza⁴; Noe López Perrusquía¹

¹ *UNIVERSIDAD POLITÉCNICA DEL VALLE DE MEXICO*

² *universidad Veracruz facultad Xalapa*

³ *Universidad Autónoma Metropolitana*

⁴ *tec de Monterrey campus Santa fe*

Autor responsable de la comunicación: david.sanchez@upvm.edu.mx

This work focuses on the surface modification on drilling tool with boriding treatment to obtain holes on tempered glass. The boriding treatment by dehydrated boron paste was carried out on drilling tool in tempered glass, in a conventional muffie without inert atmosphere; with temperatures at 900 °C for 1 h [Bh1] and 900 °C for 2 h [Bh2]. By optical microscopy the presence of iron boride formed on the surface of [Bh1] and [Bh2] was obtained. To verify the presence of iron borides on the surface of [Bh1] and [Bh2], X-ray diffraction analysis was performed. The hardness evaluation in [Bh1] and [Bh2] was determined by Vickers Microindentation test. Finally, by NOM-146 and under industrial conditions, tempered glass boring was carried out with specimens [Bh1] and [Bh2]. The results showed an increase when using specimens [Bh1] and [Bh2] compared to those without boride coating.

Keywords:

Boriding treatment, tempered glass, hardness evaluation, microindentation, X-ray diffraction

Reference:

[1] Leopoldo García Vanegas, Milton Carlos Elías Espinosa, Noé López Perrusquía, Marco Antonio Doñu Ruiz, Víctor Hugo Olmos Domínguez, Leticia Hernández Ramírez, Lizbeth Melo-Máximo, Analysis of the wear mechanisms of the boriding drill tip,

Ris work was supported by:

This research was funded by Laboratorio de Estudios, Modificación y Aplicación de Superficies (LEMAS)-Universidad Politécnica del Valle de México in the project CIR/0022/2022 of the program "Investigadoras e Investigadores por México" of SECIHTI. Also Grupo Ciencia e Ingeniería de Materiales



GROWTH OF IRON BORIDE ON 304 STAINLESS STEEL

Autor: Marco Sebastian Barrios Hernández¹

Coautores: Noé López Perrusquia ²; Jorge Víctor Cortes Suarez ³; Adalberto Zamudio Ojeda ⁴; Ernesto David García Bustos ²; Marco Antonio Doñu Ruiz ¹; Dulce Aide Sandoval Rosas ¹

¹ *Universidad Politécnica del Valle de México, División de Ingeniería Industrial*

² *Universidad Politécnica del Valle de México División de Ingeniería Industrial*

³ *Universidad Autónoma Metropolitana Unidad Azcapotzalco. Departamento de Materiales*

⁴ *Department of Physics, School of Exact Sciences and Engineering, University of Guadalajara*

Autor responsable de la comunicación: marco.barrios.hernandez@upvm.edu.mx

Modification of surface characteristics is a useful process to increase the efficiency of materials for different applications. The boriding process by dehydrated paste is used in order to obtain iron borides for possible applications in manufacturing. This work shows the change in the surface characteristics of 304 stainless steel by means of the boriding process. This process was performed on substrates with dimensions 0.35 x 0.26 inches at temperatures of 950, 1000 and 1050 °C, using the boriding process by dehydrated paste with times of 1, 3, 6 and 9 h. The modified surfaces were characterized by using the dehydrated paste boriding process. The modified surfaces were characterized using optical microscopy techniques. The results of the surface micrographs show that the growth of the iron boride increases as a function of temperature and time, obtaining a sawing-flat morphology. XRD confirms the formation of iron boride.

Keywords:

boriding, surface characteristics, iron boride, 304 stainless steel.

Reference:

- [1] F.E. Mariani et.al., Characterization and Wear Performance of Borided AISI 304 and UNS S31254 Stainless Steels, Mater. Perform. Charact.,
- [2] Sukru Taktak, Some mechanical properties of borided AISI H13 and 304 steels, Materials & Design, 28(6), 2007, pp 1836-1843,.

Ris work was supported by:

This research was funded by Laboratorio de Estudios, Modificación y Aplicación de Superficies (LEMAS)-Universidad Politécnica del Valle de México in the project CIR/0022/2022 of the program "Investigadoras e Investigadores por México" of SECIHTI. Also Grupo Ciencia e Ingeniería de Materiales



HYBRID PLASMA DEPOSITION OF GaN THIN FILMS FROM A GaAs TARGET

Autor: Enrique Camps¹

Coautores: Enrique Campos-González ²; Manolo Ramírez López ³; Victor Hugo Castrejón-Sánchez ⁴

¹ *ININ, depto de Física*

² *ININ, depto. de Física*

³ *upiiita, IPN*

⁴ *TESJO*

Autor responsable de la comunicación: enrique.camps@inin.gob.mx

Gallium nitride (GaN) thin films were deposited using the pulsed laser deposition technique, in combination with a stationary microwave nitrogen plasma. To carry out the ablation process a GaAs target was used. The ablation plasma interacts with the nitrogen microwave plasma and condensates on the substrate forming the GaN thin film. During the deposition process the substrate was heated by the microwave nitrogen plasma reaching a temperature of 250 °C after a few minutes. The composition of the films was studied by XPS measurements. The oxygen and arsenic contents remain at low levels of 5 and 3 at. %, respectively. The x-ray diffraction measurements showed that the crystalline structure of the films can be modified as a function of the mean kinetic energy of the ions produced during the ablation of the target. For low ion energies (around 100 eV) a polycrystalline hexagonal structure was obtained, with peaks along the (002) and (110) directions. Meanwhile, when higher ion energies were used (around 150 eV), the films showed a preferential orientation along the (110) direction. To induce a further crystallization of the material the as deposited samples were annealed in a nitrogen atmosphere at 600 °C during 1 hour. Photoluminescence and band gap measurements of the as deposited and annealed samples were carried out and the results are discussed.

Keywords:

GaN thin films, microwave plasma, pulsed laser deposition

His work was supported by:

ININ



DEVELOPMENT OF LUBRICANT ADDITIVES BASED ON ADVANCED MATERIALS

Autores: BENJAMIN MARCOS MARIN SANTIBAÑEZ¹; JESUS MORALES INFANTE²; NOE ESAU VALDES SAN- TOS²; SERGIO ODIN FLORES VALLE²

¹ Laboratorio de Reología y Pruebas Físicas, ESIQIE, Instituto Politécnico Nacional, Zacatenco 07738, CDMX, México

² Laboratorio de Química e Ingeniería Verde, ESIQIE, Instituto Politécnico Nacional, Zacatenco 07738, CDMX, México

Autor responsable de la comunicación: noe-456vasa@hotmail.com

Lubricants are essential elements in various industrial sectors, particularly in applications involving moving parts and the transfer of mechanical energy. Their use is critical for ensuring the efficient operation of moving components by reducing friction and wear, thereby extending the lifespan of equipment. However, formulating lubricants suitable for specific operational conditions presents significant challenges due to the wide range of available additives and their particular properties.

In this context, it is anticipated that new additives will not only enhance lubrication under high- pressure conditions but also contribute to sustainability by reducing reliance on tra- ditional addi- tives that may be harmful to the environment. This study focuses on the formulation of alternative lubricants using advanced materials as extreme pressure addi- tives, specifically MXenes.

To this end, three types of lubricant bases incorporating MXenes were developed, utiliz- ing hy- drotreated mineral oil, polyalphaolefin (PAO), and polyol ester as matrices. The lubricant bases were characterized from a rheological and physicochemical perspective, and tribological tests were conducted to evaluate the influence of MXenes on the per- formance of the lubricants compared to conventional formulations.

At the conclusion of the study, the results obtained will be presented, allowing for the assessment of the viability of alternative lubricants and their potential application in the industry. This inno- vative approach could open new technological avenues for the devel- opment of more efficient and sustainable lubricant products.

Keywords:

Mxenes, lubricants, additives, extreme presure

Reference:

Z. Tang y S. Li, «A review of recent developments of friction modifiers for liquid lubricants (2007– present)», Curr. Opin. Solid State Mater. Sci., vol. 18, n.o 3, pp. 119-139, jun. 2014, doi: 10.1016/j.cossms.2014.02.002.

Ris work was supported by:

Instituto Politécnico Nacional



INFLUENCE OF TIMES AND TEMPERATURES ON THE MECHANICAL PROPERTIES OF THE BORIDING LAYERS FORMED IN AN 8620 STEEL

Autores: IRVING LORENZO GALINDO¹; VICTOR JORGE CORTÉS SUÁREZ¹; MIDORI LANDA CASTRO¹; DANIEL FLORES SANCHEZ¹

¹ UNIVERSIDAD AUTÓNOMA METROPOLITANA - AZCAPOTZALCO

Autor responsable de la comunicación: al2212000927@azc.uam.mx

The present work shows a study on the thermochemical treatment of boriding in stages to obtain a multilayer in AISI 8620 steel, using times of 2, 4, 6 and 8 h. The research focused on analyzing fundamental parameters for industrial applications, among which the following stand out: the maximum bending load, microhardness and the formation of the multilayers, mainly [1]. The results indicated a progressive increase in the maximum load, hardness and layer thicknesses. The characterization of the multilayers was carried out by optical microscopy (OM), Scanning Electron Microscopy (SEM) and X-ray diffraction (XRD).

Keywords:

Boriding, 8620 Steel, Heat Treatment, Mechanical properties, Bending test.

Reference:

V. J. Cortés-Suárez, G. González-Mancera, D. Flores-Sanchez, M. Landa-Castro, Susceptibility of nitrided layer mechanical properties in AISI 4140 steel as a response to hydrogen embrittlement. Eng. Res. Express., 7 (2025), 1-8, <https://doi.org/10.1088/2631-8695/adc067>

Ris work was supported by:

Área de Ciencia de Materiales, Departamento de Materiales



MODIFICATION OF CHITOSAN FILMS BY LASER PROCESSING

Autor: BRIAN PINEDA GARCIA¹

Coautores: Adalberto Zamudio Ojeda ²; Ernesto David García Bustos ³; Marco Antonio Doñu Ruiz ⁴; NOE LOPEZ PERRUSQUIA ⁵

¹ *Universidad Politécnica del Valle de México*

² *Department of Physics, School of Exact Sciences and Engineering, University of Guadalajara*

³ *Universidad Politécnica del Valle de México División de Ingeniería Industrial*

⁴ *Universidad Politecnica del Valle de Mexico*

⁵ *Universidad Politecnica del Valle de México*

Autor responsable de la comunicación: jasonbp555@gmail.com

Modification of chitosan films by laser processing

The development of biomaterials has revolutionized the field of regenerative medicine, offering innovative solutions for the repair and replacement of damaged tissues. Among these materials, chitosan has emerged as a promising alternative due to its natural origin, biocompatibility, biodegradability, and bioactive properties. Derived from chitin, chitosan exhibits characteristics that make it ideal for tissue engineering applications, particularly in the form of films, hydrogels, or membranes.

Laser treatment techniques represent a promising approach to modify the surface properties of chitosan films, enabling the optimization of their performance in biomedical applications. To produce these films, a mixture was prepared consisting of 4 g of chitosan, 3 ml of acetic acid, 100 ml of alcohol, and 0.3 ml of triethanolamine. This mixture was stirred magnetically until a homogeneous solution was obtained. The solution was then poured into Petri dishes, which were kept in a light-free environment and allowed to dry under ambient conditions for a period of three days.

Once the films were formed, laser treatment was applied using three variations of power and speed parameters. The equipment used was a laser with a power of 12W and 5W. Square marks measuring 5 mm in length were generated on the surface of the chitosan films, designed to evaluate localized changes.

The morphology of the treated films was analyzed using optical microscopy, while their crystalline structure and elemental composition were evaluated to determine the effects of laser treatment on the material.

Laser treatment induced visible changes in the surface morphology of the chitosan films. Through optical microscopy, modifications in texture and the formation of microstructures in the irradiated areas were observed, depending on the parameters used. At low power and high speed, the surface exhibited slight roughness, whereas at higher power and lower speed, microcracks and carbonized zones were evident, suggesting localized thermal degradation of the material.

Keywords:

chitosan, film, laser, interface, characterization

Reference:

Mujtaba, M., Morsi, R. E., Kerch, G., Elsabee, M. Z., Kaya, M., Labidi, J., & Khawar, K. M. (2019). Current advancements in chitosan-based film production for food technology; A review. *International journal of biological macromolecules*, 121, 889-904.

Ris work was supported by:

This research was funded by Laboratorio de Estudios, Modificación y Aplicación de Superficies (LEMAS)-Universidad Politécnica del Valle de México in the project CIR/0022/2022 of the program "Investigadoras e Investigadores por México" of SECIHTI. Also Grupo Ciencia e Ingeniería de Materiales



SELECTIVE SURFACE PROCESSING ON CUTTING TOOL

Autor: NOE LOPEZ PERRUSQUIA¹

Coautores: Aarón Basilio Guerrero ²; Jorge Víctor Cortes Suarez ³; Leopoldo García Vanegas ⁴; Marco Antonio Doñu Ruiz ¹; Milton Carlos Elías Espinosa ⁵

¹ *Universidad Politécnica del Valle de México*

² *Estancia de Investigación-COMECYT,*

³ *Universidad Autónoma Metropolitana Unidad Azcapotzalco.*

⁴ *Universidad Tecnológica Fidel Velázquez Emiliano Zapata S/N, El Trafico, 54400 Cdad. Nicolás Romero, Méx.*

⁵ *Tecnológico y de Estudios Superiores de Monterrey, Campus Santa F*

Autor responsable de la comunicación: nlopezp@upvm.edu.mx

The present study addresses the application of selective boriding on twist drills made of AISI M2 steel, a material widely used in cutting tools due to its high strength and toughness. The use of copper foil as a boron diffusion inhibitor in specific areas of drill bits is investigated, analyzing its effectiveness in controlling the formation of boride layers. Copper foil as a boron diffusion inhibitor in specific areas of drill bits is a strategy a key to selective thermochemical boriding Treatment; This approach is based on the ability of copper to act as a physical and chemical barrier that prevents the penetration of boron atoms into the coated areas during treatment at high temperatures.

Keywords:

Boriding, Tools, Copper, Surface, Hardening

Reference:

- [1] Vanegas, Leopoldo García et al. Microscopy and Microanalysis (2021) 27 S1 3406–8
- [2] Domínguez, Víctor Olmos et al.. Microscopy and Microanalysis (2020) 26 S2 388–90.
- [3] Domínguez, Víctor Hugo Olmos et al. Microscopy and Microanalysis 27 S1 (2021) 2384–86.

Ris work was supported by:

This research was funded by Laboratorio de Estudios, Modificación y Aplicación de Superficies (LEMAS)- Universidad Politécnica del Valle de México in the project CIR/0022/2022 of the program “Investigadoras e Investigadores por México” of SECIHTI



TERMOCHEMICAL BORIDING OF AISI 1080 STEEL: A STUDY ON SURFACE HARDENING AND LAYER GROWTH

Autores: MAURICIO RODRÍGUEZ MONROY¹; IRVING LORENZO GALINDO¹; VÍCTOR JORGE CORTÉS SUÁREZ¹; MIDORI LANDA CASTRO¹; DANIEL FLORES SANCHEZ¹

¹ *UNIVERSIDAD AUTÓNOMA METROPOLITANA - AZCAPOTZALCO*

Autor responsable de la comunicación: al2182002144@azc.uam.mx

This study evaluates the effect of time and temperature on the boriding process of AISI 1080 steel, aiming to analyze the microstructural and mechanical modifications induced on the surface layer [1]. Thermal treatments were conducted under controlled conditions, and the resulting layers were characterized using scanning electron microscopy (SEM), X-ray diffraction (XRD), and Vickers microhardness testing. The results allow the establishment of correlations between process variables and parameters such as layer thickness, hardness, and morphology. It is hypothesized that increasing the boriding time and/or temperature enhances boron diffusion, leading to thicker layers with higher surface hardness.

Keywords:

Boriding, AISI 1080 Steel, Heat Treatment, Mechanical properties, Surface hardening.

Reference:

V. J. Cortés-Suárez, G. González-Mancera, D. Flores-Sanchez, M. Landa-Castro, Susceptibility of nitrided layer mechanical properties in AISI 4140 steel as a response to hydrogen embrittlement. *Eng. Res. Express.*, 7 (2025), 1-8, <https://doi.org/10.1088/2631-8695/adc067>

Work was supported by:

Área de Ciencia de Materiales, Departamento de Materiales



LASER-INDUCED SURFACE MODIFICATION OF SPUTTERED MO FILMS ON GLASS: INFLUENCE OF IRRADIATION DIRECTION AND WAVELENGTH

Autor: José Guadalupe Quiñones Galván¹

Coautores: Yamilet Rodríguez Lazcano ²; Enue Barrios Salgado ³; Laura Patricia Rivera Reséndiz ⁴; Gilberto Gómez Rosas ¹

¹ *Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara*

² *Universidad Autónoma de Nayarit*

³ *Instituto de Energías Renovables, Universidad Nacional Autónoma de México*

⁴ *Universidad de Guadalajara*

Autor responsable de la comunicación: jose.quinones@academicos.udg.mx

Laser surface modification techniques offer a flexible, non-contact approach to tune the structural and optical properties of metallic films with high spatial resolution. Previous studies have shown that Mo films undergo oxidation, phase changes, or ablation depending on the laser fluence and ambient conditions. Furthermore, in film-substrate systems, the direction of laser incidence—whether through the film or through the substrate—can significantly affect energy deposition dynamics and heat propagation, yet this aspect remains underexplored for Mo layers.

In this work molybdenum thin films were deposited on glass substrates by DC magnetron sputtering and subsequently irradiated in air with a single pulse of a Nd:YAG laser at 1064 and 532 nm. Irradiation was carried out from both the film side and the substrate side to assess the influence of the incidence direction and wavelength on the modification process. Post-irradiation analyses reveal significant changes in the optical and structural properties of the Mo layers, which vary with the laser wavelength and the side of incidence. These results provide insight into direction-sensitive energy transfer mechanisms and contribute to the understanding of laser-assisted engineering of Mo-based coatings.

Keywords:

Mo, laser modification, surface irradiation

Reference:

No reference

Ris work was supported by:

Universidad de Guadalajara



SYNTHESIS AND CHARACTERIZATION OF Chitosan (Cts) REINFORCED WITH HYDROXYAPATITE (Ha) VIA AN ELECTROCHEMICAL PROCESS ON 316L STAIN- LESS STEEL

Autor: Karla García Mares¹

Coautores: Ernesto David García Bustos²; Jesús Leonardo Juárez Rojas¹; Marco Antonio Doñu Ruiz¹; Noe Lopez Perrusquia¹

¹ Universidad Politécnica del Valle de México

² Universidad Politécnica del Valle de México División de Ingeniería Industrial

Autor responsable de la comunicación: karlaamaress@gmail.com

The development of biofunctional coatings for orthopedic implants is essential to enhance osseointegration and extend the service life of medical devices. This study reports the synthesis and characterization of chitosan (Cts) films reinforced with hydroxyapatite (Ha), deposited on 316L stainless steel substrates by means of an electrodeposition process.

The electrolyte consisted of an aqueous solution of chitosan dissolved in glacial acetic acid, in which hydroxyapatite particles were homogeneously dispersed. The electrodeposition conditions were controlled by varying the applied voltage (2, 6, 8, and 10 V) and deposition time (30, 60, 90, and 120 minutes), enabling the formation of coatings with different morphologies and thicknesses.

The surface morphology and film thickness were evaluated using optical microscopy, revealing continuous, and porous surfaces. An increase in both thickness and porosity was observed at higher voltages and longer deposition times.

The crystalline structure of the coatings was analyzed using X-ray diffraction (XRD), identifying characteristic peaks corresponding to hydroxyapatite, along with semi-crystalline signals attributed to chitosan. These findings confirm the coexistence of both phases within the composite coating. Chemical composition was assessed by Fourier-transform infrared spectroscopy (FTIR), where absorption bands associated with the functional groups of chitosan ($-\text{OH}$, $-\text{NH}_2$, $\text{C}-\text{O}-\text{C}$), as well as the phosphate and calcium signals of hydroxyapatite, were detected.

The adhesion of the coatings to the metallic substrate was evaluated using the tape test method in accordance with ASTM D3359. Good adhesion was observed in coatings deposited at intermediate voltages (6–8 V).

Overall, the results indicate that the electrodeposition of chitosan reinforced with hydroxyapatite on 316L stainless steel produces bioactive coatings that are structurally stable and possess surface properties conducive to osseointegration. This technique shows promise as a viable method for the surface modification of orthopedic implants.

Keywords:

AISI 316L, electrodeposition, chitosan, hydroxyapatite, characterization.

Reference:

Louvier-Hernández, J. F., García, E., Mendoza-Leal, G., Flores-Flores, T., Flores-Martínez, M., Rodríguez de Anda, E., & Hernández-Navarro, C. (2021). Effect of the variation of the electrodeposition time of hydroxyapatite/chitosan coatings on AISI 316L SS. *Journal of Composite Materials*, 55(29), 4421-4430.

Ris work was supported by:

This research was funded by Laboratorio de Estudios, Modificación y Aplicación de Superficies (LEMAS)-Universidad Politécnica del Valle de México in the project CIR/0022/2022 of the program "Investigadoras e Investigadores por México" of SECIHTI. Also Grupo Ciencia e Ingeniería de Materiales.



WEAR STUDY OF CHITOSAN (Cts) FILMS REINFORCED WITH HYDROXYAPATITE (Ha) DEPOSITED VIA ELECTROCHEMICAL METHOD ON 316L STAINLESS STEEL

Autor: Jesús Leonardo Juárez Rojas¹

Coautores: Ernesto David García Bustos²; Karla Garcá Mares¹; Marco Antonio Doñu Ruiz¹; Noe Lopez Per-Rusquia¹

¹ Universidad Politécnica del Valle de México

² Universidad Politécnica del Valle de México División de Ingeniería Industrial

Autor responsable de la comunicación: leonardojuarez976@gmail.com

The development of biofunctional coatings on metallic materials for orthopedic implants is essential to improve integration and functionality in contact with bone tissue. In this study, films composed of chitosan (Cts) reinforced with hydroxyapatite (Ha) were deposited on 316L stainless steel substrates via electrodeposition.

The electrolyte consisted of a solution of chitosan dissolved in bidistilled water and glacial acetic acid, with a homogeneous dispersion of hydroxyapatite particles. Electrodeposition was performed by applying voltages of 2, 6, 8, and 10 V for durations of 30, 60, 90, and 120 minutes, producing coatings with different morphologies and thicknesses.

The films exhibited homogeneous morphology and continuity, with thickness increasing as deposition voltage and time increased. The incorporation of hydroxyapatite conferred bioactive properties to the coatings, promoting osseointegration. The coatings demonstrated good adhesion to the substrate, evaluated through standard tests.

Wear tests were conducted using a sliding technique based on a modified microabrasion test (without abrasive), revealing variation in wear track dimensions depending on coating thickness. Thicker coatings exhibited greater wear resistance, highlighting the importance of thickness control to optimize coating durability.

Overall, these results indicate that Cts-Ha coatings not only enhance bioactivity but also provide adequate surface wear resistance under frictional conditions, making them a promising alternative for applications in orthopedic implants subjected to repeated mechanical stress.

Keywords:

AISI 316L, electrodeposition, chitosan, hydroxyapatite, characterization.

Reference:

Louvier-Hernández, J. F., García, E., Mendoza-Leal, G., Flores-Flores, T., Flores-Martínez, M., Rodríguez de Anda, E., & Hernández-Navarro, C. (2021). Effect of the variation of the electrodeposition time of hydroxyapatite/chitosan coatings on AISI 316L SS. *Journal of Composite Materials*, 55(29), 4421-4430.

Ris work was supported by:

This research was funded by Laboratorio de Estudios, Modificación y Aplicación de Superficies (LEMAS)-Universidad Politécnica del Valle de México in the project CIR/0022/2022 of the program "Investigadoras e Investigadores por México" of SECIHTI. Also Grupo Ciencia e Ingeniería de Materiales.



STUDY OF Ti-Mg COATINGS AND THEIR EFFECT AS SHIELDING AGAINST IONIZING RADIATION

Autor: Carlos Rivera Rodriguez¹

Coautores: Enrique Campos Gonzalez ²; Enrique Camps ²; Ivan Camps ^{3 1}

INSTITUTO NACIONAL DE INVESTIGACIONES NUCLEARES

² *ININ*

³ *Tecnologico de Monterrey*

Autor responsable de la comunicación: carlos.rivera@inin.gob.mx

High-purity nanostructured multilayers of titanium and magnesium, composed of 10 and 20 periods, are obtained using the Pulsed Laser Ablation Deposition technique on Pyrex glass substrates under various working conditions, without exceeding certain allowable values, such as: maximum and minimum laser power, excellent base and working vacuums, similar time-of-flight curves of the ions present during the growth of the films, etc. The thicknesses of each sample are calculated using the previously determined growth ratio and corroborated by contact profilometry. The elemental characterization of the multilayers was performed by various techniques such as: X-ray Photoemission Spectroscopy and Energy Dispersed X-ray Spectroscopy. Once each sample was characterized, they were subjected to continuous irradiation until reaching dose of 6.0 kGy of gamma radiation, by being subjected to a ⁶⁰Co source, directly exposing them and protecting them with the different multilayers as a shield.

Keywords:

Nanostructured multilayers, Ti-Mg, PLD, Gamma Radiation

Reference:

Pellicori S. F., Russell E. E. & Watts L. A. (1979). Radiation induced transmission loss in optical materials. *Applied. Optics*, 18(15), 2618-2621. <https://doi.org/10.1364/AO.18.002618>.



APPLICATION OF COUPLED RESONANCES (CR) LINE SHAPE IN XPS ANALYSIS OF FIFTH PERIOD ELEMENTS

Autor: Abraham Jorge Carmona Carmona¹

Coautores: Alberto Herrera Gomez²; B.V. Crist; Carlos Alberto Ospina-Ocampo²; Dulce María Guzmán Bucio³; Martin Rodolfo Palomino Merino; Orlando Cortazar Martinez⁴

¹ FCFM, Benemérita Universidad Autónoma de Puebla

² CINVESTAV

³ Centro de Investigación y Estudios Avanzados (CINVESTAV) unidad Querétaro

⁴ CINVESTAV, Unidad Querétaro

Autor responsable de la comunicación: carmona95@yahoo.com.mx

This article presents the application and advantages of the Coupled Resonances (CR) line shape in X-ray photoelectron spectroscopy (XPS) for analyzing core-level spectra of sixth-period elements. The CR line shape is formed by combining the left and right halves of two Lorentzian functions with different widths, convoluted with a Gaussian profile. This asymmetric and integrable form provides significant benefits over the standard Doniach-Sunjić (DS) function, including a reduction in the number of free peak parameters and greater stability in spectral fitting. The CR line shape enables more reliable quantification by minimizing uncertainties and improving fit precision. For example, Bi 4f spectra can be modeled effectively using asymmetric CR doublets instead of multiple symmetric Voigt doublets, simplifying analysis while achieving superior results. The article also emphasizes the importance of selecting an appropriate background model, such as the Shirley-Vegh-Salvi-Castle (SVSC) background, which is particularly useful for complex spectra involving overlapping peaks or sloped backgrounds. The SVSC background facilitates accurate extraction of peak intensities without operator bias. This work provides practical guidance for researchers seeking robust peak shapes and background models for high-quality XPS data analysis.

Keywords:

CR line shape, XPS, fifth-period elements, SVSC

Reference:

The Coupled-Resonances Asymmetric Lineshape for Photoemission Spectra, Herrera-Gomez, Guzman- Bucio, Cabrera-German, Carmona-Carmona, Vincent Crist, Anthony D. Dutoi⁵.
Characterizing the Intrinsic Background in XPS Using the Narrow-Shirley Approach. Herrera-Gomez, Dulce Guzman-Bucio, Cabrera-German, Anthony Dutoi, Vazquez-Lepe, Cortazar-Martinez, Carmona- Carmona



EXPERIMENTAL STUDY ON MICROALLOYED STEEL WITH LAYERS SUBJECTED TO DIESEL

Autor: Victor Hugo Olmos Domínguez¹

Coautores: David Sánchez Huitrón¹; Ernesto David García Bustos¹; Gerardo Julián Pérez Mendoza¹; Marco Antonio Doñu Ruiz¹; Tomas de la Mora Ramírez²

¹ UNIVERSIDAD POLITECNICA DEL VALLE DE MEXICO

² TecNM Tecnológico de Estudios Superiores de Jocotitlán

Autor responsable de la comunicación: victor.dominguez@utfv.edu.mx

Abstract: This work studies the mechanical behavior of microalloyed steels (API X60 and API X70) with boride layers using a boriding process and immersion in diesel. First, the microalloyed steels were borided using dehydrated boron paste at a temperature of 1273 K for 6 h, and then the borided microalloyed steels were immersed in diesel for one year. The characterization of the layers on the specimens subjected to diesel used scanning electron microscopy (SEM), energy dispersive spectroscopy, and X-ray diffraction (XRD). The evaluation of the mechanical properties was performed with tensile tests according to ASTM E8, and then the fracture surface was observed by SEM. This work contributes to the understanding of the changes in the mechanical properties of borided microalloyed steel immersed in diesel for possible potential applications in the storage of fuels, oils, hydrogen, and biofuels.

Keywords:

dehydrated boron; mechanical testing; surface engineering

Reference:

Uczak de Goes, W. Thermal Barrier Coatings with Novel Architectures for Diesel Engine Applications. *Surf. Coat Technol.* 2020, 396, 125950.
Sathish, M. Challenges, and Future Prospects of Thin Film Coating Techniques and Coating Structures. *J. Bio-Tribo-Corros.* 2023, 9, 35.

Ris work was supported by:

This research was funded by Laboratorio de Estudios, Modificación y Aplicación de Superficies (LEMAS)-Universidad Politécnica del Valle de México in the project CIR/0022/2022 of the program "Investigadoras e Investigadores por México" of SECIHTI. Also Grupo Ciencia e Ingeniería de Materiales



INFLUENCE OF TiO₂ COATING SURFACE ROUGHNESS ON THE CORROSION BEHAVIOR OF AZ31 ALLOY

Autor: José Antonio Barrera Fernández¹

¹ *Universidad de Guanajuato*

Autor responsable de la comunicación: ja.barrerafernandez@ugto.mx

This study investigates the effect of TiO₂ coating surface roughness on the pitting corrosion and passivation behavior of AZ31 magnesium alloy in a simulated body fluid (SBF) environment. Electrochemical impedance spectroscopy (EIS) and potentiodynamic polarization (PDP) techniques were employed to assess the electrochemical performance. The results indicated that the surface roughness significantly influences the passivation characteristics of the alloy. Scanning electron microscopy of samples immersed for 72 hours revealed pronounced pitting corrosion on the alloy with the highest surface roughness, while no visible pitting was observed on the smoother surface, likely due to the presence of corrosion residues. Notably, when passivity was disrupted by galvanostatically maintaining the alloy at an anodic current for 1 hour at 37° C, severe pitting corrosion occurred. These findings highlight surface roughness as a critical parameter affecting the stability and pitting susceptibility of TiO₂-coated AZ31 magnesium alloys.

Keywords:

Surface roughness, Pitting corrosion, Passivation

Reference:

Song G, Atrens A. Understanding magnesium corrosion—a framework for improved alloy performance. *Adv Eng Mater* 2003;5:837–58.

His work was supported by:

SECIHTI



INFLUENCE OF BORIDING AND NITRIDING ON AISI 9840 STEEL

Autor: Gerardo Julián Perez Mendoza¹

Coautores: Ernesto David García Bustos²; Jorge Víctor Cortez Suárez³; Marco Antonio Doñu Ruíz¹; Noe López Perruzquia¹

¹ *Universidad politécnica del valle de México*

² *CONAHCYT-UPVM*

³ *Universidad autónoma metropolitana*

Autor responsable de la comunicación: geras493@hotmail.es

Using an AISI 9840 steel used for engineering components in the metal-mechanical, aeronautical, naval and automotive industries; a novel surface coating is formed by means of Dehydrated paste pack Boriding and Gas Nitriding treatment. The characterization of the obtained coating was performed by optical microscopy, Microhardness and X-ray diffraction (XRD). The results showed a duplex coating type Fe₃N+Fe₂B/FeB. The microhardness measured on the Fe₃N+Fe₂B/FeB coating shows microhardness change on iron nitride and iron borides. On the other hand, the mechanical behavior is evaluated by Three-point bend detecting the flexural behavior of the Dehydrated paste pack Boriding and Gas Nitriding duplex treatment.

Keywords:

Boriding, Nitriding, Surface Dúplex

Reference:

References

[1] Carbucicchio, M., Palombarini, G. Surface modifications for mechanical applications, *Hyperfine Interact.* 83 (1994) 91-110. <https://doi.org/10.1007/BF02074262>

Ris work was supported by:

SECIHTI



A STUDY ON SLIDING WEAR OF HDPE COATED WITH A TITANIUM LAYER DE- POSITED USING THE PULSED LASER DEPOSITION (PLD) TECHNIQUE.

Autor: Ernesto García¹

Coautores: José Guadalupe Quiñones Galván ²; Marco Antonio Doñu Ruiz ³; NOE LOPEZ PERRUSQUIA ⁴

¹ SECIHTI-UPVM

² Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara

³ Universidad Politécnica del Valle de México

⁴ Universidad Politécnica del Valle de México

Autor responsable de la comunicación: edgb007@hotmail.com

High-density polyethylene (HDPE) is utilized in various applications, particularly in orthopedic de- vices. However, HDPE has demonstrated lower wear resistance, leading to surface wear and a significant accumulation of debris. To address this issue, several projects focus on modifying the surfaces of HDPE to improve their tribological properties. One effective method for enhancing these surface characteristics involves depositing a layer of specific materials that possess desirable properties. This work presents initial results on improving the wear resistance of HDPE through the deposition of a titanium (Ti) layer using pulsed laser deposition (PLD). The Ti layers were de- posited on HDPE substrates with varying laser power, using a Ti target. The structural, elemental, and morphological characteristics of the Ti layers were characterized using X-ray diffraction (XRD), energy-dispersive X-ray spectroscopy (EDS), and optical and scanning electron microscopy (SEM). The change in hardness due to the PLD process was measured using the Shore D hardness scale, revealing an increase from 58 to 61 for both uncoated and coated, respectively HDPE surface. Addi- tionally, the impact of the Ti layer on the wear resistance of HDPE surfaces was examined using a modified ball-cratering technique, and the wear track was characterized using optical and scanning electron microscopy.

Keywords:

Wear, PLD, HDPE, Microabrasion

Reference:

Gopanna, Polyethylene and polypropylene matrix composites for biomedical applications. In Materials for biomedical engineering; Elsevier: 2019.
Hasegawa, M. Ultra-high-molecular-weight polyethylene in hip and knee arthroplasties. Materials 2023. Bitar, D. Biological response to prosthetic debris. World journal of orthopedics 2015.

Ris work was supported by:

Investigadoras e Investigadores por México- SECIHTI



FRactal SCALING OF Fe_2B MONOLAYER ROUGHNESS FORMED ON AISI 9254 STEEL USING REUSED BORON PASTE

Autores: Lizbeth Sanchez Fuentes¹; Marco Antonio Doñu Ruiz²; Noé López Perrusquia²

Coautores: Edgar Israel García Otamendi ³; Hugo David Sánchez Chávez ⁴; Sergio Matias Gutierrez ⁵

¹ Doctorado en ciencias de materiales, Universidad Politécnica del Valle de México

² Universidad Politécnica del Valle de México

³ Universidad Autónoma del Estado de Hidalgo

⁴ Universidad Tecnológica de la Mixteca

⁵ Instituto Tecnológico de Estudios Superiores del Oriente del Estado de México

Autor responsable de la comunicación: lizbeth.sanchez@upvm.edu.mx

This study investigates the fractal scaling behavior of fluctuations associated with the rough inter- faces formed by the growth of the Fe_2B layer produced through the thermochemical treatment using dehydrated boron paste at temperatures of 1173.15, 1223.15, and 1273.15 K, and treatment times of 3600, 7200, 10800, and 14400 seconds, respectively, on AISI 9254 steel. The structure function metric of order q is employed to quantify the scaling of fluctuations linked to surface roughness, representing variations in borided layer thickness as a function of the observation scale δ . The results show that the fluctuation patterns exhibit scaling behavior characterized by Hurst exponents within regimes of both statistical persistence and antipersistence. Additionally, the activation energy for boron diffusion in AISI 9254 steel was estimated by considering diffusivity v was obtained, with diffusivities $K_1 = 1.33 \times 10^{-13}$, $K_2 = 2.12 \times 10^{-13}$, and $K_3 = 2.972 \times 10^{-13}$. Furthermore, the activation energy range was determined by considering the correlation scales δ of the fluctuations in borided layer thickness. This methodology not only enhances the accuracy of activation energy estimation but also reveals that different thicknesses correlated at distinct observation scales δ are governed by distinct diffusion coefficients. alues at the three evaluated temperatures. Overall, an activation

energy of $Q = 97.578 \text{ kJ} \cdot \text{mol}^{-1}$ was obtained, with diffusivities $K_1 = 1.33 \times 10^{-13}$, $K_2 = 2.12 \times 10^{-13}$, and $K_3 = 2.972 \times 10^{-13}$. Furthermore, the activation energy range was determined by considering the correlation scales δ of the fluctuations in borided layer thickness. This methodology not only enhances the accuracy of activation energy estimation but also reveals that different thicknesses correlated at distinct observation scales δ are governed by distinct diffusion coefficients.

Keywords:

Fractal analysis, Hurst exponent, boron, AISI 9254 steel

Reference:

I. Campos-Silva, A.S. Balankin, A.H. Sierra, N. López-Perrusquia, R. Escobar-Galindo, D. Morales-Matamoras, Characterization of rough interfaces obtained by boriding, Applied Surface Science. 255 (2008) 2596- 2602. <https://doi.org/10.1016/j.apsusc.2008.07.142>.

Ris work was supported by:

This research was funded by Laboratorio de Estudios, Modificación y Aplicación de Superficies (LEMAS)- Universidad Politécnica del Valle de México in the project CIR/0022/2022 of the program "Investigadoras e Investigadores por México" of SECIHTI. Also Grupo Ciencia e Ingeniería de Materiales



DEPOSITION OF SUPERCONDUCTING MOLYBDENUM NITRIDE FILMS USING A HYBRID PLASMA SYSTEM.

Autor: Enrique Campos Gonzalez¹

Coautores: Agustin Conde-Gallardo ²; CARLOS RIVERA RODRIGUEZ ³; Enrique Camps ¹; José Guadalupe Quiñones Galván ⁴

¹ *ININ*

² *FISICA-CINVESTAV*

³ *INSTITUTO NACIONAL DE INVESTIGACIONES NUCLEARES*

⁴ *Departamento de Física, Centro Universitario de Ciencias Exactas e Ingenierías, Universidad de Guadalajara*

Autor responsable de la comunicación: enriquecampos82@gmail.com

In this work, superconducting molybdenum nitride (MoN) thin films were deposited at a relatively low temperature (250 °C) using a hybrid plasma system. This system combines stationary continuous plasma, generated by an electron cyclotron resonance (ECR) microwave discharge in a nitrogen atmosphere, with a pulsed plasma produced by laser ablation of a molybdenum (Mo) metallic target. By varying the average kinetic energy of the pulsed plasma ions, we investigated its influence on the structural, chemical, and electrical properties of the films, specifically focusing on its superconducting behavior as a function of the ion kinetic energy.

The structural characterization of the films performed by X-ray diffraction showed the presence of the δ -MoN (hexagonal) phase in all cases. The XPS analysis showed that the nitrogen content decreases as an effect of the increase of the kinetic energy of the ions. The superconducting transition temperature (T_c) increased from 5.1 K to 7.2 K as the deposition kinetic energy increased from 200 eV to 440 eV. This suggests that higher ion kinetic energy, which promotes the formation of Mo-N bonds, leads to improved superconducting properties.

Keywords:

microwave plasma, pulsed laser deposition, kinetic energy, molybdenum nitride, superconductivity.

Reference:

[1] Z.N. Jaf, H.A. Miran, Z.T. Jiang, M. Altarawneh, Molybdenum nitrides from structures to industrial applications, *Rev. Chem. Eng.* 39 (2023) 329–361. <https://doi.org/10.1515/revce-2021-0002>.

Ris work was supported by:

E. Campos-Gonzalez thank IXM CONAHCYT, México (Grant no. CIR/004/2023)



ANALYSIS AND STUDY OF THE GROWTH OF SiO₂ AND POROUS-SiO₂ FILMS BY DC REACTIVE SPUTTERING

Autores: Lorena Conchita Cruz Gabarain¹; Noemi Abundiz Cisneros²; Roberto Sangines³

Coautores: Duilio Valdespino Padilla ⁴; Estrella Terán Hinojosa ⁵; Juan Águila Muñoz ²; Paulina Segovia Olvera ¹; Roberto Machorro Mejía ⁵

¹ Centro de Investigación Científica y de Educación Superior de Ensenada, Baja California

² SECIHTI, Centro de Nanociencias y Nanotecnología, UNAM

³ SECIHTI, Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México

⁴ Facultad de Ciencias, Universidad Autónoma de Baja California

⁵ Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México

Autor responsable de la comunicación: nabundiz@ens.cnyn.unam.mx

This study details the properties and applications of silicon dioxide (SiO₂) thin films, with a particular emphasis on their porous variants, highlighting their importance in optical applications. SiO₂ thin films are widely used in various applications, including optical lenses, solar panels, architectural windows, and building facades, thanks to their exceptional attributes such as abrasion resistance, transparency, biocompatibility, and low refractive index. The tunable porosity of these films facilitates precise tuning of the refractive index, positioning them as ideal candidates to produce optical filters and biomedical applications. For the deposition process, the reactive sputtering technique with DC magnetron was used. A high-purity silicon target was used as the primary starting material.

Throughout the process, argon and oxygen gases were used to generate plasma, which was meticulously monitored using high-precision spectrometers and software developed in Python. The emission lines of species such as Si, Ar, and O were thoroughly analyzed to establish direct correlations with the properties of the synthesized films, thus ensuring a better understanding of their intrinsic characteristics. The primary objective of this study is to establish a precise correlation between the attributes of the plasma generated during the sputtering process and the intrinsic properties of the resulting films. A comparative characterization of the results of Raman spectroscopy, atomic force microscopy (AFM), plasma spectral line ratio, and spectral ellipsometry is performed.

Keywords:

Thin films, sputtering, Emission Lines, optical properties

Reference:

Sanginés, R., Abundiz N., Utrera, O. H., Dilegros C., Machorro, R. (2018). Plasma emission spectroscopy and its relation to the refractive index of silicon nitride thin films deposited by reactive magnetron sputtering. J. Phys. D: Appl. Phys. 51 095203. DOI:10.1088/1361-6463/AAA8D4

Ris work was supported by:

This work was supported by SECIHTI [CF-2023-I-704] and PAPIIT-UNAM [Grant Number BG101123].



CHARACTERIZATION OF CHITOSAN (Cts) COATINGS REINFORCED WITH HYDROXYAPATITE (Ha) ON CYLINDRICAL TITANIUM ALLOY (Ti) SUBSTRATES

Autor: Wendy Esperanza Rico Cabrera¹

Coautores: Daniel Andre Herrera Arellanes²; Ernesto David García Bustos³; Marco Antonio Doñu Ruíz²; Noe López Perruzquia²

¹ Universidad Politécnica del Valle de México

² Universidad politécnica del valle de México

³ Universidad Politécnica del Valle de México División de Ingeniería Industrial

Autores responsables de la comunicación: danyandre.ha@gmail.com, alezasunion000@gmail.com

One of the main challenges in permanent orthopedic prostheses is their limited interaction with surrounding biological tissue. Enhancing bone tissue regeneration to improve integration between the implant and natural bone remains a key objective in the design and development of implant materials, particularly given the complex geometries of these devices. Chitosan (Cts) is widely studied due to its biocompatibility and ease of functionalization with materials possessing specific properties, such as hydroxyapatite (Ha). Electrochemical deposition of Cts films reinforced with Ha particles on titanium surfaces offers a promising approach for improving implant-tissue interaction. This study presents the characteristics of Cts-Ha composite coatings obtained through electrochemical methods. The electrolyte, composed of Cts and Ha in denatured ethyl alcohol, was placed in a graphite crucible serving as the anode, while cylindrical Ti alloy samples functioned as the cathode. Coatings were deposited at voltages of 15 V and 20 V for 60 minutes. The morphology and thickness of the resulting films were analyzed by optical microscopy, while crystalline structure and elemental composition were studied using X-ray diffraction (XRD) and Fourier-transform infrared spectroscopy (FTIR). Adhesion was evaluated through the ASTM D3359 "tape test." Morphological analysis showed a relatively homogeneous microstructure, while spectroscopic techniques confirmed the presence of organic and inorganic phases. Voltage and deposition time influenced coating thickness and stability.

Preliminary results suggest electrochemical deposition is an effective technique for producing bioactive coatings, potentially enhancing osseointegration and reducing implant failure risks, making it a viable surface modification strategy for titanium-based biomedical devices.

Keywords:

Wear, PLD, HDPE, Microabrasion, Chitosan

Reference:

Che Isa, N. N., Mohd, Y., & Yury, N. (2012). Effect of chitosan on the formation of hydroxyapatite (HAp) coatings on titanium by electrodeposition technique.
Conference: CHUSER. XRD y FTIR confirmaron fases orgánicas e inorgánicas.

Ris work was supported by:

This research was funded by Laboratorio de Estudios, Modificación y Aplicación de Superficies (LEMAS)-Universidad Politécnica del Valle de México in the project CIR/0022/2022 of the program "Investigadoras e Investigadores por México" of SECIHTI. Also Grupo Ciencia e Ingeniería de Materiales.



PLASMA NITRIDING OF QUARTZ

Autor: Stephen Muhl¹

Coautores: Julio Cruz²; Marco Antonio Martinez Fuentes³

¹ *Instituto de Investigaciones en Materiales, Uni Nacional Autonoma de Mexico*

² *IIM, UNAM*

³ *Instituto de Investigaciones en Materiales - UNAM*

Autor responsable de la comunicación: muhl@unam.mx

Plasma nitriding is a well-established technique for surface hardening of metals to improve their mechanical and tribological properties. Typically, plasma nitriding involves the use of a glow discharge of a mixture of nitrogen and hydrogen, where the metal component to be treated is the cathode and the chamber wall is the anode. The low-pressure plasma (15–1500 Pa) produced by a DC potential (0.3–1.0 kV) contains nitrogen ions, which are accelerated towards the cathode and implanted in the surface of the metal. The treatment time, surface concentration of nitrogen, and temperature of the metal component determine the depth of the nitride layer, but various tens of microns are often formed. We have developed a variant of the normal plasma nitriding scheme where the discharge is produced by applying an RF potential and the piece to be nitrided is mounted on a magnetron cathode. Studies have shown that the DC voltage bias generated on an insulating target used in a RF magnetron sputtering depends on the following factors: the areas of the anode and cathode, the RF power, the gas pressure and composition, and the matching of the impedance system. We have measured the DC bias potential and the rate of sputtering of a quartz target mounted on a 2"MAK magnetron cathode in a pure nitrogen gas discharge as a function of the area of the anode, the gas pressure, the applied power, and the degree of matching. Using conditions of minimum sputter etching of the target, we nitrided various samples as a function of relative area of the anode, the gas pressure and time. We present the dimensions and composition of the nitride layer measured using XPS and RBS, and the hardness and wear resistance of a selection of the layers.

Keywords:

Nitriding, plasmas, quartz

Reference:

Vethanayagam, Thirukumar K. and P. F. Johnson. "Surface hardness and chemical durability of low pressure plasma-nitrided amorphous silica." *Glass Technology* 30 (1989): 179-183.

Ris work was supported by:

PAPIIT Project IG101123



INTERFACIAL RHEED STUDY FOR 2D WSe₂ CVD-GROWN OVER SAPPHIRE

Autor: Felipe Eduardo Perea Parrales¹

Coautores: Alexis Fernández Fernández²; Daniel Lopez Vilchis³; Donato Valdez Pérez⁴; Felipe Cervantes Sodi⁵; Gerardo García Naumis⁶; Guadalupe del Carmen Yépez Barradas²; Leticia Ithsmel Espinosa Vega⁷; Maria Fernanda Mora Herrera⁸; Victor Hugo Mendez García³

¹ Universidad Nacional Autónoma de México

² Facultad de Ciencias, Universidad Autónoma de San Luis Potosí

³ Universidad Autónoma de San Luis Potosí

⁴ Instituto Politécnico Nacional, SEPI-ESIME,

⁵ Universidad Iberoamericana

⁶ UNAM

⁷ Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí

⁸ Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

Autores responsables de la comunicación: felipe.cervantes@ibero.mx, fperea@fisica.unam.mx

The interaction between chemical vapor deposition (CVD)-grown 2D materials (2DMs) and their native substrates (NS) significantly modulate 2DM optical and electronic properties [1]. This interaction also dictates the 2DM/NS interfacial adhesion energy (Γ), a critical parameter for 2DM transfer to other surfaces [2]. Efficient transfer is essential for leveraging 2DM properties in device integration and diverse applications [3].

2DM transfer remains an unresolved challenge. A recent methodology proposes clean, integral 2DM transfer by enhancing intrinsic out-of-plane vibrations, which stabilize 2DMs [4]. This is achieved via slight NS temperature elevation. Increased out-of-plane vibrations expand the average 2DM/NS interfacial distance ($\bar{d}$), reducing Γ sufficiently to facilitate transfer. Limited theoretical and experimental studies describe or measure this phenomenon [5, 6].

This work focuses on measuring $\bar{d}$ as a function of temperature without transducer perturbation. Reflection High-Energy Electron Diffraction (RHEED) was employed for in situ reciprocal space observation of the 2DM/NS interface. Reciprocal space analysis yields $\bar{d}(T)$ and enables $\Gamma(\bar{d})$ estimation when combined with an appropriate theoretical model of intrinsic 2DM vibrations.

References

- [1] Su et al. (2015). Nano Research, 8, 2686-2697.
- [2] Gurarslan, A. et al. (2014). ACS nano, 8(11), 11522-11528.
- [3] Dong, W. et al. (2024). Advanced Materials, 36(22), 2303014.
- [4] Cheliotis, I., & Zergioti, I. (2024). 2D Materials, 11(2), 022004.
- [5] Wang, P., Gao, W., & Huang, R. (2016). Journal of Applied Physics, 119(7) [6] Polfus, J. et al.(2021). Advanced Materials Interfaces, 8(20), 2100838.

Keywords:

RHEED, 2D materials, CVD, sapphire, WSe₂, interface

Reference:

- [6] Polfus, J. et al.(2021). Advanced Materials Interfaces, 8(20), 2100838.

Ris work was supported by:

Proyecto de Sinergia CONAHCYT 1564464



STUDY OF THE FRICTIONAL BEHAVIOR OF STEEL-POLYMER SLIDING INTERFACES IN DOUBLE-CURVED SLIDING ISOLATORS

Autores: Héctor Guerrero Bobadilla¹; Ulises Espinoza Nava²

¹ *Instituto de Ingeniería UNAM*

² *UNAM*

Autor responsable de la comunicación: ultz.ulises@gmail.com

A study is presented on the frictional behavior of steel-polymer sliding interfaces in a double-curvature seismic isolator configuration with polymeric materials based on polyethylene and polyamide formulations in combination with stainless steel surfaces with different levels of surface roughness. The study emphasizes the surface properties of the materials and presents experimental results obtained in a specialized European laboratory capable of performing tests in accordance with European standard EN15129. The tests were carried out under dynamic conditions that represent typical earthquake conditions such as sliding velocities of up to 345 mm/s and average normal pressure of up to 38 MPa, which allowed estimating friction coefficients at various velocities and pressures.

Keywords:

sliding interface, sliding materials, sliding isolator, tribological, tribological characterization

Reference:

Tyler, R. G. 1977. "Dynamic test on PTFE sliding layers under earthquake conditions." Bulletin of the New Zealand National Society for Earthquake Engineering, 10 (3): 129–138

Ris work was supported by:

Instituto de Ingeniería, UNAM



NUMERICAL ANALYSIS OF A PIN ON DISK SYSTEM UNDER DRY FRICTION CONDITIONS.

Autor: ELVIS COUTIÑO MORENO¹

Coautores: TOMAS DE LA MORA RAMIREZ ²; MARCO ANTONIO DOÑU RUIZ ³; NOE LOPEZ PERRUSQUIA ⁴; QUIRINO ESTRADA BARBOSA ⁵; DANIEL MALDONADO ONOFRE ²

¹ *Universidad Politécnica del Valle de México*

² *TecNM: TECNOLÓGICO DE ESTUDIOS SUPERIORES DE JOCOTITLÁN*

³ *Universidad Politécnica del Valle de México*

⁴ *Universidad Politécnica del Valle de México*

⁵ *Universidad Autónoma de Ciudad Juárez*

Autores responsables de la comunicación: elvis.coutino.moreno@upvm.edu.mx, daniel.maldonado@tesjo.edu.mx

In classical mechanics, wear is a critical and complex phenomenon that significantly influences the functional lifespan and reliability of mechanical components. Although it has been the subject of numerous studies, several fundamental aspects of wear behavior remain unclear, particularly under extreme or variable operating conditions. This research focuses on predicting mechanical wear in unlubricated metal-to-metal contact scenarios using a Pin on Disk tribometer configuration. The primary objective is to simulate and understand the wear mechanisms by developing a robust numerical model through the finite element method (FEM) in the Abaqus simulation environment. Archard's theoretical wear model is integrated into the numerical framework to estimate material loss due to sliding contact. The study incorporates the thermal and mechanical properties of 316-L stainless steel, including thermal conductivity, specific heat capacity, and the Johnson-Cook constitutive model to account for strain-rate and temperature-dependent plasticity. Several test cases with varying contact pressures and sliding velocities were analyzed to observe their influence on both the wear rate and temperature distribution. A key feature of the simulation is the ability to evaluate wear at the micrometer scale and to track the progressive stages of material degradation

—something that is extremely difficult to capture through laboratory testing alone. The simulation results were validated by comparing them with analytical approximations and available experimental data where possible. The findings highlight that accurate prediction of wear not only requires a detailed numerical representation but also demands empirical validation, especially for temperature measurements, due to limited and inconsistent literature data.

Keywords:

finite element analysis, pin on disk, wear, archard law, simulation

Reference:

de la Mora R. T, López EC, Maldonado D, Coutiño E, Perrusquia NL, Ruíz MAD, San Miguel CRT. Finite Element Simulation of Dry Wear of Prosthesis Made of UHMWPE and 316LVM Stainless Steel. *Coatings*. 2024; 14(7):876. <https://doi.org/10.3390/coatings14070876>

Ris work was supported by:

Without funding



THEORY AND SIMULATION OF MATERIALS

CHAIRMEN

Dra. Ariadna Sánchez Castillo (UAEH), ariadna_sanchez@uaeh.edu.mx

Dr. Edgar Martínez (UANL), edgar.martinezgrr@uanl.edu.mx

Dra. Sandra Julieta Gutierrez (IFUNAM), sjulietago@fisica.unam.mx

The aim of this symposium is to bring together experts in the field of surfaces and interfaces to discuss recent developments in electronic and transport properties of bulk materials, surfaces, optical properties, physical properties of clusters, and 2D materials, Density Functional Theory and Time Dependent DFT.

The topics include (but are not limited to)

- Density Functional Theory
- Time-dependent DFT
- plasmonics
- chiral materials
- physical properties of clusters
- transport properties
- mechanical properties at the nanoscale
- 2D materials
- Oral and poster presentations are welcome.



Ag AND Au ATOMIC WIRES ON THE Si (113)-1X1 SURFACE STUDY BY DFT

Autor: García Díaz, Reyes¹

Coautor:, Wilfrido Calleja Arriaga²; Hernández Cocoltzi² Gregorio³

¹ *Universidad Autónoma de Coahuila, Facultad de Ciencias Físico Matemáticas Prol. David Berlanga S/N Edif. "A" Unidad Camporredondo C.P. 25000, Saltillo, Coahuila, México*

² *Instituto Nacional de Astrofísica, Óptica y Electrónica, Luis Enrique Erro # 1, Tonantzintla, Puebla, México C.P. 72840*

³ *Instituto de Física, Benemérita Universidad Autónoma de Puebla, Avenida 18 sur y San Claudio, Ciudad Universitaria, Colonia San Manuel, CP 72570, Puebla, Puebla, México*

Autor responsable de la comunicación: reyesgarcia@uadec.edu.mx

Silver (Ag) and gold (Au) deposit on the high index silicon (113) surface is investigated using ab-initio calculations, within the density functional theory (DFT). Ag and Au concentrations are varied from 1 atom up to 3 monolayers (MLs). The atomic structure stability is determined by applying the surface formation energy (SFE) formalism. When 4 metal atoms are deposited on the silicon surface, one possible stable atomic structure is the atomic wire formation, with the Au atomic wire being more stable. The deposit of 1, 2 and 3 MLs form stable structures, with those of Au displaying better energetic stability. We have also considered the deposit of one Au (Ag) ML on top of two Ag (Au) MLs, with results showing good structure stability. Mention must be done that the formation of 1 Ag ML on top of 2 Au MLs is more favorable than that when the Au is interchanged with the Ag. Electronic properties are studied in terms of the total density of states (DOS) and its projections (pDOS). Results of the atomic wires indicate that charge transport may take place mediated by the silicon atoms underneath the metal atoms. The metal structure formation on top of the Si (113)-1x1 may have applications in ohmic contacts, which may be used in the nano-electronic industry

Keywords:

gold, silver, atomic wires, Si(113), DFT.

Reference:

A. Bhukta, P. Guha, B. Satpati, P. Maiti, P.V. Satyam, Growth of large aspect ratio AuAg bimetallic nanowires on Si(110) substrate, *Applied Surface Science*, 407 (2017) 337–344. <http://dx.doi.org/10.1016/j.apsusc.2017.02.200>

Ris work was supported by:

SECIHTI. Calculations have been performed at the LNS-BUAP and the computer center of the Institute of Physics of the BUAP.



BORON PHOSPHIDE MONOLAYER FOR C₂H₂ AND H₂Se ADSORPTION BY DFT

Autor: Akari Narayama Sosa Camposeco¹

Coautor: Gregorio Hernández Cocoltzi¹

¹ *Instituto de Física, Benemérita Universidad Autónoma de Puebla*

Autor responsable de la comunicación: asosacamposeco@gmail.com

The growing population as well as the rapid development of the industry have substantially affected the environmental quality. Nowadays, special importance has been placed on the management of chemical products that cause environmental contamination and affect human health. Motivated by the current problems of environmental contamination and the excellent physical properties of 2D materials, we have studied the structural and electronic properties of pristine and metal-doped boron phosphide (BP) monolayer [1], interacting with the C₂H₂ and H₂Se molecules using the density functional theory (DFT). The adsorption energies, band gap values and work function were calculated. The introduction of doping elements significantly increased the sensitivity of the systems, which is promising for their possible application as gas sensors to solve different environmental pollution problems.

Keywords:

DFT, Adsorption, Molecules, Boron Phosphide.

Reference:

A. N Sosa, S. E. Gómez, J. C. Moreno Hernández, D. García Toral, G. Hernández Cocoltzi, First-principles studies of the SCl₂ adsorption on the doped boron phosphide monolayer, J. molecular modeling.31(2025) 111. <https://doi.org/10.1007/s00894-025-06333-8>.

Ris work was supported by:

SECIHTI for the financial support provided through "Estancias Posdoctorales por México 2022"



STRUCTURAL, VIBRATIONAL AND ELECTRONIC PROPERTIES OF α -SULFUR BASED NANOSHEET

Autor: Victor Alan Ibarra Ortiz¹

Coautores: Ariadna Sánchez Castillo ¹; José de Jesús Pelyao Cardenas ¹; Maria del Pilar Gutierrez Amador ¹

¹ *Universidad Autónoma del Estado de Hidalgo*

Autor responsable de la comunicación: ib335373@uaeh.edu.mx

2D nanomaterials have been found to present interesting properties and potential applications, and while some of them have been thoroughly studied both theoretically and experimentally, such as graphene, others lack proper characterizations. Structures such as the α -sulfur cyclooctasulfur (S₈), which present photocatalytic and photoelectric properties, have been studied and considered as the building blocks of sulfur-based nanosheets. Therefore, the objective of this work is to construct α -sulfur S₈ based nanosheets, and use theoretical calculations based on the density functional theory (DFT) to obtain their structural, vibrational and electronic properties. Here we propose bidimensional structures created with rings of 6 or 8 atoms.

Keywords:

nanomaterials, DFT, α -sulfur

Reference:

Zhuangwei Bai, Lihua Shen, Jianhang Wei, Yuangang Li, Azhar Abbas, Yinyan Li, Mengnan Qu, Dong-dong Zhang, and Chengxiao Zhang
ACS Applied Nano Materials 2020 3 (11), 10749-10756 DOI:
10.1021/acsanm.0c02024

Ris work was supported by:

DGTIC-UNAM, por medio de los proyectos LANCAD-UNAM-DGTIC-049, LANCAD-UNAM-DGTIC (59-2025), LNS con en el proyecto 202201046N



STUDY OF ENERGY BARRIERS BETWEEN FUNCTIONAL GROUPS PRESENT IN GRAPHENE OXIDE BY DFT.

Autor: Luis Ángel Campos Ortiz¹

Coautores: Hector Noé Fernandez Escamilla ²; José Israel Paez Ornelas ³; Luis Ángel Alvarado Leal ¹; Jose Manuel Romo Herrera ⁴; José Manuel Ruiz Mariscal ⁴; Eduardo Gerardo Perez Tijerina ²; Noboru Takeuchi ⁴

¹ *Universidad Autónoma de Nuevo León*

² *UANL*

³ *Centro de Nanociencias y Nanotecnología*

⁴ *CNIN-UNAM*

Autor responsable de la comunicación: luis.camposo@uanl.edu.mx

Graphene oxide (GO) is a nanomaterial of great interest due to its electronic properties, which are highly dependent on the oxygenated functional groups present on its surface. These functional groups, formed by oxygen and hydrogen atoms anchored to graphene, significantly modify its physical and chemical properties. The transition of functional groups present on GOs has been observed experimentally. In this study, first-principles calculations were used to investigate the reaction mechanisms that allow the transformation from one functional group to another. Three transition routes were analyzed: from carboxylic acids to anhydrides (Reaction 1), from hydroxyls to ethers (Reaction 2) and from hydroxyls to carbonyls (Reaction 3). In addition, the effect of the addition of hydrogen ions and OH radicals in these reactions was studied, identifying alternate routes with reasonably small energy barriers.

Keywords:

DFT, OG, Functional Groups, carboxylic acids, hydroxyls, anhydrides, ethers, carbonyls

Reference:

Ruiz-Marizcal, J.M., Paez-Ornelas, J.I., Fernández-Escamilla, H.N., Murillo-Bracamontes, E.A., Alonso-Núñez, G., Perez-Tijerina, E.G., Takeuchi, N. and Romo-Herrera, J.M. (2025), From Graphene Oxide to N-Doped Graphene: Understanding the Doping Process. *Adv. Energy Sustainability Res.*, 6: 2400310. <https://doi.org/10.1002/aesr.202400310>

Ris work was supported by:

This work was supported by PAPIIT-UNAM, Project No. IN102725. Calculations were performed in the DGCTIC-UNAM Supercomputing Center, projects LAN- CAD-UNAM-DGTIC-051 and LANCAD- UNAM-DGTIC- 382.



ATOMISTIC-LEVEL UNDERSTANDING OF CHARGE STORAGE BEHAVIOR In α -MnO₂ NANOSTRUCTURES

Autor: Christian Alejandro Celaya López¹

Coautores: Ana Karina Cuentas Gallegos²; Jesús Muñoz Soria³

¹ Centro de Nanociencias y Nanotecnología-UNAM

² Centro de Nanociencias y Nanotecnología-UNAM

³ Instituto de Energías Renovables-UNAM

Autor responsable de la comunicación: acelaya@ens.cnyn.unam.mx

Manganese dioxide (MnO₂) is widely recognized for its promising role as an electrode material in energy storage devices, particularly supercapacitors, due to its high energy and power densities. In this work, a theoretical framework based on density functional theory (DFT) and non-equilibrium Green's function (NEGF) formalism is employed to explore the electronic transport properties and energy storage capabilities of a composite system composed of α -MnO₂ supported on nanostructured carbon.

Electron transmission calculations indicate that the current reaches a maximum value of 90.0 μ A at 3.0 V, demonstrating that the carbon substrate significantly enhances the electronic conductivity of MnO₂.

Moreover, the quantum capacitance (QC), evaluated within a potential window of -0.5 to 0.5 V, shows a peak value of 767.52 μ F/cm², highlighting the importance of electronic coupling at the MnO₂/carbon interface for the development of high-performance electrodes [1].

Additionally, the effect of MNO₃ electrolytes (M = Li, Na, K) and water molecules on the α -MnO₂ surface is investigated. Analysis of the potential energy surface provides insight into the diffusion mechanisms and relative energies of the metal cations. Results indicate that the KNO₃ electrolyte promotes more efficient charge accumulation, thereby enhancing pseudocapacitive behavior. The electronic density of states and charge density difference analyses offer a detailed understanding of ion-surface interactions [2].

This theoretical approach offers atomic-scale insights into the charge/discharge mechanisms that occur in α -MnO₂ and establishes a robust framework for the rational design of next-generation energy storage materials.

Keywords:

DFT, Storage Energy, pseudocapacitance, Quantum Capacitance, Electronic properties

Reference:

[1] Applied Surface Science, 2025, 686, 162141. <https://doi.org/10.1016/j.apsusc.2024.162141>

[2] Applied Surface Science. 708, 2025, 163605. <https://doi.org/10.1016/j.apsusc.2025.163605>

Ris work was supported by:

Fondo Sectorial de Ciencia Básica de Frontera-SECIHTI, Mexico under Project No. CBF2023-2024-336 and 21077



STRUCTURAL AND ELECTRONIC PROPERTIES OF FULL AND HALF-HEUSLER CO₂VGA STRUCTURES: DFT STUDY

Autor: Abigail Valdés¹

Coautores: EDGAR MARTINEZ GUERRA ²; Eros Fabián Acosta Vázquez ³; Gerardo Cárdenas Rodríguez ²; Miguel Daniel Treviño Martínez ¹; María Teresa Romero de la Cruz ³

¹ *Universidad Autónoma De Coahuila*

² *Universidad Autónoma de Nuevo León*

³ *Universidad Autónoma de Coahuila*

Autores responsables de la comunicación: abigailvaldes@uadec.edu.mx, daniel.trevino@uadec.edu.mx

Half-metallic ferromagnetic materials are of great interest to the research community due to their selective electron conduction that depends on spin orientation. This unique property, which results in spin polarization at the Fermi level, makes them highly desirable for spintronic applications. Half-metallic ferromagnetism has been observed in materials such as full Heusler alloys, binary oxides, and spinel-type materials. Herein, this work presents a theoretical study of the Co₂VGa full Heusler and half Heusler compounds. Spin-polarized calculations were executed within the periodic density functional theory as implemented in the PWscf code of the Quantum Espresso Package. A conventional Co₂VGa structure was used. The density of the full Heusler structure shows spin polarization at the Fermi level; the majority spin states correspond to spin up, while the minority spin states are spin down. There is no polarization at the Fermi level in the half-Heusler structure.

Keywords:

Co₂VGa, spin, full-Heusler structure, half-Heusler structure

Reference:

Saadi, H., Salama, M., Jalal, E., Kerrai, H., Baghaz, E., & Bouziani, M. E. (2025). Magnetic properties and magnetocaloric effect of Co₂VGa Heusler alloy: A theoretical study. *Physica A Statistical Mechanics And Its Applications*, 130626. <https://doi.org/10.1016/j.physa.2025.130626>

Ris work was supported by:

The authors gratefully acknowledge the computing time granted by LANCAD and SECIHTI on the supercomputer Yoltla/Miztli/Xiuhcoatl at LSVP UAM-Iztapalapa/DGTIC UNAM/CGSTIC CINVESTAV, with project No. 18-2025



ELECTRODYNAMIC MODEL OF REBCO STRIPS FOR USE IN THE GENERATION OF HIGH MAGNETIC FIELDS

Autores: Cecilia Uribe Estrada¹; Felipe Pérez Rodríguez²; Michell Alejandra Osornio Plancarte²

¹ *ICUAP*

² *IFUAP*

Autor responsable de la comunicación: mi.ale.2906@gmail.com

This project aims to develop an electrodynamic model of high-temperature superconducting (HTS) strips using the general formalism based on the equation of motion for the magnetization M in superconductors of arbitrary shape. The results of this work will contribute not only to improving the design of magnets for applications requiring high magnetic fields, thereby increasing the sustainability and reliability of these systems in demanding operating environments, but also to a better understanding and modeling of the magnetic behavior of REBCO superconductors under extreme and/or specific conditions.

Keywords:

Superconductors, HTS, REBCO, Magnetization, Modelling

Reference:

E. Berrospe-Juarez, F. Trillaud, V. M. R. Zermeño, F. Grilli, H. W. Weijers, and M. D. Bird, "Screening Currents and Hysteresis Losses in the REBCO Insert of the 32 T All-Superconducting Magnet Using T-A Homogenous Model,"

Ris work was supported by:

IFUAP



METALLIC IONS ADSORBED ON MXENE Ti_3C_2

Autores: Victor Hugo Muñoz Domínguez¹; Sandra Julieta Gutiérrez Ojeda²

¹ *Facultad de Ciencias Universidad Nacional Autónoma de México*

² *Instituto de Física Universidad Nacional Autónoma de México*

Autor responsable de la comunicación: victhor@ciencias.unam.mx

The two dimensional transition metal carbides, known as MXenes, have shown big potential in various applications, like energy storage, electromagnetic interference shielding, transparent electrodes, catalysis, photo-thermal therapies, among others. In this way, the present work studied the interaction of metal ions on the surface of the MXene Ti_3C_2 using the Density Functional Theory (DFT). Since the surface of these systems usually features functional group terminations, OH and F groups were considered. For the adsorption of metal ions on the surface was analyzed by considering high-symmetry sites, in addition electronic properties were studied.

Keywords:

MXene, DFT, adsorption

Reference:

Qin, R., G. Shan, M. Hu y W. Huang: Two-dimensional transition metal carbides and/or nitrides (MXenes) and their applications in sensors. *Materials Today Physics*, 21:100527, 2021, ISSN 2542-5293.

Ris work was supported by:

The authors acknowledge project IA105225 of DGAPA-UNAM and the supercomputing laboratory DGCTIC-UNAM for the resources provided through the projects LANCAD-UNAM-DGTIC-444, where the MXene calculations were performed. Additionally, we thank Carlos Ernesto Lopez Nataren for the supercomputing technical support provided.



STRUCTURAL, ELECTRONIC, AND OPTICAL PROPERTIES OF BaTiO₃ AND Sr-BaTiO₃ : DFT STUDY

Autores: Adrián Ramírez Ortiz¹; Aracely del Carmen Martínez Olguín²; Cristopher Eduardo Barrón Ramos¹; Edgar Martínez Guerra³; María Teresa Romero de la Cruz⁴; Octavio Abdalá Carranza Ortega¹

¹ 1. Universidad Autónoma de Coahuila, Facultad de Ciencias Físico Matemáticas, Edificio A Unidad Camporredondo, Saltillo, Mexico, 25020 Saltillo

² 3. SECIHTI-Universidad Autónoma de Coahuila, Facultad de Sistemas, Carretera a México Km 13, 25350 Arteaga, Saltillo, Coahuila, México

³ 2. Universidad Autónoma de Nuevo León, Facultad de Ciencias Físico Matemáticas, 66451, San Nicolás de los Garza, Nuevo León México.

⁴ 4. Universidad Autónoma de Coahuila, Facultad de Sistemas, Carretera a México Km 13, 25350 Arteaga, Saltillo, Coahuila, México.

Autor responsable de la comunicación: barron.cristopher@uadec.edu.mx

The structural, electronic, and optical properties of BaTiO₃ and Sr-BaTiO₃ are studied using Density Functional Theory as implemented in Quantum Espresso software. A PBE functional was used to model the correlation and exchange interactions. Total energy calculations were performed using a conventional cubic unit cell for BaTiO₃, and a 1x2x2 cell was used for the Sr-BaTiO₃ doped structure. A cutoff energy of 70 Ry was used for the wavefunction expansion. The optimized parameter for the BaTiO₃ cell is 4.04 Å; this value decreases slightly upon doping with Sr. Band structure shows an indirect bandgap for BaTiO₃ ranging from R to Γ . In the Sr-doped cell, the structure shows a direct Γ - Γ bandgap. Optical properties were also calculated, and it was observed that the presence of Sr enhances these properties.

Keywords:

DFT, BaTiO₃, total energy, DOS.

Reference:

M. Khalil, M. Tauseef Qureshi, M. Al Elaimi, L. Aamir, M. Ahmad, M. Saleem, M. Saleem, Influence of Sr doping on BaTiO₃ properties: A combined DFT and experimental approach. Results in Physics, Volume 67, December 2024, 108041. <https://doi.org/10.1016/j.rinp.2024.108041>

Ris work was supported by:

The authors gratefully acknowledge the computing time granted by LANCAD and SECIHTI on the supercomputer Yoltla/Miztli/Xiuhcoatl at LSVP UAM-Iztapalapa/DGTIC UNAM/CGSTIC CINVESTAV, with project No. 18-2025



BREAKING HOLE-ELECTRON SYMMETRY AND STRAIN-TUNABLE MAGNETISM IN $\text{ScSi}_2\text{N}_4/\text{VSi}_2\text{N}_4$ VAN DER WAALS HETEROSTRUCTURE

Autor: Brandon Pedroza-Rojas¹

Coautores: Ariadna Sánchez-Castillo²; Rodrigo Ponce-Pérez³

¹ *Universidad Autónoma del Estado de Hidalgo*

² *Universidad Autónoma del Estado de Hidalgo*

³ *CNyN UNAM*

Autor responsable de la comunicación: brandonrpce@gmail.com

Our DFT+U investigation of the van der Waals (vdW) heterostructure formed by ScSi_2N_4 and VSi_2N_4 monolayers reveals a system where the intrinsic dynamic stability and ferromagnetic (FM) character of the individual layers are preserved post-stacking. The ScSi_2N_4 layer retains its half-metallic behavior, while the VSi_2N_4 layer remains semiconducting, with interlayer interactions governed exclusively by vdW forces, as confirmed by non-covalent interaction (NCI) analysis. Among tested configurations, the T4 stacking emerges as the most energetically favorable, stabilized by optimized vdW contacts without chemical bonding. Both FM and antiferromagnetic (AFM) couplings are experimentally accessible, evidenced by marginal energy differences (<3 meV/cell), while magnetic anisotropy energy (MAE) calculations robustly favor in-plane magnetization (MAE ≈ -0.52 meV/atom), critical for thermal stability. Strain engineering induces dramatic electronic transitions: compressive strain ($\sim 3\%$) on ScSi_2N_4 drives a metallic transition via spin-resolved band shifts, whereas tensile strain on VSi_2N_4 triggers a half-metallic state with an emergent Dirac cone in the V-based layer, suggesting enhanced carrier mobility and potential topological phenomena. These tunable properties, coupled with the heterostructure's air stability and absence of rare-earth elements, position $\text{ScSi}_2\text{N}_4/\text{VSi}_2\text{N}_4$

as a sustainable, scalable platform for spintronic applications—notably spin valves and magnetic tunnel junctions. By leveraging early transition metals (Sc, V) instead of rare-earth counterparts, this work advances spin-coherent materials compatible with mainstream semiconductor technologies, bridging fundamental design principles with device-ready functionality.

Keywords:

2D materials, ferromagnetism, vdW heterostructures, hole-electron break parity, MTJs

Reference:

B. Pedroza-Rojas. A. Sanchez-Castillo. R. Ponce-Pérez. Structural, Electronic, and Magnetic Properties of the van der Waals $\text{ScSi}_2\text{N}_4/\text{VSi}_2\text{N}_4$ Heterostructure: A First-Principles Study. ACS Omega. <https://doi.org/10.1021/acsomega.5c02195>

Ris work was supported by:

DGAPA-UNAM projects IA100624 and IN101523 for financial support. Calculations were performed in the DGCTIC-UNAM Supercomputing Center, project LANCAD-UNAM-DGTIC-422. Also was supported by the Consejo Nacional de Humanidades Ciencias y Tecnologías (CONAHCYT, Scholarship No. 2022-000018-02NACF-01110).



SOLIDS: A MODULAR PYTHON TOOLKIT FOR CRYSTAL STRUCTURE PREDICTION

Autor: Carlos López-Castro¹

Coautor: Gabriel Merino ¹

¹ *Departamento de Física Aplicada, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Mérida 97310, Yucatán, México*

Autor responsable de la comunicación: filiberto.ortiz@cinvestav.mx

We present Solids, a modular and open-source Python package for crystal structure prediction based on first-principles calculations. The theoretical prediction of stable crystal structures plays a key role in the rational design of materials, and Solids addresses this challenge by enabling the exploration of the potential energy surface using only the chemical formula and external pressure conditions as input.

Solids implements two complementary algorithms for global optimization. The first method is a stochastic approach that generates a diverse set of candidate structures guided by symmetry constraints (via PyXtal), relaxes them using external codes, and selects the low-energy configurations.

The second is a genetic algorithm equipped with crossover and mutation operators, designed to refine the search through evolutionary principles. To ensure diversity and avoid redundancy, Solids incorporates a discriminator based on Many-Body Tensor Representation descriptors to filter equivalent structures.

The package interfaces seamlessly with external relaxation engines such as VASP and GULP. Solids is installable via pip, compatible with high-performance computing environments (PBS, SLURM), and can also be executed in Google Colab for rapid prototyping.

We demonstrate its capabilities with benchmark studies on carbon (recovering graphite and diamond phases), MgAl_2O_4 (spinel), TiO_2 (rutile and anatase), and SrTiO_3 (cubic perovskite). The predicted structures were relaxed using GULP and refined via Density Functional Theory with VASP, yielding agreement with experimental and literature data.

These results validate Solids as a reliable, flexible, and user-friendly tool for CSP across a broad range of chemical compositions and dimensionalities. Its modular design and compatibility with multiple computational backends make it well-suited for integration into automated materials discovery pipelines.

Keywords:

Materials Discovery, Crystal structure prediction, Global optimization, Genetic algorithms

Reference:

López-Castro, C., Ortiz-Chi, F., & Merino, G. An Efficient Growth Pattern Algorithm (GrowPAL) for Cluster Structure Prediction. *J. Chem. Theory Comp.*, 2024, 20(11), 4939–4948. <https://doi.org/10.1021/acs.jctc.4c00365>

Ris work was supported by:

Project CF-2023-G-1177, Continuous-flow photocatalytic microfluidic reactors based on 2D heterojunction materials for the treatment of aqueous pollutants. C.L.C. gratefully acknowledges Secihti for the doctoral fellowship provided during his postgraduate studies.



NUMERICAL ANALYSIS OF HEAT TRANSFER IN SOLIDS FROM INFRARED PHOTOTHERMAL RADIOMETRY MEASUREMENTS

Autor: Roberto Carlos García Zúñiga¹

Coautores: Alejandro Rojas-Marroquin²; Ernesto Marin Moares¹; Joel Hernández-Wong²; José Antonio Calderón Arenas¹; José Bruno Rojas-Trigos¹; Lizbeth Luviano Elizalde³; Rocío A. Muñoz-Hernández¹; Uriel Nogal Luis²

¹ Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada, CICATA Unidad Legaria, Instituto Politécnico Nacional

² SECIHTI-Instituto Politécnico Nacional, Centro de investigación en Ciencia Aplicada y Tecnología Avanzada, CICATA Unidad Legaria

³ Universidad Tecnológica Fidel Velázquez, Av. Emiliano Zapata S/N, Col. El tráfico, C.P.54474, Nicolás Romero, Estado de México, México.

Autor responsable de la comunicación: rcgzfis@gmail.com

We conducted a numerical analysis of heat transfer in a homogeneous and isotropic solid subjected to a continuum and a square periodic light beam on its front surface. To achieve this, we employed Infrared Photothermal Radiometry in a front configuration to measure the temperature difference on the front surfaces of three samples: silicon, copper, and wood, over varying exposure times. Additionally, we solved the heat transport equation congruent to the problem by applying boundary conditions that aligned with the physical situation, utilizing numerical simulations with COMSOL Multiphysics software, which is based on finite element analysis. Our results demonstrated a good agreement between the experimental data and the numerical simulations, demonstrating the utility of this methodology in the analysis of the photothermal response of solids.

Keywords:

Heat transfer; photothermal radiometry; finite element analysis.

Reference:

- [1] Nordal, Kanstad, (1979). Physica Scripta 659.
- [2] Martínez, K et al. (2015). International Journal of Thermal Sciences, 98.
- [3] Suarez, V. et al. (2014) Applied Radiation and Isotopes 83.
- [4] Wong, J. et al. (2019). Rev. Mex. Fis. 65.

Ris work was supported by:

Secretaría de Investigación y Posgrado del Instituto Politécnico Nacional (IPN), México; Comisión de Fomento de Actividades Académicas del IPN, México; Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECIHTI), México.



CO₂ ADSORPTION ON GRAPHENE OXIDE NANORIBBONS WITH HETEROATOM DOPING OF KETIDIC SYSTEMS: A COMPARATIVE STUDY USING DFT

Autor: Juan Enrique Ramirez Hernandez¹

Coautores: Alessandro Fortunelli ²; Alvaro Posada Amarillas ¹; Jonathan Casildo Luque Ceballos ¹; Thantip Roongcharoen ²

¹ *Departamento de Investigación en Física. Universidad de Sonora*

² *CNR-ICCOM*

Autor responsable de la comunicación: a211290232@unison.mx

Graphene oxide nanoribbons (GONRs) are emerging as promising materials for CO₂ capture due to their high surface area, functionalizability, and tunable electronic properties. However, the influence of heteroatom doping on their adsorption behavior and electronic structure remains insufficiently understood. In this work, we investigate the effects of B, N, and P doping, as well as BN co-doping, on the CO₂ adsorption performance of GONRs using first-principles density functional theory (DFT) calculations. Structural optimizations and electronic structure analyses reveal that N- and P-doping favor weak physisorption, while B- and BN-co-doping enable stronger chemisorption mechanisms. The B-doped GONRs display the highest CO₂ adsorption energy (-3.33 eV), with the molecule forming covalent bonds with both the boron atom and a carbonyl oxygen, resulting in a closed hexagonal edge configuration. The BN-co-doped GNR, with a similar adsorption energy (-3.24 eV), forms a distinct pentagonal edge through simultaneous interactions with boron and nitrogen atoms. Density of States (DOS) and Projected DOS (PDOS) analyses reveal pronounced orbital hybridization and a significant bandgap widening in the BN system (from 0.48 eV to 0.78 eV) upon CO₂ adsorption. Bader charge analysis further confirms substantial charge transfer and polarization, with localized interaction in B-doped GONRs and more delocalized redistribution in the BN system. These results highlight the critical role of dopant selection in tuning the adsorption mechanism and electronic properties of GONRs. We conclude that B- and BN-co-doped GONRs are promising candidates for CO₂ capture and sensing technologies, and future work should focus on optimizing doping patterns and assessing thermal stability and adsorption reversibility under realistic operating conditions.

Keywords:

Graphene oxide nano-ribbons, CO₂ adsorption, CO₂ capture and sensing

Reference:

xxx

Ris work was supported by:

We acknowledge funding from CONAHCYT through project A1-S-31326 A.P.-A. We are grateful to the Italian CINECA supercomputing center for providing computational resources within the ISCRA program and to the Italian ICSC (grant CN00000013) for support.



MODELLING THE SPUTTERING PROCESS VIA MONTE CARLO BINARY COLLISION

Autor: Luis Fernando Benítez Rodríguez¹

Coautores: Julio Cesar Cruz Cardenas ²; Marco Antonio Martinez Fuentes ³; Veronica Cristel Vázquez De la Cruz⁴; Stephen Muhl ⁵

¹ *Universidad Nacional Autónoma de México*

² *UNAM*

³ *Instituto de Investigaciones en Materiales - UNAM*

⁴ *Facultad de Ciencias, Universidad Nacional Autónoma de México, Ciudad de México, C. P. 04510, México.*

⁵ *Instituto de Investigaciones en Materiales, Uni Nacional Autonoma de Mexico*

Autor responsable de la comunicación: luisfbr2001@ciencias.unam.mx

DC magnetron sputtering is a widely used technique in the coating industry due to its high deposition rate and versatility; the sputtering process involves collision cascades within the target caused by the bombardment of argon ions from the plasma. However, limitations persist when working with materials that exhibit low sputtering yields, this quantity indicates how many atoms are ejected from the target per incident argon ion. The sputtering yield depends on several factors, including the target material, the presence of heavier dopant elements, and the angle of incidence of the incoming ions. Simulation tools such as SRIM and SIMTRA are commonly employed to model ion-target interactions and the transport of sputtered atoms, respectively. Nevertheless, we have found that SRIM presents limitations in predicting the phenomenon known as sputtering yield amplification. The aim of this work is to compare, through simulations, the sputtering yield of a pure target, in this case silicon, as a function of the argon ion incidence angle. To achieve this, Monte Carlo binary collision simulations were implemented, solving the equations of motion and interactions of the sputtering process while considering elastic collisions between incident ions and target atoms. The results show significant variations in the sputtering yield of the base material depending on ion incidence angle. Therefore, our findings highlight a model for predicting complex phenomena such as sputtering yield as a function of the experimental parameters.

Keywords:

Simulation, sputtering, sputtering yield

Reference:

Sigmund, Peter, Theory of Sputtering. I. Sputtering Yield of Amorphous and Polycrystalline Targets, Phys. Rev. 184 (1969) 383-416.
10.1103/PhysRev.184.383

Ris work was supported by:

Julio Cruz and Marco Martinez would like to thank CONAHCYT (SECIHTI) for their postdoctoral fellowship. One of the authors acknowledges support of DGAPA-UNAM under contract IG101123.



ELECTRONIC AND MAGNETIC PROPERTIES OF CeN: A FIRST PRINCIPLES STUDY

Autor: Jose Mario Galicia Hernandez¹

Coautores: Gregorio Hernández Cocoltzi²; Juan Francisco Rivas Silva¹

¹ Instituto de Física Ing. Luis Rivera Terrazas (BUAP)

² Instituto de Física, Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: josemariogahe@gmail.com

In this work we performed a first principles study in regards the magnetic and electronic properties of Cerium Nitride (CeN). The compound contains a rare-earth element (Cerium-Ce) which can not be treated within the standard DFT framework. For this reason, we have used the best *ab-initio* technique in order to study the high-correlated materials, the so called *Dynamical Mean Field Theory* (DMFT), that is able to capture all the dynamic effects of a high-correlated system, allowing a complete description of time-evolution of correlation effects. With this approach, it was possible to predict the paramagnetic magnetic phase as reported in experiments. All the results concerning the magnetic properties of the material are included in this work. We have also included the study of the electronic properties by computing the spectral function for describing the Density of States of the System. Our results are in good agreement with the experiments, suggesting the possibility of building nanostructures based on this compound, which is also discussed in this work.

Keywords:

CeN, DMFT, Paramagnetic

Reference:

A. Georges; G. Kotliar; W. Krauth; M. Rozenberg (1996). "Dynamical mean-field theory of strongly correlated fermion systems and the limit of infinite dimensions". *Reviews of Modern Physics*. 68 (1): 13

Ris work was supported by:

Secretaria de Ciencia, Humanidades, Tecnología e Innovación



EXPLORING THE STRUCTURAL CONDITIONS FAVORING ANIONIC BEHAVIOR ON Au IMPURIFIED CeO₂

Autor: Luis Enrique López González¹

Coautores: Felipe Francisco Castillon Barraza²; Jonathan Guerrero Sanchez³; Mario Humberto Farías Sánchez²; Rodrigo Ponce Perez⁴; Sergio Aguila Puentes²; Trino Armando Zepeda Partida²

¹ *Universidad Nacional Autónoma de México*

² *Centro de Nanociencias y Nanotecnología. Universidad Nacional Autónoma de México*

³ *Centro de Nanociencias y Nanotecnología, UNAM*

⁴ *CNyN UNAM*

Autor responsable de la comunicación: luis.lopez@ens.cnyn.unam.mx

The environmental impact caused by man has reached levels of no return. Among the problems of this nature are climate change and air pollution. The use of materials to remove contaminants has been widely studied. However, the search for new materials that improve efficiency in contaminant removal has been constant. In this sense, gold is known for its ability to improve various material properties. It facilitates the conditions to catalyze several reactions of high interest in environmental remediation.

It is well known that gold behaves as a cation in a wide variety of materials of which it is a part or in which it is deposited or incorporated. However, the existence of anionic gold in some compounds has also been reported in the literature. Although it has been discussed in terms of experimental evidence, and it is known that it can exist in double perovskite-type structures, so far, there is no atomic-scale explanation of the interaction mechanisms, as well as the conditions that lead to the anionic behavior of gold in this type of structures and the potential applications it has in environmental remediation.

Prominent candidates for finding anionic gold with great possibilities for application in environmental remediation are rare earth oxides since they have been shown as excellent catalysts for the CO oxidation reaction with great selectivity, in addition to the low electronegativity that f-block metals have.

In this work, the modification of CeO₂ with Au was studied experimentally and employing density functional theory (DFT) calculations. Initially, the synthesis of different gold concentrations of CeO₂ Au impurified materials was carried out, and structural characterization was made by XRD, FT-IR, UV-vis and SEM. Surface models of (111) were constructed. The most probable adsorption sites were determined by electrostatic potential maps. Au adsorption was assessed by constructing several models. Determination of anionic gold behavior Bader charge analysis was carried out. Finally, The chemical character of Au on CeO₂ was studied by XPS, finding two components attributed to negatively charged Au. These findings help to understand how gold improves CeO₂ catalytic activity.

Keywords:

anionic gold, rare earths, DFT, surface defects

Reference:

T.A. Zepeda, R. Ponce-Pérez, A. Solis-Garcia, J. Guerrero-Sanchez, S. Fuentes, S.A. Gomez, Boosting oxygen activation in ceria-oxide via gallium addition, Appl Catal B 336 (2023). <https://doi.org/10.1016/j.apcatb.2023.122936>.

Ris work was supported by:

DGAPA-UNAM projects IG101124 and IA100624 . Calculations were performed in the DGCTIC-UNAM Supercomputing Center projects LANCAD-UNAM-DGTIC-368 and LANCAD-UNAM-DGTIC-422. JGS acknowledges LNS-BUAP project 202201042N and THUBAT KAAL IPICYT project TKII-JGSA001. We thank Aldo Rodriguez-Guerrero, Eloisa Aparicio, David Domínguez and Israel Gradilla.



TWO-DIMENSIONAL SiSe AS A PROMISING ANODE MATERIAL FOR ALKALI- ION BATTERIES

Autor: Gabriel Antonio Cosío Aguilar¹

Coautores: Jassiel Rolando Rodríguez Barreras²; Jonathan Guerrero Sanchez³; María Guadalupe Moreno Armenta³; Rodrigo Ponce Pérez³

¹ *Department of electronics and telecommunications - CICESE; Department of Nanostructures - CNyN (UNAM)*

² *Centro de Investigación Científica y de Educación Superior de Ensenada*

³ *Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México*

Autor responsable de la comunicación: gcosio@cicese.edu.mx

Recent efforts in electrochemical energy storage have been focused on addressing the limited capacity of commercial lithium-ion batteries. Specifically, the graphite anode, with a theoretical capacity of 372 mAh/g[1], is unable to meet the energy demands of new portable electronic devices. As an alternative, two-dimensional chalcogenide materials have emerged as promising candidates, as they exhibit both conversion and alloying reactions. Two-dimensional silicon selenide (2D-SiSe) has attracted significant attention because of its interesting laminar structure and large energy storage capability that can also store alkali-ions via intercalation reactions. By Density Functional Theory (DFT) calculations, this work presents a systematic analysis of the stability and storage capability of 2D-SiSe with a phosphorene-like structure as potential anode for alkali-ion batteries. To evaluate the stability of the structure, its cohesive energy was calculated, getting a value of 4.5 eV. Ab Initio Molecular Dynamics (AIMD) calculations were performed at 300 K and 500 K to assess its thermal stability and phonon band structure. The electronic band structure was calculated using PBE, RSCAN, R2SCAN, and HSE06 functionals, obtaining a maximum band gap of 1.83 eV by HSE06. The alkali-ion storage process was investigated through the systematic insertion of Li, Na, and K atoms into the monolayer of 2D-SiSe. Energy barriers for different reaction pathways involving the first inserted ion were evaluated using the CI-NEB calculations. Additionally, the formation energy and open circuit voltage (OCV) curves were obtained to determine its electrochemical stability, lattice parameter changes and maximum theoretical capacity for each alkali metal.

Keywords:

2D materials, Alkali-ion storage, Chalcogenide, DFT Calculations, Electrochemistry

Reference:

X. Yi, G. Qi, X. Liu, C. Depcik, L. Liu, Challenges and strategies toward anode materials with different lithium storage mechanisms for rechargeable lithium batteries, *J Energy Storage* 95 (2024) 112480. <https://doi.org/10.1016/j.est.2024.112480>.

Ris work was supported by:

SECIHTI and CICESE with scholarships and financial support, as well as DGAPA-UNAM projects IA100624, IG101124, and IN101523. Calculations were performed in the DGCTIC-UNAM supercomputing center, projects No. LANCAD-UNAM-DGTIC-150, LANCAD-UNAM-DGTIC-368 and LANCAD-UNAM-DGTIC-422.



INTEGRATING CLUSTERING TECHNIQUES TO GLOBAL OPTIMIZATION OF ATOMIC STRUCTURES

Autores: FILIBERTO ORTIZ-CHI¹; Isaac Rafael Gutiérrez Campos²

Coautores: Carlos López-Castro ³; Gabriel Merino ³

¹ *Secihti-Departamento de Física Aplicada, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Mérida 97310, Yucatán, México*

² *Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional*

³ *Departamento de Física Aplicada, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Mérida 97310, Yucatán, México*

Autor responsable de la comunicación: filiberto.ortiz@cinvestav.mx

Clustering is a machine learning technique used to group unlabeled elements based on similarity in numerical representations (descriptors). In cheminformatics, it is employed to explore chemical space, identify structural similarities, and analyze structure–activity relationships. In this work, we integrated clustering techniques into a global optimization algorithm based on growth pattern to enhance seed selection and reduce the number of energy evaluations. We tested four morphological descriptors —Coulomb Matrix, Smooth Overlap of Atomic Positions, Many-Body Tensor Representation (MBTR), and Ultrafast Shape Recognition—combined with two clustering algorithms: K-means and Agglomerative. Two seed selection rules were implemented: a uniform rule and an energy-weighted rule. We applied this methodology to Lennard-Jones clusters from 4 to 100 atoms, successfully obtaining all the global minima structures, including the historically challenging 98-atom cluster. A substructure analysis using chemical graphs enabled us to identify morphological patterns that explain the difficulty in predicting this case, while also providing insights into the structural performance of the clustering methods employed. We extended the approach to three Sutton-Chen type potentials: (9,6), (10,8), and (12,6); obtaining the first 80 minimum-energy structures in each case using only 500 seed structures per iteration. The combination of MBTR, Agglomerative clustering, and the energy-weighted rule consistently achieved the best performance across all systems. These results demonstrate that our methodology not only accelerates the exploration of potential energy surfaces but also adapts effectively to different interatomic potentials.

Keywords:

Atomic clusters, Clustering algorithms, Global optimization, Structural prediction, Interatomic potentials.

Reference:

López-Castro, C., Ortiz-Chi, F., & Merino, G. An Efficient Growth Pattern Algorithm (GrowPAL) for Cluster Structure Prediction. *J. Chem. Theory Comp.*, 2024, 20(11), 4939–4948. <https://doi.org/10.1021/acs.jctc.4c00365>

Ris work was supported by:

I.R.G.C. gratefully acknowledges Secihti for the master's fellowship provided during his postgraduate studies.



REACTION FORCE AND ELECTRONIC FLUX AS DESCRIPTORS FOR OXYGEN ADSORPTION IN N-DOPED GRAPHENE-BASED SINGLE-ATOM CATALYSTS

Autor: Luis Alvarado¹

Coautores: Alejandro Toro Labbé²; Eduardo Gerardo Perez Tijerina¹; Hector Noé Fernandez Escamilla¹; Jose Manuel Romo Herrera³; Noboru Takeuchi⁴

¹ UANL

² PUUC

³ CNYN-UNAM

⁴ CNYN UNAM

Autor responsable de la comunicación: luiz.kh@hotmail.com

Understanding the interaction between molecular oxygen and catalytic surfaces is essential for the rational design of high-performance materials for energy conversion reactions such as the Oxygen Reduction Reaction (ORR). In this work, we employ Density Functional Theory (DFT) to investigate the initial adsorption of O₂ on a series of N-doped graphene-based single-atom catalysts (TM-N₄V₂, where TM = Cr, Mn, Fe, Co, Ni, Cu). We introduce the use of Reaction Force Analysis (RFA) and Reaction Electronic Flux (REF) as quantum descriptors that provide a detailed picture of the bond formation and electronic rearrangement during the adsorption process.

Our results reveal a strong correlation between the magnetic moment of the transition metal center and the strength of O₂ adsorption, with higher-spin systems such as Cr and Mn exhibiting deeper potential wells and higher electronic flux values. The analysis demonstrates that RFA and REF can capture subtle differences in interaction strength and charge redistribution, offering a complementary approach to conventional energy-based descriptors. These insights suggest that spin polarization and electronic structure evolution play a key role in oxygen activation and that RFA and REF can serve as efficient screening tools for catalyst pre-evaluation.

This study highlights the potential of force- and flux-based descriptors to guide the selection and optimization of active sites in single-atom catalysts for ORR and related electrochemical processes.

Keywords:

DFT, ORR, SACs, N-doped graphene, Reaction Force

Reference:

Alvarado-Leal, L. A., et al. (2025). DFT study of oxygen adsorption by single-atom catalysts on N-doped graphene: Implications for oxygen reduction reactions. *ACS Appl. Nano Mater.*, 8(22), 11642–11654. <https://doi.org/10.1021/acsanm.5c01990>

Ris work was supported by:

This work was supported by DGAPA-UNAM (IN105722, IN111223, IG101124), FONDECYT-Chile (1241224), and computational resources from DGTIC-UNAM Supercomputing Center (LANCAD-UNAM-DGTIC- 051, -382, -368).



THEORETICAL STUDY OF CARBOPLATIN ENCAPSULATION IN BORON PHOSPHIDE NANOTUBES USING DFT-D

Autores: Aracely Del Carmen Martínez Olguín¹; Gregorio Hernández Coccoletzi²; María Teresa Romero de la Cruz¹; Yuliana Elizabeth Avila Alvarado¹

¹ *Universidad Autónoma de Coahuila*

² *Instituto de Física, Benemérita Universidad Autónoma de Puebla*

Autor responsable de la comunicación: acmolguin@gmail.com

In zigzag chirality, boron phosphide nanotubes (BPNTs) are particularly interesting due to theoretical predictions of their solubility in polar solvents, which suggests potential applications in biomedical applications. On the other hand, encapsulation is one of the most promising strategies for anticancer drug transportation, which reduces collateral damage to healthy cells. In this work, we have investigated the structural and electronic properties of the (14,0) BPNTs in the pristine form and doped with C/Ti, analyzing their interaction with carboplatin in different orientations and configurations. First-principles calculations were performed using density functional theory with dispersion corrections (DFT-D), as implemented in the PWscf code of the Quantum ESPRESSO package. The Perdew–Burke–Ernzerhof (PBE) functional under the generalized gradient approximation (GGA) was used for exchange–correlation energies, and PAW pseudopotentials described the electron-ion interactions. Results show that chemisorption occurs when carboplatin and the BPNT form covalent bonds. In contrast, in C-doped BPNTs, physisorption predominates, as indicated by the absence of bond formation. High adsorption energy values are attributed to van der Waals interactions. So, non-covalent interaction (NCI) analysis was performed to identify weak intermolecular forces. A more negative adsorption energy value means stronger interactions between drugs and nanotubes; however, such high values would not benefit the desorption of the molecule. C-doped nanotubes are more favorable because these systems have adsorption energy that is good enough to bond and not too strong, so desorption is possible.

Keywords:

carboplatin, Boron phosphide Nanotubes, DFT-D

Reference:

D. García-Toral, V. M. Vázquez-Báez, R. Mendoza-Báez, E. Chigo-Anota, A. Flores-Riveros, G. Hernández Coccoletzi, J. F. Rivas-Silva, Structural Stability and Electronic Properties of Boron Phosphide Nanotubes: A Density Functional Theory Perspective, *Symmetry* 14(5) (2022) 964. <https://doi.org/10.3390/sym14050964>

Ris work was supported by:

SECIHTI postdoctoral research. The authors gratefully acknowledge the computing time granted by LANCAD and SECIHTI on the supercomputer Yoltla/Miztli/Xiuhcoatl at LSVP UAM-Iztapalapa/DGTIC UNAM/CGSTIC CINVESTAV, with project No. 18-2025 and LNS, with project No. 202301010N



STRUCTURAL OPTIMIZATION OF LOW-PRESSURE SUPERHYDRIDE LaBH₈

Autores: Aracely Del Carmen Martínez Olguín¹; EDGAR MARTINEZ GUERRA²; José David Lamas Medina³; María Teresa Romero de la Cruz¹

¹ *Universidad Autónoma de Coahuila*

² *Universidad Autónoma de Nuevo León*

³ *Benemérita Universidad Autónoma de Puebla*

Autor responsable de la comunicación: jdlamedina@gmail.com

In the last 5 years a large number of new high temperature superconductors have been predicted experimentally. Such predictions have led to LaH compounds with a breaking record of a $T_c = 216$ K. The problem with all these hydrides, they require very high pressures that does not make them candidates for practical applications. Scientists have been looking for ways to reduce external pressure for hydride superconductors. One strategy is to find a third element that can be included into the voids of these known structures, it would increase overall packaging. In this way, increasing internal pressure it will decrease external pressure required for superconductivity. In this work, we use B to occupy voids in LaH₈ compounds. The LaBH₈ system was performed under pressure using the BFGS algorithm (Broyden-Fletcher-Goldfarb-Shanno), optimization technique implemented in the Quantum Espresso code (QE). A band structure formation analysis reveals that the eight bands in the -15 to 2 eV range from the Fermi level derive from the eight quasi free-electron like bands of the empty H₈ sublattice, which are only weakly perturbed by hybridization with the 2s-2p boron states, and more strongly by hybridization with the three La semi-core bands from -20 to -15 eV. Also, we computed the phonon dispersion using linear response theory within harmonic approximation on very fine $\mathbf{k}$ and $\mathbf{q}$ grids as implemented with Density Functional Perturbation Theory in QE. The possibility of stabilizing a super hydride to this pressure represents an advance towards hydride-based superconductivity at room pressure.

Keywords:

LaBH₈, superconductivity, Density Functional Theory, hybrid superconductor, structural optimization

Reference:

Belli, F., & Errea, I. (2022). Impact of ionic quantum fluctuations on the thermodynamic stability and superconductivity of LaBH₈. *Physical Review B*, 106(13). <https://doi.org/10.1103/physrevb.106.134509>

Ris work was supported by:

The authors gratefully acknowledge the computing time granted by LANCAD and SECIHTI on the supercomputer Yoltla/Miztli/Xiuhcoatl at LSVP UAM-Iztapalapa/DGTIC UNAM/CGSTIC CINVESTAV, with project No. 18-2025



EXPLORING HUBBARD CORRECTIONS IN Nb₄C₃ MXene: IMPACT ON ELECTRONIC STRUCTURE AND HYBRIDIZATION DYNAMICS

Autores: Aracely Del Carmen Martínez Olguín¹; EDGAR MARTINEZ GUERRA²; María Teresa Romero de la Cruz¹; Oscar Joel Castro Contreras¹

¹ Universidad Autónoma de Coahuila

² Universidad Autónoma de Nuevo León

Autor responsable de la comunicación: oscar-castro@uadec.edu.mx

MXenes are a class 2D nanomaterials with the general composition $M_{n+1}X_n$, where M is a transition metal and X represent carbon and nitrogen, with n values ranging from 1 to 3. They are synthesized from MAX phase materials with the composition $M_{n+1}AX_n$, where A is a main group element, commonly from groups 13 or 14 of the periodic tables. MXenes are created through selective etching of the A layer from the MAX phases, either in pure form ($M_{n+1}X_n$) or with surface functional group ($M_{n+1}X_nT_x$). These functional group (T_x) can include fluorine (F), hydroxyl (OH), and oxygen (O), imparting remarkable electronic, mechanical, optical, thermal, hydrophilic, and catalytic properties to the MXenes. This study focuses on Nb₄C₃ MXene to investigate the effect of Hubbard correction ($DFT + U$) on the d orbitals of Niobium (Nb) using density functional theory (DFT). The analysis includes band structure, density of states (DOS), and projected density of states ($PDOS$) calculations. The process employed both scalar relativistic and full relativistic pseudopotentials for Nb and C . The Hubbard correction value was determined by testing various initial values, confirming that the resulting Hubbard value remained consistent, allowing for effect verification through comparison of the aforementioned analyses. In this work, the structural and electronic properties of Nb₄C₃ have been investigated by a fully first-principles approach. By using the $DFT + U + V$ method with on-site U and inter-site V Hubbard parameters derived from DFPT, we have compared the results against DFT , $DFT + U$, and $DFT + U + V$. In addition, two types of Hubbard projectors based on NAO and OAO projectors have been used. Here, the on-site U parameter is not significant for describing the confined nature of $Nb - 4d$ states, whereas the intersite V parameter is relevant for describing the strong hybridization between $Nb - 4d$ and $C - 2p$ states.

Keywords:

MXenes, DFT, Nb₄C₃, Hubbard correction, Electronic Structure

Reference:

Floris, A., Timrov, I., Himmetoglu, B., Marzari, N., de Gironcoli, S., & Cococcioni, M. (2020). Hubbard-corrected density functional perturbation theory with ultrasoft pseudopotentials. *Physical Review B*, 101(6), 064305. <https://doi.org/10.1103/PhysRevB.101.064305>

Ris work was supported by:

The authors gratefully acknowledge the computing time granted by LANCAD and SECIHTI on the supercomputer Yoltla/Miztli/Xiuhcoatl at LSVP UAM-Iztapalapa/DGTIC UNAM/CGSTIC CINVESTAV, with project No. 18-2025



FIRST-PRINCIPLES STUDIES ON Sc_2RuZ ($Z = \text{Si}, \text{Ge}, \text{Sn}$) INVERSE HEUSLER ALLOYS: STRUCTURAL, ELECTRONIC, AND TRANSPORT PROPERTIES

Autores: Carlos Eduardo Rufino da Silva¹; Edgar Martínez-Guerra²

Coautores: María Teresa Romero de la Cruz³; Miguel José Yacamán¹; Philip Asare¹; Sergio Javier Mejía Rosales²

¹ Northern Arizona University

² Universidad Autónoma de Nuevo León

³ Universidad Autónoma de Coahuila

Autor responsable de la comunicación: edgar.martinezgrr@uanl.edu.mx

The continuous demand for efficient, non-toxic, and thermally stable materials for room-temperature energy conversion motivates the exploration of novel thermoelectric systems beyond the traditional magnetic Heusler alloys. While full and half-Heusler compounds, especially those based on Co-, Ni-, and Mn-, have demonstrated promising thermoelectric properties, their typically high operating temperatures and magnetic complexities limit their applicability in ambient thermal management. In this context, we investigate whether Sc-based inverse Heusler alloys can offer a viable non-magnetic alternative with competitive thermoelectric performance. In this work, we perform a systematic first-principles study of the inverse Heusler compounds Sc_2RuZ ($Z = \text{Si}, \text{Ge}, \text{Sn}$), focusing on their structural, electronic, mechanical, and thermodynamic-thermoelectric properties. Density Functional Theory (DFT) was employed to compute optimized lattice structures and band dispersion, while dynamical stability was assessed via phonon calculations. Thermoelectric transport coefficients, including Seebeck coefficient, electrical conductivity, and thermal conductivity, were estimated using the semi-classical Boltzmann transport theory within the constant relaxation time approximation. Our results show that all Sc_2RuZ compounds are thermodynamically stable semiconductors with indirect band gaps ranging from 0.12 to 0.16 eV, and exhibit high elastic moduli, particularly Sc_2RuSn , which demonstrates superior stiffness and incompressibility. Notably, all compounds exhibit promising room-temperature thermoelectric properties, including high Seebeck coefficients and power factors. These findings reveal that Sc_2RuZ alloys represent a rare class of stable, non-magnetic inverse Heusler semiconductors with intrinsic thermoelectric potential at room temperature, unlike many existing Heusler systems optimized for spintronics or high temperature.

Keywords:

thermoelectric, Heusler alloys, Seebeck coefficient, electrical conductivity, thermal conductivity

Reference:

C. Felser and A. Hirohata, Heusler alloys: properties, growth and applications, Springer Series in Materials Science 222 (2016) pp. 1-486

Ris work was supported by:

The authors gratefully acknowledge the computing time granted by LANCAD on the supercomputer Yoltla at LSVP UAM-Iztapalapa with project No. 35-2025.



IMPACT OF ELECTRODE SPACING ON ELECTRICAL CHARACTERIZATION SENSITIVITY OF SKIN LAYERS: A FINITE ELEMENT APPROACH

Autores: Daniela Campo¹; José Herrera-Celis²; René Antaño-López¹

¹ *Centro de Investigación y Desarrollo Tecnológico en Electroquímica*

² *Universidad Industrial de Santander*

Autor responsable de la comunicación: dcampo@cideteq.mx

Bioimpedance is a non-invasive technique that enables the dielectric characterization of living tissues. In this technique, electrode spacing affects both the penetration depth and the overall sensitivity of the measurements [1]. However, due to the heterogeneous and multilayered structure of skin, the electrode distance that maximizes measurement sensitivity to changes in specific skin layers remains undetermined, making accurate and non-invasive characterization challenging. This study aimed to analyze the effect of electrode distance on the sensitivity of bioimpedance measurements to changes in the dielectric properties of the dermis. To achieve this, finite element simulations were performed in COMSOL Multiphysics® using a simplified array of interdigitated electrodes coupled to a 2D multilayer forearm skin model, including the stratum corneum, epidermis, dermis, and subcutaneous tissue. The behaviors of the impedance magnitude at 100 kHz versus the electrical conductivity (varied from 0.1 to 0.5 S/m) and the relative permittivity (varied from 30,000 to 60,000) of the dermis were obtained and analyzed. The analysis was performed for electrode distances ranging from 100 μm to 10 mm, both in the presence and absence of the stratum corneum. Under the studied conditions with the stratum corneum, bioimpedance measurements were most sensitive to variations in dermis conductivity and permittivity at electrode distances of 4 mm and 3.7 mm, respectively. In the absence of the stratum corneum, the greatest impedance variation was observed at 4.5 mm for conductivity changes and 3.5 mm for permittivity changes. According to data postprocessing, sensitivities as high as 20 $\text{k}\Omega\cdot\text{m}$ were obtained. These findings contribute to advancing the non-invasive characterization of specific skin layers, which contain medically relevant information for applications such as drug delivery and disease assessment.

Keywords:

Skin model, interdigitated electrodes, bioimpedance, finite element simulation

Reference:

[1] S. Grimnes and Ø. G. Martinsen, "Geometrical Analysis," in *Bioimpedance and Bioelectricity Basics*, Third Edition., Academic Press, 2015.

Ris work was supported by:

Laboratorio Nacional CONAHCYT de Impedancia y Bioimpedancia



SIMULATION-BASED STUDY OF FERMI ENERGY LEVEL AND DIELECTRIC SUB- STRATE EFFECTS ON THE ELECTROMAGNETIC RESPONSE OF GRAPHENE-BASED METASURFACES

Autor: Gustavo Hilario Perez¹

Coautores: Pablo Córdova Morales ; Alfredo David Morales Vite ²; José Didino García Aguilar ³; Donato Valdez Pérez ⁴; Ángel Adalberto Duran Ledezma ⁵

¹ *Instituto Politécnico Nacional*

² *Estudiante*

³ *Centro de Estudios Científicos y Tecnológicos N° 16 "Hidalgo"*

⁴ *Instituto Politécnico Nacional, SEPI-ESIME,*

⁵ *Instituto Politécnico Nacional, SEPI-ESIME unidad Ticomán.*

Autores responsables de la comunicación: gustavohilariop@gmail.com, pcordovam1800@alumno.ipn.mx

In this work, we present a simulation-based study of a unit cell composed of ring-shaped graphene elements to analyze the effects of Fermi energy level variations and dielectric substrate properties on the electromagnetic response of a metasurface in the terahertz (THz) range. Three different geometries and three dielectrics with varying permittivity values were considered. Using finite element method (FEM)-based electromagnetic simulation tools, we modeled the unit cell under Fermi energy levels ranging from 0 eV to 1.5 eV. Results show that increasing the Fermi energy significantly affects both the resonance frequency and absorption efficiency. Furthermore, substrates with lower permittivity broaden the absorption bandwidth, while those with higher permittivity enable sharper resonances. These findings demonstrate that the electromagnetic response can be effectively tuned by adjusting the Fermi energy level and selecting an appropriate dielectric substrate. The results of this work contribute to the development of reconfigurable THz absorbers and sensing applications.

Keywords:

Terahertz, Graphene, Metasurface, Fermi energy tuning, FEM simulation.

Reference:

C. Zeng et al., "Graphene-empowered dynamic metasurfaces and metadevices," *Opto-Electronic Advances*, vol. 5, no. 4, 2022, doi:10.29026/oea.2022.200098.

Ris work was supported by:

Authors are thankful to SIP-IPN Project Number 20250035.



ESTIMATION OF ABSORBED DOSE RESPONSE DUE TO γ -RAYS AND NEUTRONS IN PURE AND DY- AND EU-DOPED HYDROXYAPATITE USING MONTE CARLO METHODS

Autor: Carina Oliva Torres Cortés¹

Coautores: Antonio Baltazar Raigosa ¹; Héctor René Vega Carrillo ¹; Maria Leticia Pérez Arrieta ¹; Ángel García Durán¹

¹ *Universidad Autónoma de Zacatecas*

Autor responsable de la comunicación: carina.torres@uaz.edu.mx

The study of the potential behavior of materials using computational methods is crucial for decision-making in the experimental stage. Due to the Monte Carlo features its use for development and study of materials for the detection of neutrons and gamma rays is widely used. Hydroxyapatite is a material characterized by its compatibility with human tissue and luminescent properties when doped with certain impurities incorporated into its structure. In this work, the absorbed dose was estimated using Monte Carlo simulations with the MCNP6 code for both pure hydroxyapatite and hydroxyapatite doped with dysprosium (Dy) and europium (Eu) at two concentrations (0.1 M and 0.5 M). Simulations were performed for monoenergetic neutrons ranging from 10⁻⁹ to 20 MeV, in addition, the dose response was estimated using polyenergetic neutron sources whose spectrum describes isotopic neutron sources. Likewise, the absorbed dose response was estimated for gamma rays the energy range of 0.5 to 20 MeV. The results indicate that Eu-doped materials at a concentration of 0.5 M exhibit the highest absorbed dose response for both neutrons and gamma rays. The response behavior varies depending on the type of radiation: for low-energy neutrons, the absorbed dose is significantly higher, whereas for gamma rays, the dose response increases proportionally with photon energy.

Keywords:

Monte Carlo Methods, Absorbed Dose Response, Hydroxyapatite, Neutrons, Gamma Rays

Reference:

Vega-Carrillo, H.R., Guzmán-García, K.A., Gallego, E., Lorente, A., (2014). Passive neutron area monitor with pairs of TLDs as neutron detector. *Radiat. Meas.* 69, 30-34.

Ris work was supported by:

SECIHTI



MODELING THE 2D HEXAGONAL AsBi AND AsSb MONOLAYERS: A FIRST- PRINCIPLES STUDY

Autor: Carlos Antonio Corona García¹

Coautores: Christian Alejandro Celaya López ¹; Gregorio Hernández Cocoltzi ³; Jonathan Guerrero Sanchez

¹ Centro de Nanociencias y Nanotecnología-UNAM

³ Instituto de Física, Benemérita Universidad Autónoma de Puebla

Autor responsable de la comunicación: cacorona@ens.cnyn.unam.mx

In recent years, the development of two-dimensional (2D) materials has gained considerable attention due to their exceptional electronic, optical, mechanical, and magnetic properties. The first reported 2D material, graphene, was initially considered revolutionary, especially in the post-silicon era, owing to its high electrical conductivity, excellent carrier mobility, outstanding mechanical strength, and remarkable thermal conductivity [1]. However, the absence of an intrinsic band gap in graphene limits its applicability in conventional electronic devices. This limitation has motivated the exploration of novel 2D materials with tunable or intrinsic band gaps. Notable examples include silicene, germanene, the family of phosphorene allotropes, arsenene, bismuthene, antimonene [2], among others. While many of these materials have been synthesized and characterized both theoretically and experimentally, others remain purely theoretical proposals. Among the most promising candidates for electronic applications are arsenene, bismuthene, and antimonene, as they exhibit intrinsic band gaps and favorable carrier transport properties. Motivated by these features, we propose two new hexagonal binary compounds: AsBi and AsSb. In this work, we employ first-principles total energy calculation using the density functional theory (DFT) to investigate the structural, dynamical, and electronic properties of monolayer AsBi and AsSb. Their dynamical and thermodynamic stability is assessed through phonon dispersion calculations and cohesive energy analysis. Additionally, we compute their electronic properties in terms of the density of states (DOS) and the band structures. To overcome the under-estimation of the bandgap in standard DFT calculations, we compute the band structure using the HSE06 hybrid functional to obtain a more accurate estimation of the band gap. Our results show that both AsBi and AsSb monolayers are dynamically stable and possess intrinsic band gaps. Our findings suggest these materials as promising candidates for electronic applications.

Keywords:

Bismuthene, Arsenene, Antimonene, DFT, Two-dimensional materials

Reference:

- [1] Geim, A. K.; Novoselov, K. S. The rise of graphene. Nat. Mater. 2007, 6, 183–191.
- [2] Galicia-Hernandez, J. M.; et al. Electronic and optical properties of the buckled and puckered phases of phosphorene and arsenene. Sci. Rep 2022,12,20979.

Ris work was supported by:

We acknowledge partial financial support from DGAPA-UNAM project IG101124. CACG thanks DGAPA for the postdoctoral scholarship. CACL thanks SECIHTI for the postdoctoral scholarship.



DFT STUDY ON THE INFLUENCE OF BIPHENYLENE-TYPE NANOSTRUCTURING ON THE ELECTRONIC PROPERTIES OF GROUP IV-A CARBIDES

Autores: Ricardo Bermeo Campos¹; Gabriela Mariela Reyes Chaparro²; Alejandro Trejo Baños¹; Raúl Oviedo Roa³; Miguel Cruz Irissón¹

¹ IPN - ESIME Culhuacán

² UPIITA - IPN

³ Instituto Mexicano del Petróleo

Autores responsables de la comunicación: rick.berm.gin@gmail.com, mreys.gaby@gmail.com

Semiconductor carbides have increased interest in the scientific community due its potential use in electronic devices such as batteries, supercapacitors or gas sensing. On the other hand, it has been demonstrated that the properties of some materials would be modified by the reorganization of the atoms, this is called nanostructuration, an example of this is the graphene whose electronic and mechanical properties are different if it is compared with graphite. The most studied nanostructure is the monolayer, which consists of layers of some material that have only one thick atom. In recently years, the carbon based biphenylene monolayer has been studied and synthesized [1].

The present work investigates the electronic properties of IV-A group carbides based on biphenylene monolayers, focusing on silicon (SiC), germanium (GeC), and tin (SnC), using density functional theory (DFT) within the supercell approach. The electronic properties show a significant change compared to their graphene-like counterparts. Graphene-like SiC is typically reported with an estimated band gap of 2.52 eV, while biphenylene SiC exhibits a band gap of 1.42 eV, thus reducing the band width around 56 %. These results may suggest potential applications for these monolayers in energy storage and generation, gas sensing, among others.

Keywords:

DFT, Carbides, Biphenylene, Monolayer, Nanostructures, Nanomaterials

Reference:

[1] Qitang F. et al., Biphenylene network: A nonbenzenoid carbon allotrope, Science 372, 852-856 (2021).

Ris work was supported by:

2025-0107 SIP-IPN. LANCAD-UNAM-DGTIC-180 y 380.



KEKULÉ DISTORTIONS IN GRAPHENE ON CADMIUM SULFIDE

Autor: Yonatan Betancur Ocampo¹

Coautores: Francisco Sánchez Ochoa²; José Reyes Gasga²; Samuel Tehuacanero Nuñez²; Santiago Galván y García³; Thomas Stegmann³

¹ ybetancur@fisica.unam.mx

² Instituto de Física, UNAM

³ Instituto de Ciencias Físicas, UNAM

Autor responsable de la comunicación: ybetancur@fisica.unam.mx

The deposition of a two-dimensional material on the surface of a three-dimensional crystal can generate superlattices with electronic properties modified through the proximity spin-orbit effect. In this paper, we found that Kekulé graphene superlattices are obtained by placing graphene on Cd-terminated (001)-(1×1) cadmium sulfide (CdS) surface. From an effective model of Kekulé superlattices, which is corroborated by density functional theory calculations, we identified that the puckered surface of CdS modifies the on-site energies (staggered potential) and C-C bonds, giving rise to two possible $\sqrt{3}\times\sqrt{3}$ hexagonal superlattices, which are known as Kekulé-O graphene and Kekulé-Y with a quadratic band crossing point. Both Kekulé superlattices present spin-orbit coupling due to the interaction of graphene with the CdS surface. To guide the experimental realization of Kekulé superlattices based on graphene/CdS heterostructures, we simulate electron diffraction patterns as well as images from high-resolution transmission electron microscopy and scanning transmission electron microscopy in the mode of high-angle annular dark field.

Keywords:

Graphene superlattice, Kekulé distortion, spin-orbit coupling, Dirac fermions, proximity effect

Reference:

Y. Betancur-Ocampo, S. Galván y García, S. Tehuacanero-Nuñez, J. Reyes-Gasga, T. Stegmann, and F. Sánchez-Ochoa, Kekulé distortions in graphene on cadmium sulfide, *Phys. Rev. B* 111, 085431 (2025).

Ris work was supported by:

UNAM- PAPIIT under Projects No. IA106223, No. IA102125, No. IG100725, No. IA105623, and No. IN103922, and CONAHCYT (SECIHTI) Grant No. CF-2023-I-336.



THIN FILMS

CHAIRMEN

Dr. Alfredo Morales Sánchez (INAOE)

Dr. Servando Aguirre (CIMAV)

The purpose of this symposium is to provide an international forum for discussion and exchange of ideas on the up-to-date research and developments of processing and characterization of advanced thin films. The physical properties of thin films are critically dependent on the deposition conditions and post-treatment details therefore discern the correlations between the experimental conditions and film properties are of great interest for the field. The participants from various universities, industries and research laboratories are welcome to submit contributions for both oral and posters presentations to discuss recent advances, developments, field applications, and future challenges for the thin film technologies. The topics include, but are not limited to, every kind of thin films used in:

- Energy applications
- Protective coatings
- Memory storage
- Optoelectronic devices
- Sensors and actuators
- Biomedical applications.



OPTICAL AND STRUCTURAL STUDIES OF POLYCRYSTALLINE THIN FILMS OF CADMIUM TELLURIUM PROCESSED BY CSVT TECHNIQUE

Autores: Cassandra González Armendaríz¹; Jorge Ricardo Aguilar Hernández²; María de los Ángeles Hernández Pérez¹; Montserrat Gema Córdova Julián³

¹ Departamento de Metalurgia y Materiales, Escuela Superior de Ingeniería Química e Industrias Extractivas, Instituto Politécnico Nacional. C.P. 07738, CDMX, México

² Departamento de Física, Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional. C.P. 07738, CDMX, México

³ Departamento de Física, Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional. C.P. 07738, CDMX, México.

Autor responsable de la comunicación: mcordovaj1500@alumno.ipn.mx

Polycrystalline thin films of Cadmium Tellurium (CdTe) were processed by the near-space sublimation (CSVt) technique. The films were optically characterized by UV-Vis Absorption spectroscopy, Photoluminescence and Raman spectroscopy. The analysis of the optical absorption results allowed us to determine the value of the bandgap energy. In order to analyze the homogeneity of the samples ($2 \times 2 \text{ cm}^2$), Photoluminescence (at room temperature 300 K) as well as Raman measurements were carried out. The Photoluminescence results showed an asymmetric band centered at 1.5 eV, no significant changes were detected along the surface of the samples. According to literature the main band corresponds to the band-band transition. Raman spectroscopy results show three peaks located around 125.2 cm^{-1} , 141.4 cm^{-1} , and 164.7 cm^{-1} , which correspond to the modes $A_1(\text{Te})$, $\text{TO}(\text{CdTe}) + \text{E}(\text{Te})$ and $\text{LO}(\text{CdTe})$ respectively. There is a shift of the peaks up to 6 cm^{-1} along the surface of the sample, which indicates structural inhomogeneity of the surface of the samples.

Keywords:

CdTe, CSVt, UV-Vis, Photoluminescence, Raman.

Work was supported by:

Instituto Politécnico Nacional, Proyecto SIP: 20250129



INFLUENCE OF SOLVENTS AND PRECURSORS ON THE DEPOSITION OF ZnO RIN FILMS BY AACVD

Autor: Axel Nicolas Martinez Rodriguez¹

Coautores: Ciro Falcony Guajardo ²; Jesús Uriel Balderas Aguilar ³; LUIS ALBERTO BECERRIL LANDEROS⁴

¹ Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional. Departamento de Física

² Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional - Zacatenco, Departamento de Física

³ Instituto de Investigaciones en Materiales -UNAM

⁴ Cinvestav Zacatenco

Autor responsable de la comunicación: axelni563@gmail.com

Zinc oxide (ZnO) is a wide band gap semiconductor that continues to be the subject of intense research due to its attractive properties, such as high transparency, tunable band gap, adjustable conductivity, and high exciton binding energy. The aerosol-assisted chemical vapor deposition (AACVD) technique represents a promising alternative for the fabrication of ZnO thin films, thanks to its low cost and the possibility of operating under atmospheric conditions, as well as the wide range of variables it offers to modify the characteristics of the resulting material. This study analyzes the influence of different solvents (water, toluene, and ethanol) and zinc precursors (zinc nitrate and zinc acetate) on the morphological and structural properties of ZnO films, as a function of the deposition temperature. The films were obtained by pyrolytic spray at temperatures ranging from 200 °C to 500 °C. The formation of crystalline films was achieved starting at 200 °C, with notable morphological variations observed depending on the conditions used.

Keywords:

ZnO, AACVD, Antisolvents

Reference:

Sanchez-Perez, C., et al. (2023). Self-textured ZnO via AACVD of alkyl alkoxides: a solution-based seed-less route towards optoelectronic-grade coatings. *Materials Advances*, 4(17), 3774–3786. <https://doi.org/10.1039/d3ma00468f>

Ris work was supported by:

SECIHTI y Cinvestav



(CdTe)_{1-x}Al_x FILMS PRODUCED BY RF CO-SPUTTERING employing CdTe AND ALUMINUM TARGETS

Autor: Leonel Sanchez-Garcia¹

Coautores: Carlos Torres-Frausto ²; Angel Guillen-Cervantes ²; Sergio Tomas-Velazquez ¹; Rafael Kitl-Hernández ¹; Miguel Melendez-Lira ¹

¹ Departamento de Física, Cinvestav

² Departamento de Física, Cinvestav-IPN

Autor responsable de la comunicación: leon.szg14@gmail.com

(CdTe)_{1-x}Al_x films produced by RF co-sputtering employing CdTe and aluminum targets were deposited on soda lime glass and p-type silicon. Aluminum content in the films was self-controlled by the plasma interaction, the maximum aluminum content achieved was $x=0.08$. The maximum value of the bandgap was 1.59 eV for $x=0.07$. X ray diffractograms suggest that $x=0.08$ is close to the saturation limit of aluminum in the CdTe lattice. Optical constants were obtained from the analysis of transmission spectra, their values were systematically lower than those of CdTe. From the fitting of X ray photoelectron spectra values of 573.4 3v and 583.4 eV are proposed for the Te-Al bonding energy. Samples grown on silicon substrate shown rectifying characteristics for IvsV curves. The obtained photoresponse indicates that (CdTe)_{1-x}Al_x films have potential as an optoelectronic material.

Keywords:

semiconductors, photovoltaics, thin films

Reference:

Gurevich, Y. G., & Meléndez Lira, M. (2024). Fenómenos de contacto y sus aplicaciones en celdas solares.

His work was supported by:

partially funded by CONAHCyT



PHYSICAL PROPERTIES OF GaN AND AlN THIN FILMS DEPOSITED BY SPUTTERING

Autores: Marcelino Becerril Silva¹; Alfredo Cruz-Orea¹

Coautores: Máximo López López¹; Mario Cervantes Contreras²; Jesús Dominguez Bravo²

¹ Departamento de Física, CINVESTAV-IPN, Apdo. Postal 14-740, 07000 México D.F., México

² Unidad Profesional Interdisciplinaria de Biotecnología del Instituto Politécnico Nacional, Av. Acueducto S/N, Col. Barrio La Laguna Ticomán, Gustavo A. Madero, 07340, Ciudad de México, México.

Autor responsable de la comunicación: marcelino.becerril@cinvestav.mx

GaN and AlN polycrystalline thin films were grown on Si (111), Si (100), and as reference on 7059 Corning glass substrates at room temperature by radio frequency magnetron sputtering from a target prepared with GaN, AlN powders. The structural and optical properties of the films were analyzed and compared. The structure of the films was determined from X-ray diffraction and Raman measurements. The optical properties were studied by UV-vis spectroscopy. It was found that using this deposition method, polycrystalline films with a different phase and band gap can be obtained depending on the substrate used.

Keywords:

Semiconductors III-V, thin films, radio frequency sputtering, X-ray diffractions.

Reference:

T.L. Chu, S.S. Chu, J. Britt, C. Ferekides, C. Wang, C.Q. Wu, H.S. Ural, IEEE Elect. Device Lett. 43 (1992) 303.

His work was supported by:

Conhacyt from México



A FEASIBLE SURFACE MODIFICATION OF GLASS SUBSTRATES TO ENHANCE CADMIUM SULFIDE FILM ADHESION

Autores: Dalia Alejandra Mazón Montijo¹; Jose Pablo Estrella Leyva²

Coautores: Obed Yamín Ramírez Esquivel³; Zeuz Montiel González²

¹ Laboratorio de Diseño y Optimización de Recubrimientos Avanzados (DORA-Lab), CIMAV-Mty/TECNL-CIIT, Apodaca, Nuevo León 66629, México, SECIHTI-Tecnológico Nacional de México campus Nuevo León (TECNL), Centro de Investigación e Innovación Tecnológica (CIIT), Apodaca, Nuevo León 66629, México.

² SECIHTI-Centro de Investigación en Materiales Avanzados S. C., subsele Monterrey, Apodaca, Nuevo León 66628, México, Laboratorio de Diseño y Optimización de Recubrimientos Avanzados (DORA-Lab), CIMAV-Mty/TECNL-CIIT, Apodaca, Nuevo León 66629, México.

³ Laboratorio de Diseño y Optimización de Recubrimientos Avanzados (DORA-Lab), CIMAV-Mty/TECNL-CIIT, Apodaca, Nuevo León 66629, México, SECIHTI-Tecnológico Nacional de México campus Nuevo León (TECNL), Centro de Investigación e Innovación Tecnológica (CIIT), Apodaca, Nuevo León 66629, México

Autor responsable de la comunicación: 00estrellapablo@gmail.com

In the context of chalcogenide semiconductor thin films, one of the most studied materials is cadmium sulfide (CdS) due to its interesting optical and electrical properties. Several deposition methods can be used, with chemical bath deposition (CBD) being one of the most common due to its simplicity and low cost. However, along with the widespread use of this method, there is still a need for a deeper understanding of the underlying phenomena governing the growth of the films on different types of glass substrates, which leads to a well-known variability of adhesion strength through the wide variety of deposited materials. Surface modification processes are often employed to address this issue. In this work, we report the effect of temperature on the modification process of glass substrates by a $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$ aqueous solution to enhance adhesion of CdS films synthesized by CBD.

Additionally, we investigate the impact of substrate modification on the CdS films morphology and microstructure. The higher temperatures of the modification solution resulted in greater surface modification. Moreover, further thermal treatment of the modified surfaces improves adhesion of CdS thin films. We suggest that this improvement can be attributed to the formation of SnO_2 after thermal treatment, a species known to promote adhesion. Overall, our results demonstrated an alternative surface modification method that can be conducted under simple conditions without the need for additional modifying agents. This research opens the possibility to study the deposition of other chalcogenide compounds to get a deep insight into the phenomena involved during the formation of films on glass substrates.

Keywords:

Surface modification, Chemical bath deposition, Adhesion, Cadmium sulfide.

Reference:

Estrella-Leyva J.P. Thesis undergrad: Modificación superficial de sustratos para promover la adherencia de películas de sulfuro de cadmio. (2024).

García-Valenzuela, et al. (2019). Chemistry select, 4(5), 1650-1665.

Ris work was supported by:

This work was partially supported by Centro de Investigación en Materiales Avanzados, S. C. [Proyectos Internos CIMAV 23025 (2021) and 25024 (2023)].



OPTIMIZATION OF CUS COATINGS DEPOSITED BY SILAR THROUGH ADVANCED MATHEMATICAL MODELS: THE IMPORTANCE OF TRANSPORT PARAMETERS

Autores: Axel Agustín Ortiz Atondo¹; DALIA ALEJANDRA MAZÓN MONTIJO²; Jonathan Montalvo Urquiza³; Zeuz Montiel González⁴

¹ Centro de Investigación en Materiales Avanzados S. C., subsede Monterrey, Apodaca, Nuevo León 66628, México, Laboratorio de Diseño y Optimización de Recubrimientos Avanzados (DORA-Lab), CIMAV-Mty/TECNL-CIIT, Apodaca, Nuevo León 66629, México.

² TECNMI/INSTITUTO TECNOLÓGICO DE NUEVO LEÓN-CENTRO DE INVESTIGACIÓN E INNOVACIÓN TECNOLÓGICA (TECNL-CIIT)

³ School of Engineering and Sciences, Tecnológico de Monterrey, Monterrey, N. L. 64700, México.

⁴ SECIHTI-Centro de Investigación en Materiales Avanzados S. C., subsede Monterrey, Apodaca, Nuevo León 66628, México, Laboratorio de Diseño y Optimización de Recubrimientos Avanzados (DORA-Lab), CIMAV-Mty/TECNL-CIIT, Apodaca, Nuevo León 66629, México.

Autor responsable de la comunicación: a96ortiza@gmail.com

Semiconductor coatings have been widely studied for their usefulness in various energy-harvesting technologies, especially in solar cells, photocatalytic processes, and smart windows. For low-emissivity applications, various chalcogenide-based films have recently gained attention as potential alternatives, with covellite-phase CuS—synthesized via successive ionic layer adsorption and reaction (SILAR)—showing particularly promising results. Nevertheless, extended deposition time needed to reach a suitable thickness poses a challenge for large-scale implementation. Additionally, in applications such as building windows, obtaining uniform films is critical to guarantee consistent functionality across the entire surface. In this study, a mathematical metamodel was employed to simulate deposition of CuS films using the SILAR method, for simultaneously optimizing film thickness, uniformity, and deposition time. Four key input variables—immersion speed, emersion speed, transfer speed, and distance between solutions—were selected to represent substrate transport conditions during the process. Through an iterative approach involving three experimental rounds, it was demonstrated that these transport parameters play a crucial role in determining both the growth dynamics and the final quality of deposited films. The study reveals that changes in thickness and uniformity are primarily influenced by the emersion speed: at slower speeds, the impact of the other variables is reduced. The optimized transport parameters were found to be 34.33 mm/s for immersion speed, 3 mm/s for emersion speed, 75 mm/s for transfer speed, and 118.33 mm for distance between solutions. These values resulted in a higher deposition rate within a shorter time frame, achieving a film homogeneity of 5% across the entire deposition area. The results underscore the critical role of managing transport parameters in this methodology and show that metamodels enable the assessment of multiple variables even with limited data. These findings are anticipated to enhance the reproducibility of existing studies and support the transition from laboratory-scale synthesis to industrial-scale production.

Keywords:

Multi-objective optimization, CuS films, SILAR deposition, Transport parameters

Reference:

Montiel-González, Z. et al. (2022). Structural, chemical, and MIR response of covellite CuS films via SILAR as opaque Low-E coatings. *Optical Materials*, 126, Artículo 112208. <https://doi.org/10.1016/j.optmat.2022.112208>

Ris work was supported by:

Centro de Investigación en Materiales Avanzados, S. C. [Proyectos Internos CIMAV 23025 (2021) and 25024 (2023)] and MOCTECH.



ZINC SULFOXIDE THIN FILMS BY CHEMICAL BATH DEPOSITION WITH POTENTIAL FOR UTILIZATION OF SOLAR ENERGY

Autores: Dalia Alejandra Mazón Montijo¹; Jorge Alberto Escamilla Paredes²; Zeuz Montiel González³

¹ Laboratorio de Diseño y Optimización de Recubrimientos Avanzados (DORA-Lab), CIMAV-Mty/TECNL-CIIT, SECIHTI-Tecnológico Nacional de México campus Nuevo León (TECNL), Centro de Investigación e Innovación Tecnológica (CIIT).

² Tecnológico Nacional de México campus Nuevo León (TECNL), Centro de Investigación e Innovación Tecnológica (CIIT), Laboratorio de Diseño y Optimización de Recubrimientos Avanzados (DORA-Lab), CIMAV-Mty/TECNL-CIIT.

³ Laboratorio de Diseño y Optimización de Recubrimientos Avanzados (DORA-Lab), CIMAV-Mty/TECNL-CIIT, SECIHTI-Centro de Investigación en Materiales Avanzados S. C., subsede Monterrey.

Autor responsable de la comunicación: mm23481535@nuevoleon.tecnm.mx

Current urban growth is intensifying the pressure on the need for energy and water resources, driving the scientific and technological communities to constantly search for alternatives to counteract this serious situation. At this point, exploration of semiconductor coatings (given their impact on the development of optoelectronics devices) of chalcogenides and oxides looking for new opportunities for utilization of solar energy, is a topic under current scrutiny. This work focuses on synthesizing zinc sulfoxide (ZnSO) thin films using chemical bath deposition (CBD), a scalable and cost-effective method, to investigate the relationship between the evolution of the films' characteristics (thickness, morphology, elemental composition, and crystalline structure) and their functional performance. ZnSO thin films are predominantly amorphous with nanocrystalline domains corresponding with the zincblende phase of ZnS. The surface morphology reveals small grain clusters distributed in an island growth pattern. Moreover, the films show an increasing thickness as a function of deposition time and high transparency in the visible-NIR regions of the electromagnetic spectrum and optical band gap ~ 3.6 eV, which is in between values for ZnS and ZnO. These findings provide valuable insights for developing ZnSO thin films as photoactive component for optoelectronic devices with potential application for the utilization of solar energy.

Keywords:

ZnSO thin films, chemical bath deposition, chalcogenide/oxide semiconductor.

Reference:

Das, S. &. (2021). Chemical solution synthesis for materials design and thin film device applications. (S. &. Das, Ed.) Elsevier.

Vallejo, W. H. (2010). Kinetic study on Zn(O,OH)S thin films deposited by chemical bath deposition. *Electrochimica Acta* 55, 5610–5616.

Ris work was supported by:

SECIHTI - Beca Nacional para estudios de posgrado 1323963 and Proyecto Interno CIMAV 25024-2023.



SILICON OXYNITRIDE RIN FILMS BY MEANS HFCVD: A STUDY OF THE COMPOSITION, STRUCTURE, AND OPTICAL PROPERTIES

Autor: Eduardo Oswaldo Mendo Perez¹

Coautores: José Alberto Luna López¹; Eduardo Ernesto Flores Cuevas²; Zaira Jocelyn Hernández Simón¹; José Álvaro David Hernández De la Luz¹; Godofredo García Salgado¹; Mario Moreno Moreno³; Xochitl Aleyda Morán Martínez¹

¹ Centro de Investigación en Dispositivos Semiconductores - Instituto de Ciencias de la Benemérita Universidad Autónoma de Puebla

² Centro de Investigaciones y Estudios Avanzados del Instituto Politécnico Nacional (CINVESTAV-IPN)

³ Instituto Nacional de Astrofísica, óptica y Electrónica (INAOE)

Autor responsable de la comunicación: eduardo.mendop@alumno.buap.mx

Silicon oxynitride (SiO_xN_y) thin films offer a compelling combination of compositional flexibility and functional properties, positioning them as attractive candidates for optoelectronic and microelectronic applications. In this study, we explore the synthesis of SiO_xN_y films deposited on crystalline n-type silicon substrates using Hot Filament Chemical Vapor Deposition (HFCVD), a cost-effective and scalable technique. The objective is to elucidate the relationships between deposition conditions, film composition, atomic bonding, and photonic behavior. A comprehensive characterization was conducted using Fourier-transform infrared spectroscopy (FTIR), Raman spectroscopy, X-ray photoelectron spectroscopy (XPS), and photoluminescence (PL). FTIR and Raman analyses confirmed the formation of a structurally disordered network, with prominent vibrational features attributed to Si–O and Si–N bonds. XPS revealed key insights into the surface chemistry, including the presence of sub-stoichiometric oxide and nitride species, as well as the O/N ratio across different samples. Notably, PL measurements exhibited broad visible-range emissions, suggesting the presence of radiative defect states associated with mixed anionic coordination in the amorphous matrix. These findings highlight how the incorporation of nitrogen and oxygen—modulated by HFCVD parameters—affects the structural disorder and optoelectronic response of the films. The work contributes to the understanding of SiO_xN_y as a tunable material system and demonstrates the potential of HFCVD for engineering advanced dielectric or luminescent layers for future device integration.

Keywords:

Oxynitride, HFCVD, XPS, analysis, Silicon

Reference:

R. K. Pandey et al., "Growth and characterization of SiON thin films by using thermal-CVD machine," *Opt Mater (Amst)*, vol. 25, no. 1, pp. 1–7, 2004, doi: 10.1016/j.optmat.2003.07.003.

Ris work was supported by:

Instituto de Ciencias de la Benemérita Universidad Autónoma de Puebla (ICUAP-BUAP)



STRUCTURAL ANALYSIS OF CARBON RIN FILMS DEPOSITED In TI-6AL-4V BY THE PIII&D TECHNIQUE

Autor: Beiker Martínez Rueda¹

Coautores: Fabio Antonio Xavier ¹; Nazir Monteiro ²

¹ *The Precision Engineering Laboratory -LMP, Mechanical Engineering Department, Federal University of Santa Catarina*

² *Institute of Advanced Studies (IEAv), Department of Aerospace Science and Technology (DCTA)*

Autor responsable de la comunicación: beiker.rueda@labtucal.ufsc.br

The aim of this study is to investigate the properties of carbon films coatings deposited on titanium alloy (Ti6Al4V) samples inside metal tubes in order to increase the corrosion resistance of its inner surface. These films were deposited by Plasma Immersion Ion Implantation and Deposition titanium alloy (PIII&D) system by driving Hollow Cathode (HC) discharges inside the tubes of titanium alloy (Ti6Al4V) [1]. The experimental results show an interesting change on the chemical structure and morphology of the as-deposited carbon films, when the diameter of tube varied. Therefore, the surface was evaluated by White Light Interferometry and Scanning Electron Microscopy (SEM). The chemical structure was analyzed by Raman Spectroscopy. In this study, the evaluation of the mean height deviation amplitude (S_a) and spatial density ($S_{dr}\%$) showed significantly differences in the roughness parameters in tubes with different diameter, however, the different microtopography of surfaces obtained may be categorized as smooth ($0.0\text{--}0.4\text{ }\mu\text{m}$) [2]. This surface characteristic is related with the chemical structure, where the Raman spectra presented D and G peaks, characteristic of carbonaceous materials with crystalline and amorphous regions with different ID/IG ratios [3]. The results showed that the inner surface of the tube was completely coated by carbon films, as analyzed in the samples fixed along the tube.

Keywords:

PIII&D, White Light Interferometry, carbon thin films, Raman Spectroscopy

Reference:

- [1] N.M. Santos, S.F.M. Mariano, M. Ueda, Surface and Coatings Technology. 375 (2019) 164-170.
- [2] R. Meyer, et al. , Optics and Laser Technology. 184 (2025)
- [3] 112444Yu, X et al. , Surfaces and Interfaces. 65 (2025) 106545

Ris work was supported by:

the CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) - PROEX (Programa de Excelência Acadêmica) - Brasil, LAS-INPE and LMP-UFSC



METASTABLE $\text{MgO}(001)/\text{MnGe}_2$ CO-SPUTTERED THIN FILMS SYNTHESIZED BY REACTIVE DEPOSITION EPITAXY METHOD (RDE)

Autor: Adriana Alvidrez-Lechuga¹

Coautores: Carlos Roberto Santillan-Rodriguez ¹; José Trinidad Holguín-Momaca ¹; Sion Federico Olive-Méndez ¹

¹ Centro de Investigación en Materiales Avanzados, S.C.

Autor responsable de la comunicación: adriana.alvidrez@cimav.edu.mx

The challenge of manufacturing increasingly efficient electronic devices has led to the continued miniaturization of electronic components, generating the need for innovative materials that guarantee faster data processing speeds, greater storage capacity, and lower power consumption. Materials with magnetic properties capable of processing information through a spin-polarized current are required. Diluted magnetic semiconductors (DMSs) are materials doped with transition metal atoms that combine semiconductor and magnetic properties. Mn-doped Ge ($\text{Ge}_{1-x}\text{Mn}_x$) offers a direct route for integrating magnetism with the existing silicon technology; however, DMSs have a very low Curie temperature (T_C) [1]. During the synthesis of DMSs, metastable MnGe_2 nanocolumns were grown, and magnetic measurements showed a $T_C > 400$ K. The MnGe_2 has a C16-type structure (tetragonal $I4/mcm$ symmetry) with lattice parameters $a = 5.96$ Å and $c = 5.03$ Å. The non-primitive unit cell contains 12 atoms: four Mn at 4(a) and eight Ge at 8(h) positions. We report the growth of $\text{MgO}(001)/\text{MnGe}_2$ thin films using the magnetron sputtering technique by the reactive deposition epitaxy (RDE) method, which consists of Mn+Ge co-deposition at a substrate temperature, T_s . The energy dispersive spectroscopy (EDS) analysis presented an atomic composition close to the metastable MnGe_2 phase. The X-ray diffraction (XRD) analysis showed peaks at different angles corresponding to the MnGe_2 phase. The atomic force microscopy (AFM) analysis presented an irregular grain size and surface topography. The high-resolution transmission electron microscopy (HR-TEM) analysis allowed the calculation of the lattice mismatch, which resulted from the compressive stresses during epitaxial growth. The magnetic properties were measured using a physical properties measurement system (PPMS). The different characterization techniques revealed evidence of MnGe_2 phase growth.

Keywords:

Diluted magnetic semiconductors (DMSs), magnetism, MnGe_2 thin films, metastable.

Reference:

S. F. Olive-Méndez, M. Petit, A. Ranguis, V. Le Thanh, and L. Michez, From the Very First Stages of Mn Deposition on Ge(001) to Phase, Cryst. Growth Des. 18 (2018) 5124–5129. DOI: 10.1021/acs.cgd.8b00558

Ris work was supported by:

Ciencia-Básica SEP-CONACYT grant No. 157559.



INFLUENCE OF COPPER LAYER THICKNESS AND SAMPLE WIDTH ON MAGNETIC COUPLING IN NiFe/Cu/NiFe TRILAYERS

Autor: Miguel Angel Escudero Garcia¹

Coautores: Alejandro Esparza ¹; Enrique Francisco Pinzón Escobar ²; Maria Herlinda Montiel Sanchez ²

¹ *Instituto de Ciencias Aplicadas y Tecnología UNAM*

² *Instituto de Ciencias Aplicadas y Tecnología, UNAM*

Autor responsable de la comunicación: miguel.escudero@comunidad.unam.mx

The ferromagnetic resonance (FMR) behavior of NiFe (100 nm)/Cu/NiFe(100 nm) heterostructures, where $x = 100, 200$, and 300 nm, was investigated. The trilayer systems were obtained via sputtering, and rectangular patterns with dimensions of $10 \text{ mm} \times b$ (where $b = 0.5, 1, 5$, and 10 mm) were defined through photolithography.

The ferromagnetic resonance measurements were performed using a JEOL JES-RE3X X-band spectrometer within a magnetic field range of 50 mT to 850 mT . The absorption spectra were recorded under different orientations. Two measurements were carried out with the magnetic field parallel to the sample plane: one with the microwave field parallel to the longitudinal axis and another with it parallel to the short axis of the sample. Two additional measurements were performed with the magnetic field perpendicular to the sample plane: one with the microwave field parallel to the longitudinal axis and the other parallel to the short axis of the sample.

The results indicate that magnetic exchange and magnetostatic coupling vary as a function of both the copper layer thickness and the sample width. The data also reveals that the is confined within the plane. These findings are relevant for the development of magnetic sensors based on magnetoimpedance [1].

Keywords:

FMR, Sputtering, Permalloy, Copper, photolithography.

Reference:

Valenzuela R, Zamorano R, Alvarez G, Gutiérrez MP, Montiel H. Magnetoimpedance, ferromagnetic resonance, and low field microwave absorption in amorphous ferromagnets. *J Non Cryst Solids* 2007;353. <https://doi.org/10.1016/j.jnoncrsol.2006.12.113>.

Ris work was supported by:

PAPIIT-UNAM IN113624



EFFECTS OF FIELD INTENSITY, POLARITY REVERSAL, AND AIR AGITATION ON THE PROPERTIES OF ZnO THIN FILMS SYNTHESIZED BY ELECTRIC FIELD-ASSISTED CHEMICAL BATH DEPOSITION.

Autores: Marco Antonio Sanchez-Alejo¹; Francisco Ramos-Brito²; Jorge Noé Angulo-Rocha³; Jesús Bladimir Cepero-Rodríguez²; Rafael Martínez-Martínez⁴; Enrique Camarillo-García⁵; Erika Lizárraga-Medina⁶; Fernando Sanchez-Rodríguez³; Cástulo Anselmo Alejo-Armenta⁷; Vicente Adrián Canizalez-Roman⁸; Santos Jesús Castillo⁹; Joel Molina- Duarte³; Manuel García-Hipólito¹⁰

¹ Facultad de Ciencias, Universidad Nacional Autónoma de México

² Facultad de Ciencias Físico-Matemáticas –Universidad Autónoma de Sinaloa

³ Facultad de Ciencias Físico Matemáticas, Universidad Autónoma de Sinaloa

⁴ Universidad Tecnológica de La Mixteca

⁵ Instituto de Física, Universidad Nacional Autónoma de México

⁶ CICATA-Legaria, Instituto Politécnico Nacional

⁷ Coordinación General Para el Fomento a La Investigación Científica e Innovación del Estado de Sinaloa

⁸ CIASaP, Facultad de medicina, Universidad Autónoma de Sinaloa

⁹ Departamento de Investigación en Física, Universidad de Sonora

¹⁰ Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México (UNAM)

Autor responsable de la comunicación: marco_sanchez_alejo@ciencias.unam.mx

Through the incorporation of a high-voltage electric field (HVEF), with and without electrical polarity reversal, to influence the growth dynamics of thin films. We present an innovative modification of the chemical bath deposition (CBD) method for the synthesis of zinc oxide (ZnO) thin films. Two configurations were developed to determine the effects of electric field intensity, periodic reversal, air agitation, and solution pH on the structural, morphological, and optical properties of ZnO coatings. X-ray diffraction confirmed the formation of the wurtzite crystalline phase of ZnO, with a reduction in interplanar spacing and crystal size under electric fields, especially with polarity reversal. Scanning electron microscopy revealed that the size, shape, and distribution of particles were highly dependent on the synthesis parameters. It also showed that the electric field and air injection allowed for greater surface coverage and finer nanostructures. Optical measurements showed a constant increase in the band gap and a reduction in defect-related absorption. These findings demonstrate that controlled electric field application during CBD enables precise tuning of ZnO film properties.

Keywords:

ZnO, CBD, Surface Characterization, HVEF.

Reference:

Applied Physics A (2025) 131:280, <https://doi.org/10.1007/s00339-025-08371-8>.



STRUCTURAL AND ELECTRONIC PROPERTIES OF HIGH ENTROPY THIN FILM Sr- RuTiMnFeScO₃: AN EXPERIMENTAL AND THEORETICAL APPROACH

Autor: Maury Solórzano Valencia¹

Coautores: Christian Alejandro Celaya López²; Ma. de la Paz Cruz Jáuregui³

¹ Centro de Nanociencias y Nanotecnología (CNYN-UNAM)

² Centro de Nanociencias y Nanotecnología-UNAM

³ Universidad Nacional Autónoma de México (UNAM). Centro de Nanociencias y Nanotecnología (CNYN)

Autor responsable de la comunicación: m.solorzano.ujat@gmail.com

High-entropy ceramics (HECs) are one of the most important research branches in this kind of materials because the combination of uniformity and high entropy configuration give HECs unusual performance in terms of magnetism, electrical resistance, thermal stability, as compared to bulk materials. In this work, the perovskite ceramic SrRuO₃, ferromagnetic at $T_c \sim 160$ K [1], is transformed into one new entropy ceramics: SrRuTiMnFeScO₃ in bulk form, using the solid-state reaction method. Film was deposited by laser ablation, on Si substrates, using a 0.15 J/cm² fluency, pulse frequency of 2 Hz, oxygen pressures of 25 mT, temperatures 500 °C and 10 min of deposition time. The morphological structural characterization and elemental composition of the films were performed by means of the AFM, SEM, XRD, and EDS techniques. The XRD studies (bulk and thin film samples) confirm the presence of a single phase as well as the conservation of the orthorhombic crystalline structure for all the samples, strong evidence of the two HECs formation. SEM analysis for thin film samples revealed homogeneity in all the samples. Additionally, density functional theory (DFT) calculations were performed to investigate the structural modifications induced by cation insertion into the pristine SrRuO₃ lattice. Partial density of states calculations reveal that the introduction of cations significantly alters the energy gap between the pristine system and the doped compound, effectively tuning its electronic structure. To assess the structural stability of the complex, first-principles molecular dynamics simulations were conducted at 1000 K. The diffusion coefficients of the doped cations were evaluated, providing valuable insights into the structural stability and behavior of these complex systems. Overall, the combined experimental and theoretical results confirm the successful synthesis of a high-entropy ceramic based on SrRuO₃, with preserved crystallinity and homogeneity in both bulk and thin-film forms

Keywords:

SrRuO₃, High entropy, ceramics, DFT, Molecular dynamics

Reference:

[1] J.P. Corbett, K.-Y. Meng, J.J. Repicky, et al., Applied Surface Science, 153766 (2022).

Ris work was supported by:

M. Solórzano and C.A. Celaya thanks to SECIHTI for the postdoctoral scholarship.



DESIGN OF PHOTONIC HETEROSTRUCTURES BASED ON POROUS SILICON FOR SENSING APPLICATIONS

Autor: Roberto Carlos Hernandez¹

Coautores: Jesus Madrigal Melchor ²; Augusto David Ariza Flores ²

¹ *Universidad Autónoma de Zacatecas, Maestría, de la unidad académica de ciencia y tecnología de la luz y la materia*

² *Universidad Autónoma de Zacatecas*

Autor responsable de la comunicación: rcht.1998@gmail.com

This research work aims to develop an optical sensing system based on surface plasmon resonance (SPR) and frequency spectrum analysis, using multilayer Tamm cavity-type structures made of porous silicon, forming a Multilayer-Gold-BK7 configuration. To fabricate these structures, a controlled electrochemical etching process is employed, in which the applied current and exposure time are regulated in a custom-designed electrochemical cell with electrolytic acid, allowing for high-precision adjustment of the density and size of nanocavities in each region of the silicon.

Sensing is carried out by measuring the reflectance spectrum, where the incidence of monochromatic light at a controlled angle and the tracking of the reflectance minimum shift serve as an indicator signal of analyte adsorption on the surface. In the frequency spectrum, Tamm-type cavities exhibit a curve in the reflectance at variable wavelengths, allowing quantification of the minimum shift in relation to analyte concentration. For the detection of heavy metals in water, the surface is functionalized with carbon quantum dots that modulate the dielectric environment and cause spectral shifts in the plasmonic resonance when metals such as Pb, Cd, or Hg are adsorbed. Similarly, the identification of alcohol vapors (methanol, ethanol, and propanol) is also possible.

Finally, the feasibility of incorporating a graphene oxide layer between the multilayers will be evaluated, aiming to enhance the sensitivity and selectivity of the sensor, thanks to its excellent electronic and adsorption properties, as well as its ability to modify the width and position of the resonance peak.

Keywords:

Porous silicon, Sensing, Reflectance spectrum, Multilayer structures, Tamm plasmon structures

Reference:

Helmut Föll, M Christophersen, J Carstensen y G Hasse. "Formation and application of porous silicon". En: Materials Science and Engineering: R: Reports 39.4 (2002), págs. 93-141.

Ris work was supported by:

Universidad Autónoma de Zacatecas, Universidad Autónoma del Estado de Morelos



SYNTHESIS AND CHARACTERIZATION OF NiSe RIN FILMS ON FTO SUBSTRATES FOR PHOTOVOLTAIC APPLICATIONS

Autor: Anell Rocha Espinoza¹

Coautores: Hannia Soto Salvador ¹; Ma. Estela Calixto Rodriguez ²; Miguel Angel Contreras Ruiz ³

¹ *Universidad de las Américas Puebla*

² *Benemerita Universidad Autónoma de Puebla*

³ *Instituto de Ciencias Físicas - Universidad Nacional Autónoma de México*

Autor responsable de la comunicación: anell.rochaea@udlap.mx

The search for sustainable technologies for energy generation has accelerated the development of advanced photovoltaic and thermoelectric devices based on novel semiconductor nanomaterials. Among these, metal selenides have emerged as promising candidates due to their tunable optoelectronic properties, environmental stability, and cost-effective fabrication. In this work, thin films of nickel selenide (NiSe) were synthesized onto fluorine-doped tin oxide (FTO) substrates, with pH control applied during the synthesis process to optimize film quality and evaluate its influence on structural and electrochemical properties. Comprehensive characterizations were conducted using ellipsometry, scanning electron microscopy (SEM), Raman spectroscopy, atomic force microscopy (AFM), UV-Vis spectroscopy, profilometry, and cyclic voltammetry. The results confirmed the successful deposition of uniform and compact NiSe films with controlled thickness, smooth surface morphology, and well-defined crystalline phases. Optical measurements revealed strong absorption in the visible range, highlighting their potential as active layers or counter electrodes in photovoltaic devices such as dye-sensitized solar cells. Furthermore, cyclic voltammetry analysis provided valuable insights into the electrochemical behavior and stability of the films under operational conditions. The combined structural, optical, and electrochemical evaluation demonstrates that NiSe thin films, processed under controlled synthesis parameters, present attractive properties for their integration into next-generation sustainable solar energy conversion systems.

Keywords:

NiSe Thin Films, FTO, Photovoltaics, Characterization, Solar Energy.

Reference:

Jiang, Q. S., Chen, R., Guo, X., Zhu, Y., Cheng, W., Li, W., Yang, X., & Chen, H. C. (2019a). Potentiostatic deposition of cobalt nickel selenides on FTO for advanced dye-sensitized solar cells. *Solar Energy*, 179, 59–66. <https://doi.org/10.1016/j.solener.2018.12.037>

Ris work was supported by:

Instituto de Física “Ing. Luis Rivera Terrazas”



SYNTHESIS AND CHARACTERIZATION OF CIS AND CIGS RIN FILMS BY ELECTRODEPOSITION

Autor: Hannia Soto Salvador¹

Coautores: Anell Rocha Espinoza ¹; María Estela Calixto Rodríguez ²; Miguel Ángel Contreras Ruiz ³

¹ Universidad de las Américas Puebla

² Instituto de Física "Ing. Luis Rivera Terrazas"

³ Instituto de Ciencias Físicas - Universidad Nacional Autónoma de México

Autor responsable de la comunicación: hannia.sotosr@udlap.mx

The thin films of CuInSe_2 (CIS) and CuInGaSe_2 (CIGS) have demonstrated high potential for applications in photovoltaic devices due to their high light absorption, stability, and efficiency. Moreover, they are positioned as a promising alternative to conventional materials like silicon thanks to advantages such as their lightweight nature, lower material consumption, flexibility, and reduction in production costs. Therefore, it is important to continue researching this type of material to contribute to the improvement of their qualities as semiconductors for various applications such as in solar cells. The main objective of this project was the synthesis of thin films of CuInSe_2 (CIS) and CuInGaSe_2 (CIGS) using the electrodeposition technique on solid FTO substrates. During the synthesis of the thin films, the deposition times were varied to 1, 3, 5, and 50 minutes for both CIGS and CIS, which allowed for the analysis of the effect of this variable on the final properties of the films, starting with their thicknesses. Additionally, thermal treatments at 500°C for 60 seconds were carried out for the deposited CIS and CIGS thin films using a rapid thermal processing equipment, and the effect of this treatment on the properties of the thin films was determined in comparison to the untreated thin films. For each deposited thin film, various characterization techniques were performed: structural, through Raman spectroscopy and X-ray diffraction (XRD); optical for determining absorption coefficients and band gaps, using UV-visible spectroscopy and ellipsometry; morphological, using atomic force microscopy (AFM); and thickness determination through profilometry.

Keywords:

CIS/CIGS thin films, Electrodeposition, Rapid thermal processing (RTP), Photovoltaic materials.

Reference:

Kumar, A., Giripunje, S. M., Patel, A. K., & Gohri, S. (2024). Simulation study of cadmium-free CIGS solar cell for efficiency enhancement by minimizing recombination losses through back surface field mechanism. *Solid State Communications*, 394, 115694. <https://doi.org/10.1016/j.ssc.2024.115694>

Ris work was supported by:

Instituto de Física "Ing. Luis Rivera Terrazas"



DEPOSITION AND CHARACTERIZATION OF Ag AND Mo RIN FILMS USING E-BEAM FOR OPTOELECTRONICS APPLICATIONS

Autor: Alejandra Guadalupe López Hernández¹

Coautores: Fernando Quintero ²; Mario Hidrogo ²; Eduardo Martínez Guerra ³; Abraham Arias León ⁴; Francisco Aguirre Tostado ⁵

¹ *Universidad Autónoma de Baja California*

² *CIMAV*

³ *Centro de Investigación en Materiales Avanzados (CIMAV-Monterrey)*

⁴ *UABC*

⁵ *Cimav, Unidad Monterrey*

Autores responsables de la comunicación: lopez.alejandra50@uabc.edu.mx, fernando.quintero@cimav.edu.mx

Metal deposition techniques, such as electron beam evaporation, are crucial for developing high-performance optoelectronic devices. High-quality Ag and Mo thin films are essential for optoelectronic applications, as they ensure optimal performance, efficiency, and reliability in devices such as solar cells, sensors, and light-emitting diodes. In this work, the optimization of 50 nm films of Ag and Mo was performed using a Torr Scientific e-Beam evaporator system. The e-beam spot was tuned to increase the deposition rate for a given parameter configuration. Various characterization techniques, including Scanning Electron Microscopy (SEM), X-Ray Diffraction (XRD), X-Ray Photoelectron Spectroscopy (XPS), Atomic Force Microscopy (AFM), and electrical measurements, were employed to analyze the films' morphological, structural, chemical, and electrical properties. The ultimate goal was to correlate these properties with the films' deposition parameters to determine the ideal conditions for achieving optimized performance in future optoelectronic device applications, such as solar cells, sensors, and light-emitting devices.

Keywords:

e-Beam, metal deposition, surface characterization

Reference:

Zhongping Wang, Zengming Zhang, Advanced Nano deposition Methods: Electron Beam Evaporation Deposition, Wiley 2016, pp. 33-58

Ris work was supported by:

Acknowledgments: Partial financial support was received from SECIHTI-Fronteras Grant #58518.



CONTROLLING THE α - MoO_3 GROWTH PARAMETERS VIA THERMAL OXIDATION AND REACTIVE MAGNETRON RF-SPUTTERING

Autor: Mario Elias Garcia

Coautores: Ricardo Mis Fernández ¹; Mariely Loeza-Poot ²; Lucien Veleza Muleskova ¹; Eduardo Camacho Espinosa ¹; Eduardo Ernesto Flores Cuevas ³

¹ Centro de Investigación y de Estudios Avanzados del IPN Unidad Mérida

² Centro de Investigación y de Estudios Avanzados del IPN Unidad Mérida, Departamento de Física Aplicada.

³ Centro de Investigaciones y Estudios Avanzados del Instituto Politécnico Nacional (CINVESTAV-IPN)

Autor responsable de la comunicación: mario.elias.g01@gmail.com

Transition metal oxides (TMOs) are a significant class of materials due to their diverse electronic, optical, and catalytic properties, enabling a broad spectrum of technological applications. Molybdenum trioxide (MoO_3), particularly the thermodynamically stable α -phase, has received considerable attention due to its interesting properties that can be tailored depending on the type of application. However, the synthesis of this desirable phase is the major challenge, since the tendency to form multiple stoichiometric phases. In the present work, we compare two methodologies for the preparation of α - MoO_3 thin films. The first method involves the deposition via magnetron RF-Sputtering of Mo thin films followed by thermal oxidation under atmospheric conditions at various temperatures and times. In the second method, the Reactive Magnetron RF-Sputtering (RMRFS) was used with a Mo target in an Ar/O_2 atmosphere, varying the working conditions such as O_2 partial pressure and substrate temperature. A comprehensive characterization of the physicochemical properties was conducted for all samples, encompassing the crystalline structure, chemical composition, morphology, and optical transmittance. Preliminary results indicate that temperature is a key factor in both thermal oxidation and RMRFS methods, with the latter also showing high sensitivity to the Ar/O_2 ratio. XRD and Raman spectroscopy were used to confirm the formation of a phase mixture of polycrystalline α and β - MoO_3 . XPS was used to validate the oxidation states Mo^{6+} and Mo^{5+} , which are characteristic of α - MoO_3 and substoichiometric Mo_xO_y . SEM analysis revealed uniform morphology in both methodologies. Finally, UV-Vis spectroscopy was employed to determine the bandgap energy, found to be around 3–3.5 eV. The results indicate that both methods are successful in forming α - MoO_3 , with RMRFS standing out for minimizing undesired phases appearing in the thermal treatment.

Keywords:

TMOs, Thermal Oxidation, Reactive Magnetron RF-Sputtering, MoO_3 thin films

Reference:

A. A. Shaikh, J. Bhattacharjee, P. Datta, and S. Roy, A comprehensive review of the oxidation states of molybdenum oxides and their diverse applications, *Sustain. Chem. Environ.* 7 (2024) 100125. <https://doi.org/10.1016/j.scenv.20>

Ris work was supported by:

The authors acknowledge the facilities of the National Laboratory for Nano and Biomaterials (LANNBio). The authors also thank Dr. V. Rejón and Engr. W. Cauch for his technical assistance



DEVELOPMENT OF METAL OXIDE NANOHETEROJUNCTION FILMS WITH POTENTIAL USE IN ETHANOLAMINE GAS DETECTION.

Autor: Tomás Constantino Hernández García¹

Coautores: Wendy Adamary Huerta Padilla ¹; Clarissé Hernández Santana ¹; Daniel López Serna ²

¹ *Laboratorio de Materiales I, Facultad de Ciencias Químicas, Universidad Autónoma de Nuevo León*

² *Facultad de Ingeniería Civil, Universidad Autónoma de Nuevo León*

Autor responsable de la comunicación: tomas.hernandezgr@uanl.edu.mx

Ethanolamine, a volatile organic compound (VOC) used in various industries, can cause adverse effects on human health. Previous studies show that semiconductor materials made of metal oxides and ferrites, modified through doping and synthesis techniques, improve the structural, optical, and response properties of sensors. This research paper presents the production of a film with the composition $\text{SnO}_2 - \text{Mn}_{0.5}\text{Zn}_{0.5}\text{Sm}_{0.1}\text{Fe}_{1.9}\text{O}_4$, beginning with the synthesis of ferrite through a combination of autocombustion and coprecipitation methods, followed by the production of the corresponding film using the spincoater technique. X-ray diffraction analysis confirmed the presence of the spinel phase initially, as well as spinel-rutile in the film obtained. The Fourier transform infrared spectroscopy spectrum revealed the characteristic vibrations of the metal-oxygen bond of ferrite as well as the Sn-O stretching typical of tin oxide. The band gap (E_g) value was estimated, and it was confirmed that the heterojunction is a semiconductor consistent with the typical behavior of semiconductor materials suitable for gas sensor applications. The film showed a surface roughness of ≈ 7.9 nm, suitable for chemoresistive sensors. Surface topography studies performed by SEM show images of metal oxides deposited on a glass substrate, which are porous and very dense in nature.

Keywords:

X-ray diffraction; Electron microscopy; heterojunction; metallic oxid; sensors;

Ris work was supported by:

Facultad de Ciencias Químicas, UANL.



CuSbS₂ THIN FILMS BY ELECTRODEPOSITION AND THE PHOTOELECTROCHEMICAL HYDROGEN EVOLUTION

Autores: Rocio Guadalupe Avilez García¹; Xavier Mathew¹; Nini Rose Mathews¹

¹ *Instituto de Energías Renovables UNAM*

Autor responsable de la comunicación: nrm@ier.unam.mx

In this work, we present the development of stoichiometric chalcostibite (CuSbS₂) thin films using a cost-effective single-bath pulse electrodeposition technique, aimed at their application as photocathodes in photoelectrochemical (PEC) cells. To achieve stoichiometric CuSbS₂ composition, the molar ratio of Cu to Sb in the electrolyte bath was systematically varied. Optimal deposition and dissolution potentials were determined to be -0.72 V and -0.1 V versus the saturated calomel electrode (SCE), respectively. The structural and phase purity of the resulting films were examined through a combination of characterization techniques. X-ray diffraction (XRD) and Raman spectroscopy confirmed the formation of phase-pure chalcostibite from a precursor bath with a Cu/Sb molar ratio of 0.41. To assess the photoelectrochemical performance, a heterostructure composed of CuSbS₂/CdS/Pt was fabricated and evaluated as a photocathode. Mott-Schottky analysis was employed to estimate the energy band positions. The conduction band and valence band offsets for the CuSbS₂/CdS heterojunction were calculated to be 0.1 eV and 1.04 eV, respectively. These favorable band alignments resulted in an internal electric field at the heterojunction interface, which effectively suppressed charge carrier recombination and facilitated improved charge separation and transport. The CuSbS₂/CdS/Pt photocathode exhibited an enhanced photocurrent density of 3.4 mA cm⁻² at 0 V versus the reversible hydrogen electrode (RHE), demonstrating the potential of this system for solar-driven hydrogen production. The corresponding photoelectrochemical conversion efficiency was calculated to be 0.56%. In conclusion, this study demonstrates the viability of pulse electrodeposition as a low-cost, scalable approach for producing stoichiometric and phase-pure CuSbS₂ thin films. The promising performance of the CuSbS₂/CdS/Pt heterostructure highlights the potential of this earth-abundant material as an efficient photocathode for PEC water-splitting applications.

Keywords:

Chalcogenide semiconductor thin films, electrodeposition, photoelectrochemical cells.

Reference:

<https://doi.org/10.1016/j.heliyon.2024.e24491>

<https://doi.org/10.1016/j.nanoen.2016.08.036>

Ris work was supported by:

This work is part of the project PAPIIT IN111824, and has collaboration with the project PAPIIT-IN109324



STUDY OF THE DIELECTRIC FUNCTION OF $\text{CuIn}_{1-x}\text{Ga}_x\text{Se}_2$ AND CuInSe_2 ELECTRODEPOSITED AND SELENIZED THIN FILMS BY SPECTROSCOPIC ELLIPSOMETRY.

Autor: Miguel Angel Contreras Ruiz¹

Coautores: Carolina Janani Diliegros Godines ²; Hannia Soto Salvador ³; Horacio Martínez Valencia ¹; Ma. Estela Calixto Rodríguez ²

¹ *Instituto de Ciencias Físicas - Universidad Nacional Autónoma de México*

² *Instituto de Física "Ing. Luis Rivera Terrazas"*

³ *Universidad de las Américas Puebla*

Autor responsable de la comunicación: miguel.contreras@udlap.mx

Ellipsometry is a non-destructive optical technique used to characterize the optical and structural properties of CIGS (Copper-Indium-Gallium-Selenide) and CIS (Copper-Indium-Selenide) thin films. This article summarizes the importance and applications of ellipsometry in characterizing CIGS and CIS thin films for photovoltaic solar cells. The fundamental principles of ellipsometry, its application in measuring film thickness, chemical composition, crystal structure, and surface quality are discussed. The objective of this work is to deposit CIGS and CIS using the electrodeposition technique, followed by selenization in a rapid thermal processing system, as well as to carry out their ellipsometric characterization. Electrodeposition offers a rapid and high-quality synthesis methodology, demonstrating selectivity toward the incorporation of the electroactive species of interest. The results obtained from ellipsometry are compared with other characterization methods, highlighting its advantages and limitations. Finally, the significance of ellipsometry in optimizing the performance of CIGS solar cells and its impact on cost reduction and energy efficiency improvement is emphasized.

Keywords:

Spectroscopy ellipsometry, CIGS films, Electrodeposition, Energy band gap, Semiconductors

Reference:

Paulson, P. D., Birkmire, R. W., & Shafarman, W. N., Optical characterization of $\text{CuIn}_{1-x}\text{Ga}_x\text{Se}_2$ alloy thin films by spectroscopic ellipsometry, *J. Appl. Phys.* 94 (2003), 879-888.

Ris work was supported by:

Posdoctoral fellowship by Secretaría de Ciencia, Humanidades, Tecnología e Innovación.



BISMUTH OXYIODIDE THIN FILMS DEPOSITED BY SILAR METHOD USING NON-AQUEOUS SOLUTIONS

Autores: Josué Alejandro Castillo-Nuño¹; Juan Pablo Morán-Lázaro²; Miguel Melendez-Lira³; Israel Ceja Andrade⁴; Armando Pérez-Centeno⁴; Miguel Angel Santana-Aranda⁴

¹ *Materials Science PhD program, CUCEI, Universidad de Guadalajara*

² *Departamento de Ciencias Computacionales e Ingenierías, CUValles, Universidad de Guadalajara.*

³ *Departamento de Física, Cinvestav-IPN*

⁴ *Departamento de Física, CUCEI, Universidad de Guadalajara*

Autores responsables de la comunicación: josue.cn@alumnos.udg.mx, msantana.aranda@academicos.udg.mx

Bismuth oxyhalides (BiOX, X = Cl, Br, I) have attracted attention because of their potential for photocatalytic and photovoltaic applications, being their deposition as thin film of interest for both types of application. In this work, fairly uniform bismuth oxyiodide (BiOI) thin films were deposited using an automated successive ionic layer adsorption and reaction (SILAR) process. Bismuth nitrate and potassium iodide sources were dissolved with a non-aqueous solvent mixture and diluted to desired concentrations. Oxidation is controlled by mixing distilled water in the rinsing vessel. X ray diffraction and Raman spectroscopy were used to determine the obtained crystalline phase. Diffuse reflectance spectroscopy in the UV-Visible region was used to determine the bandgap energy. Film thicknesses were measured using profilometry, and surface morphology was observed by scanning electron microscopy. Results show that all films were successfully deposited with the desired stoichiometry in a tetragonal matlockite structure; with thicknesses in the hundreds of nanometers, for tens of cycles; and bandgap values around 2.1 eV.

Acknowledgements.

Authors want to thank the technical support of Sergio Oliva, Lupita Cárdenas, and Armando Rentería, from CUCEI-UdeG; as well as Zacarías Rivera and Angel Guillén, from CINVESTAV-IPN. Along with the partial financial support from Universidad de Guadalajara (under programs pro-SNII and PROAC). JACN wants to thank SECIHTI for a doctoral scholarship.

Keywords:

Bismuth oxyiodide, Bismuth oxyhalides, BiOX, SILAR, Thin films

Reference:

.

Ris work was supported by:

Technical support: Sergio Oliva, Lupita Cárdenas, and Armando Rentería (CUCEI-UdeG); Zacarías Rivera and Angel Guillén (CINVESTAV-IPN). Partial financial support from Universidad de Guadalajara (under programs pro-SNII and PROAC). JACN wants to thank SECIHTI for a doctoral scholarship.



TOWARDS AREA SELECTIVE DEPOSITION: PHOTOASSISTED CHEMICAL VAPOR DEPOSITION USING RU PRECURSORS

Autor: Christopher Brewer¹

Coautores: Bishwaprava Das²; Rashmi Singh²; Diego Caretti¹; Dyotana Bhattacharyya¹; Oluwatamilore Oni¹; Xin Kang²; Jonah Perry²; Lisa McElwee-White²; Amy Walker¹

¹University of Texas at Dallas

²University of Florida

Autor responsable de la comunicación: christopher.brewer@utdallas.edu

Photoassisted chemical vapor deposition (PACVD) is an attractive technique for the metallization of thermally sensitive films, such as organic thin films. A set of six (η^4 -diene)Ru(CO)₃ and two (η^2 -olefin)Ru(CO)₄ precursors has been developed that demonstrate photolytic loss of both CO and alkene ligands at room temperature. Using -CH₃, -OH, and -COOH terminated self-assembled monolayers (SAMs) as model substrates, we have investigated the use of these precursors in area selective deposition. We demonstrate that the (η^4 -diene)Ru(CO)₃ precursors show a strong deposition preference onto -COOH functionalized SAMs while (η^2 -olefin)Ru(CO)₄ precursors show a deposition preference onto the -COOH and -OH functionalized SAMs. Deposition from (η^4 -diene) Ru(CO)₃ precursors have been demonstrated as being light activated, while the (η^2 -olefin)Ru(CO)₄ precursors act as a low temperature thermal CVD precursor. The -CH₃ functionalized SAMs are a non-growth surface for all the precursors screened. Using X-ray photoelectron spectroscopy, we have elucidated the composition of the deposited Ru species. Using these results, we shall discuss new potentially effective PACVD precursors for the deposition of other metals.

Keywords:

Ru precursors, photoassisted chemical vapor deposition, area selective deposition

Ris work was supported by:

We gratefully acknowledge support from the National Science Foundation (NSF) under the collaborative grants DMR-2216070 to LMW and DMR-2216069 to AVW. This work was supported in part by the Semiconductor Research Corporation (SRC) under the linked projects 2022-NM-3086 and 2022-NM-3087.



GREEN LUMINESCENCE OF $\text{Lu}_2\text{O}_3:\text{Tb}^{3+}$ AEROGELS AND THEIR ADHESION ON THIN FILMS WITH PLURONIC F-127

Autor: Alan Daniel Alcantar Mendoza¹

Coautores: Antonieta García Murillo ¹; Felipe de Jesús Carrillo Romo ¹; María del Rosario González García¹

¹ *Instituto Politécnico Nacional, Centro de Investigación e Innovación Tecnológica*

Autor responsable de la comunicación: a_daniel_am@outlook.com

This study presents the synthesis and characterization of photoluminescent $\text{Lu}_2\text{O}_3:\text{Tb}^{3+}$ aerogels, as well as the deposition onto SiO_2 substrates via dip-coating, using Pluronic F-127 as a surfactant. Aerogels doped with 1, 2, and 3 mol% of Tb^{3+} were prepared through an epoxide-assisted sol-gel method, followed by supercritical drying and thermal treatment at 800 °C. The resulting materials were characterized by infrared spectroscopy (IR), photoluminescence (PL), transmission electron microscopy (TEM), scanning electron microscopy (SEM), and X-ray diffraction (XRD). All aerogels exhibited M-O-M bonding interactions characteristic of rare-earth oxides, a cubic-type crystalline structure, and a coral-like morphology composed of primary particles smaller than 20 nm. Among them, the 2 mol% Tb^{3+} -doped sample demonstrated superior photoluminescent performance and was selected for thin-film fabrication using one and three dip-coating cycles. Pluronic F-127 was incorporated as a surfactant to support the adhesion of the crystallized aerogel to SiO_2 substrates. The resulting thin films were analyzed using XRD, SEM, energy-dispersive X-ray spectroscopy (EDS), atomic force microscopy (AFM), and PL spectroscopy. To our knowledge, this is the first report demonstrating not only the successful synthesis of $\text{Lu}_2\text{O}_3:\text{Tb}^{3+}$ aerogels via sol-gel processing but also their effective integration as thin films through dip-coating. The films exhibited a rough surface composed of agglomerated aerogel particles, with no evidence of photoluminescence quenching. Notably, PL intensity improved with the use of three consecutive immersion cycles.

Keywords:

rare-earths, aerogels, photoluminescence, pluronic F-127, thin films

Reference:

A. G. Murillo, V. H. C. Calderon, F. de J. C. Romo, and D. Y. M. Velázquez, "F-127-assisted sol-gel synthesis of $\text{Gd}_2\text{O}_3:\text{Eu}^{3+}$ powders and films," *Mater. Res.*, vol. 22, no. 3, pp. 1–9, 2019, doi: 10.1590/1980-5373-MR-2018-0623.

Ris work was supported by:

This work was funded by SECIHTI (A1-S-28234) and SIP-IPN (20253493, 20253397), with characterization support from CNMN-IPN, LabCREA-CIITEC, and CICATA Legaria.



DIELECTRIC FUNCTION OF NIOBIUM THIN FILMS BY SPECTROSCOPIC ELLIPSOMETRY

Autores: Francisco Alberto Amador Ramirez¹; Francisco Javier Flores-Ruiz²

Coautores: Alberto Herrera Gómez³; Javier Gonzáles Medrano⁴; Joaquín Gerardo Raboño Borbolla⁵; Ma. Estela Calixto Rodríguez⁶; Marco Antonio Vázquez Delgado⁷; Orlando Cortazar Martínez⁸

¹ IFUAP - Benemérita Universidad Autónoma de Puebla

² CONAHCYT-Instituto de Física, Benemérita Universidad Autónoma de Puebla, Ciudad Universitaria, Edif. IF-I, 72570 Puebla, México

³ Centro de Investigación y de Estudios Avanzados del IPN - Unidad Querétaro

⁴ Benemérita Universidad Autónoma de Puebla

⁵ Cinvestav, Unidad Querétaro

⁶ Instituto de Física "Ing. Luis Rivera Terrazas"

⁷ Park Systems Microscopy Latinoamérica

⁸ CINESTAV, Unidad Querétaro

Autor responsable de la comunicación: famador@ifuap.buap.mx

Niobium is a refractory material with high chemical and thermal stability. It has been seen that thin films of other metals like gold and silver have tunable electrical and optical properties that depend on the thickness of these materials, showing a change in the dielectric function, however they lack the stability and resistance to harsh environments that Niobium has. For this work niobium thin films of 8, 38 and 283 nm were deposited by magnetron sputtering with a pulsed frequency of 100 kHz with a power of 150 W and 4s of reversal time. These films' composition and structure were characterized by XRD and XPS. Its optical resistivity was studied by spectroscopic ellipsometry using a Horiba UVISSEL Jobin Yvon M200 ellipsometer operating in the range of 0.7–4.5 eV and an angle of incidence of 70°, which was fitted simultaneously with the transmission spectra using a model containing two Lorentz oscillators and a Drude oscillator. Electrical resistivity was determined using a Hall effect measurement system model Ecopia (HMS-5000) with a current of 1 mA, these results were compared with the calculation of the zero-frequency resistivity from the Drude's contribution of the dielectric function. It is observed that as thickness decreases, optical and electrical resistivity increases. By AFM and tunneling microscopy it is confirmed that the reduction in thickness reaches a point where there is a reduction on the conductive paths of the thinnest film, showing a change from negative to positive of the real part of the dielectric function. The observed electrical and optical properties suggest a change from metal-to-insulator transition that could be related to the crossing of the percolation threshold as observed with other reported metals.

Keywords:

Dielectric function, Sputtering, Electrical properties of niobium films, Ellipsometry

Reference:

Francisco A. Amador, J.G. Medrano, Joaquín Raboño-Borbolla, Orlando Cortazar-Martínez, Alberto Herrera-Gómez, Marco Antonio Vazquez-Delgado, Francisco J. Flores-Ruiz, Dielectric function from ellipsometry measurements of niobium films, *Optical Materials*, Volume 164 (2025), 117083, <https://doi.org/10.1016/j.optmat.2025>

Ris work was supported by:

The authors acknowledge CONAHcyT for the grants received through the projects FOINS-CONACyT 2016-01-2488 and CF-2023-I-1429.



RE ROLE OF SILICON AND GLASS SUBSTRATES IN THE ELECTROLUMINESCENT PROPERTIES OF PIN DIODES BASED ON a-SixCy:H THIN FILMS

Autor: Juan Ramón Ramos Serrano¹

Coautores: Alfredo Morales Sánchez ¹; Armando Hernández Flores ¹; Ignacio Juárez Ramírez ¹; José Juan Avilés Bravo ¹; Juan Federico Ramirez Rios ¹; Mario Moreno Moreno ¹; Victor Aca Aca ¹

¹ *Instituto Nacional de Astrofísica, Óptica y Electrónica*

Autor responsable de la comunicación: juan.ramos@inaoep.mx

This work shows a comparative study of light-emitting PIN diodes based on a-SixCy:H fabricated on silicon and glass substrates. Both electroluminescent structures were fabricated using the same low-temperature process (200 °C) via plasma-enhanced chemical vapor deposition (PECVD). The active layer, where photons are generated due to electron-hole pair recombination, was an intrinsic a-SixCy:H film, while boron-doped a-SixCy:H and phosphorus-doped a-Si:H were used as p-type and n-type layers, respectively. Before the structure deposition on the glass substrate, a 0.5 µm-thick aluminum layer was deposited as back contact. An ITO film with defined square-shaped patterns of 1 mm² was used as a transparent top contact. Both structures show electroluminescence (EL) visible to the naked eye. The silicon substrate structure displays red-orange EL, while the glass substrate structure displays it in yellow color. With the silicon substrate the structure reaches the maximum EL intensity at 10 V, while with glass substrate reaches the maximum at 15 V. The emission mechanism in EL was related to a direct injection of holes in deep states in the active layer, while the electrons lose energy by a thermalization process. The changes in the EL spectra may be related to the hole injection level due to differences in the work function of the substrates. On the other hand, the conduction mechanisms were determined from the current-voltage measurements. In both structures, Poole-Frenkel emission was proposed as the dominant charge transport mechanism.

Keywords:

PECVD, electroluminescence, light-emitting diode, amorphous silicon carbide

Reference:

<https://doi.org/10.1016/j.jallcom.2024.174047>

Ris work was supported by:

Secretaría de Ciencia, Humanidades, Tecnología e Innovación



SPECTROSCOPIC ELLIPSOMETRY CHARACTERIZATION OF SPRAY-DEPOSITED COPPER OXIDE THIN FILMS

Autores: Claudia Ramos¹; Gilberto Alarcón Flores¹; Ismael Arturo Garduño Wilches²; Jennifer Olarte¹; José Antonio Calderón Arenas¹; Miguel Angel Aguilar Frutis¹; Rafael Martínez Martínez³

¹ INSTITUTO POLITECNICO NACIONAL

² Cátedras SECIHTI Instituto Politécnico Nacional

³ Universidad Tecnológica de la Mixteca

Autor responsable de la comunicación: maguilarf@ipn.mx

Copper oxide thin films were successfully deposited on glass substrates via ultrasonic spray pyrolysis using copper acetylacetonate ($\text{Cu}(\text{acac})_2$) as the copper precursor and N,N-dimethylformamide (DMF) as the solvent. The deposition of the films was carried out at $T \leq 550^\circ\text{C}$ from a 0.01 M chemical solution, resulting in the formation of both cuprite (Cu_2O) and tenorite (CuO) phases within the film, as confirmed by X-ray diffraction (XRD). Optical and electronic characterization was realized via UV-Vis spectroscopy and spectroscopic ellipsometry. Both techniques indicated the presence of two phases of copper oxide. Furthermore, spectroscopic ellipsometry allowed us to obtain the critical points that enhanced a clear determination of the phases of copper oxide in the films. A clarification of the pseudo dielectric function of the sample structure and the dielectric function for the bulk layer of the optical model was computed through a least squares minimization process considering the fitting between the experimental spectra and a dispersion model consisting of four oscillators. The absorption coefficient of the bulk layer was also computed, and good agreement was obtained between the spectroscopic ellipsometry and UV-Vis results.

Keywords:

CuO, Cu₂O, Optical Properties, Structural Properties, Spray Pyrolysis

Reference:

Transparent Oxide Electronics, From Materials to Devices, Pedro Barquinha, Rodrigo Martins, Luis Pereira and Elvira Fortunato, John Wiley & Sons 2012.

Ris work was supported by:

INSTITUTO POLITECNICO NACIONAL



TUNABLE ELECTRICAL PROPERTIES IN THIN FILMS OF TRANSITION METAL OXIDES (TMO) THROUGH MAGNETRON SPUTTERING

Autor: Karen Ailed Neri Espinoza¹

Coautores: Acela López Benítez ¹; Diana Palma Ramírez ²; Francisco Gutiérrez Galicia ¹; José Alberto Andraca Adame ¹; Lucía Ivonne Juárez Amador ³; Ramón Peña Sierra ⁴

¹ *Department of Nanomaterials, Unidad Profesional Interdisciplinaria de Ingeniería Campus Hidalgo (UPIIH), Instituto Politécnico Nacional (IPN)*

² *Department of Polymers and Nanomaterials, Unidad Profesional Interdisciplinaria de Ingeniería Campus Hidalgo (UPIIH), Instituto Politécnico Nacional (IPN)*

³ *Departamento de Ingeniería de Proyectos, CUCEI, Universidad de Guadalajara*

⁴ *Department of Electrical Engineering, Sección de Electrónica de Estado Sólido (SEES), Center for Research and Advanced Studies of the National Polytechnic Institute (CINVESTAV-IPN)*

Autor responsable de la comunicación: neri.karen8@gmail.com

This work delves into the tunable electrical properties of thin-film transition metal oxides (TMOs) achieved through magnetron sputtering techniques. It presents a short review of how precise control over methods and deposition parameters for the thin films allow the control of different electrical and structural properties and their effects on transport mechanisms, in order to improve the performance of the material for various applications such as semiconductor-insulator-semiconductor (SIS) devices, memristors, thin-film transistors (TFT), coatings and electrodes among others. The results demonstrate the variations in material performance due to co-sputtering techniques. Additionally, we outline future prospects and provides recommendations for potential combinations of transition metal oxides. Insights from recent research on co-sputtering and its impact on electrical properties are included, highlighting the potential of these methods in developing next-generation electronic and optoelectronic devices.

Keywords:

Magnetron Sputtering, Co-Sputtering, Transition Metal Oxides, Semiconductor Materials, Electrical Properties

Reference:

A. Behera, S. Aich, and T. Theivasanthi, "Magnetron sputtering for development of nanostructured materials," *Design, Fabrication, and Characterization of Multifunctional Nanomaterials*, pp. 177–199, Jan. 2022, doi: 10.1016/B978-0-12-820558-7.00002-9.

Ris work was supported by:

This study was supported by the Consejo Nacional de Humanidades, Ciencia y Tecnologías (CONAH- CyT, Mexico) under grant #2777300



STUDY OF THE PHOTO-RESPONSE PROPERTIES OF THIN FILMS OF BaTiO₃ DOPED WITH Mn AND Nb

Autor: Jesús Iván Peña Flores¹

Coautores: Christian Ivan Enriquez Flores; José Martín Yáñez Limón ¹

¹ *Cinvestav Unidad Queretaro*

Autor responsable de la comunicación: gueban_19@hotmail.com

This study investigates the effect of manganese (Mn) and niobium (Nb) on the photo-response properties of barium titanate (BaTiO₃) ferroelectric, deposited as thin films on ITO, and then evaluated in a photovoltaic cell array. The samples were synthesized using BaCO₃, TiO₂, Nb₂O₅ and MnO₂ powders. They were measured in appropriate proportions for doping at concentrations of 0, 1, 3, and 5 mol %. The methodology involves conventional ceramic synthesis, where the reagents are mixed, mechanically milled, and then compressed to form a target. The materials are sintered at high temperatures, reaching 1250°C, to facilitate the solid-state reactions. The physicochemical properties of the materials were analyzed using AFM/PFM images, UV-Vis spectra, I-V curves, and ferroelectric hysteresis loops. The AFM technique revealed the evolution topography of the surface characteristics, which is composed of grains that increase in size with increasing doping (for 5%, they are larger than 100 nm). Analyzing the amplitude, the corresponding ferroelectric domains are observed through variations in contrast, and the phase images reveal the domain direction in the different systems. The bandgap energy of the selected materials decreased with increasing doping (BaTiO₃, 3.2-3.4 eV), allowing absorption at lower energies in the visible range. For the ferroelectric hysteresis loops, a slight decrease in saturation polarization was observed with increasing doping, the highest value being in BTO sample. The piezoelectric coefficient (d₃₃) was determined by PFM analysis, which decreases with increasing doping in the BaTiO₃ matrix. I-V measurements show that the photo-response of the system is favorable and that increasing doping modifies the photovoltaic effect. This is important because it leverages two key aspects of the research: enhanced separation of photocarriers and a reduction in the band gap toward lower energies, with applications in photovoltaic and photocatalytic materials as well as ferroelectric transistors.

Keywords:

ferroelectric, BaTiO₃, Photo-response, Band gap, Doped

Reference:

Mukherjee S., Phuyal D., Segre C. U., Das s., Karis O., Edvinsson T., Rensmo H. J. Phys. Chem. C 2021, 125, 27, 14910–14923

Ris work was supported by:

SeCiHTI-Mexico for postdoctoral stays in Mexico in 2022



OPTOELECTRONIC CHARACTERIZATION OF ULTRATHIN 2D NANOMATERIAL FILMS FOR THZ DEVICES

Autor: Pablo Córdova Morales^{None}

Coautores: Gustavo Hilario Perez ¹; Alfredo David Morales Vite ²; José Didino García Aguilar ³; Donato Valdez Pérez ⁴; Ángel Adalberto Duran Ledezma ⁵

¹ *Instituto Politécnico Nacional*

² *Estudiante*

³ *Centro de Estudios Científicos y Tecnológicos N° 16 "Hidalgo"*

⁴ *Instituto Politécnico Nacional, SEPI-ESIME,*

⁵ *Instituto Politécnico Nacional, SEPI-ESIME unidad Ticomán.*

Autores responsables de la comunicación: pcordovam1800@alumno.ipn.mx, gustavohilariop@gmail.com

Two-dimensional materials exhibit significant potential for integration into diverse applications, including optoelectronics, photonics, and nanophotonics, owing to their exceptional mechanical, electrical, and optical properties. These properties enable the development of next-generation devices capable of enhancing system performance (making them ultrafast) and seamlessly integrating optical components with conventional electronics. For this reason, the scientific community is actively working to characterize and understand ultra-thin films of these 2D materials. In this investigation, we present the results of microscopies and spectrums from an experimental thin films composed of Graphene (G), graphene oxide (GO) and reduced graphene Oxide (rGO) deposited onto glasses substrates via the Langmuir-Blodgett technique (LB). For morphological, structural and topographical evaluation Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM) were employed to know the distribution and quality of the material. On the other hand, Raman spectroscopy enabled comprehensive characterization of the deposition films, monolayer uniformity and vibrational mode signatures to evaluate the structural of the materials and Terahertz time-domain spectroscopy (THz-TDS) was employed to characterize the optical and electrical properties of the nanomaterial including refractive index, dielectric response and frequency-dependent complex conductivity. The results demonstrated that rGO exhibits superior optical performance compared to graphene due to its defect-engineered structure, which enhances light-matter and enables broader tunability of optical properties. These advantages stem from oxygen-functionalized defects that facilitate charge density modulation and localized plasmonic effects, making rGO ideal for tunable photonic devices requiring strong THz response and adaptability.

Keywords:

Langmuir-Blodgett, graphene, graphene oxide, reduced graphene oxide, photodetector

Reference:

J. Wu, H. Lin, D. J. Moss, K. P. Loh, and B. Jia, "Graphene oxide for photonics, electronics and optoelectronics," *Nat. Rev. Chem.*, vol. 7, no. 3, pp. 162–183, 2023.

Ris work was supported by:

IPN SEPI ESIME Zacatenco - Telecomunicaciones



ELECTRODEPOSITED SILVER SELENIDE RIN FILMS WITH HIGH THERMO-ELECTRIC PERFORMANCE

Autor: Carlos Augusto Martin Roman Varlela¹

Coautores: Ma. Estela Calixto Rodriguez ¹; Carolina Janani Diliégros Godines ¹; Miguel Ángel Contreras Ruiz ²; Bernabe Mari Soucase ³; Ullah Shafi ³

¹ Instituto de Física "Ing. Luis Rivera Terrazas" Benemérita Universidad Autónoma de Puebla

² Instituto de Ciencias Físicas - Universidad Nacional Autónoma de México

³ Departament de Física Aplicada-IDF. Universitat Politècnica de València

Autor responsable de la comunicación: ecalixto@ifuap.buap.mx

Beta-phase silver selenide (β -Ag₂Se) is a narrow band gap semiconductor ($E_g \sim 0.1$ to 0.26 eV) that possesses properties of great interest for use in flexible thermoelectric devices operating in the room temperature range because it maintains its thermoelectric properties even when bent. It has a high electrical conductivity and a low thermal conductivity, which is reflected in its power factor (PF), which has currently been reached up to $25.9 \mu\text{W}/\text{cmK}^2$. It is known that until now it is quite difficult to synthesize silver selenide directly in the beta phase, and sometimes it is necessary to carry out specific processing of the substrates in order to obtain good crystallinity. Furthermore, the common methods used for the synthesis of β -Ag₂Se often require high purity precursor materials along with heat treatments or high pressures, in addition to a long synthesis time. On the contrary, the electrodeposition route offers a fast, low-cost, reliable, eco-friendly, and reproducible synthesis methodology to obtain β -Ag₂Se thin films, avoiding the use of high vacuum, which is especially important for scaling up to industrial processing levels. In this study, a facile and rapid strategy is reported to obtain β -Ag₂Se thin films with controlled thickness using an electrodeposition technique. As-electrodeposited β -Ag₂Se film with a thickness of 740 nm delivered a $\text{PF} = 5.59 \mu\text{W}/\text{cmK}^2$, while an 880 nm β -Ag₂Se film annealed at 210°C exhibits a higher $\text{PF} = 11.69 \mu\text{W}/\text{cmK}^2$. The results demonstrate a rapid preparation of high purity β -Ag₂Se thin film with superior thermoelectric performance, provides potential opportunities in the development of efficient thermoelectric devices.

Keywords:

Ag₂Se, Semiconductor, thin films, electrodeposition, thermoelectric

Reference:

Román-Varela, C.A.M.; Calixto, M.E.; Diliégros-Godines, C.J.; Bustamante, A.; Contreras-Ruiz, M.A.; Soucase, B.; Shafi, U. A Rapid Methodology to Obtain Silver Selenide thin Films with Highly Enhanced Thermoelectric Performance. *Small* 2025, 21, 2408477

Ris work was supported by:

VIEP-BUAP 2023-2024 and CONAHCYT grant A1-S-22706 Ciencia Básica-CONAHCYT-México



SiO₂ AND Al₂O₃ THIN FILMS CHARACTERIZATION DEPOSITED BY SPUTTERING FOR ITS APPLICATION IN PASSIVATION OF REFLECTIVE METAL SURFACES

Autor: Alejandro Esparza García^{None}

Coautores: José Guadalupe Bañuelos Muñetón; Martín Briseño García; Selene Rubí Islas Sánchez

Autor responsable de la comunicación: alejandro.esparza@icat.unam.mx

Exposure of metal surfaces to factors such as humidity, ultraviolet radiation, atmospheric pollutants of various gases, salt particles and acid rain cause deterioration through corrosion. To extend its useful life, these surfaces are protected by various treatments, one of which consists of covering them with suitable materials. Thin films of SiO₂ and Al₂O₃ are known for their passivation properties on metallic surfaces, which can be used depending on their electrical resistance, in the manufacture of semiconductor devices, in the manufacture of solar cells and optical systems, depending on their electrical resistance, their resistance to corrosion and its transmittance. The objective of this work is to find the deposit conditions by the sputtering technique to deposit SiO₂ and Al₂O₃ thin films that can be used as passivation coatings on reflective metal surfaces, so its high transmittance is of utmost importance. The experimental procedure consisted of using sputtering targets of SiO₂ and Al₂O₃ in an atmosphere of argon, obtaining highly resistive films with low transmittance. Although for some applications these characteristics may be acceptable, in this work the highest possible transmittance is required, so it was decided to introduce oxygen during the deposition process. Although the entry of oxygen allowed a significant increase in transmittance of the films, the thickness was limited even when the minimum possible amount of oxygen was introduced, and the deposition time was very long. It was then decided to increase the power of the radio frequency signal applied during the deposition process, with which it was possible to obtain thicknesses that allowed its characterization. Structural characterization was carried out by using Raman spectroscopy and optical characterization by using UV-Vis.

Keywords:

SiO₂, Al₂O₃, passivation, reflective, metal surfaces

Reference:

J. Schmidt, A. Merckle, B. Hoex, M. C. M. van de Senden and W. M. M. Kessels, Surface Passivation of High-efficiency Silicon Solar Cells by Atomic-layer-deposited Al₂O₃

Ris work was supported by:

Instituto de Ciencias Aplicadas y Tecnología, Universidad Nacional Autónoma de México, Circuito Exterior S/N, Ciudad Universitaria, 04510, Mexico City



SYNTHESIS AND CHARACTERIZATION OF NOVELTY BISMUTH MULTI-PRINCIPAL ELEMENTS OR HIGH ENTROPY ALLOYS

Autor: Ukari Mejía González¹

Coautores: Carlos Ramos Vilchis ¹; Ignacio Alejandro Figueroa Vargas ¹; Sandra Elizabeth Rodil Posada ¹

¹ *Universidad Nacional Autónoma de México*

Autor responsable de la comunicación: umejia6132@gmail.com

This ongoing project seeks innovative uses of bismuth within the field of multi-principal elements alloys and high-entropy alloys. The successful synthesis of a new, stable AlBiCrCuV alloy through co-sputtering could contribute to the development of new metallic materials and expand the use of bismuth to new frontiers. The experimental phase began with the synthesis of a Bi₆₀Cu₄₀ target by electric arc smelting from the required proportion of pure metals. An immiscible alloy was obtained, free of intermetallics. This new target was placed in a magnetron along with a Al₆₀Cr₂₀V₂₀ target. The co-depositions were made on glass and 100-oriented silicon wafers with a fixed power of 28 W for the BiCu target, while the AlCrV one worked with a variant power of 30, 40, 50, 60 and 80 W. The successfully obtained thin films bore a reflective metallic aspect on the zones towards the rim of the circular substrate holder and a grey opaque zone towards the center. The XPS analysis of the thin films showed a high percentage of oxygen on the surface and after Raman spectroscopy, we found out the possible presence of bismuth trioxide. The thin films observed on scanning electron microscopy have a variant aspect when the scan is done on the reflective and opaque zone, and on each power used during the deposit, highlighting the samples of 50 W that seem to have the most uniform aspect. These 50 W thin films had no signals of possible oxides on Raman spectroscopy, a reduced percentage of oxygen on XPS and a could pass the limit of 1.5 R that defines, among other parameters, the high entropy alloys. Finally, we're currently making electrical resistance tests and near future nanoindentation that could give us more information about the behavior and characteristics of this novelty material.

Keywords:

film, alloy, bismuth, entropy, sputtering

Reference:

Chen, Y., Xie, B., Liu, B., Cao, Y., Li, J., Fang, Q., & Liaw, P. K., A Focused Review on Engineering Application of Multi-Principal Element Alloy (2022). <https://doi.org/10.3389/fmats.2021.816309>

His work was supported by:

DGAPA-UNAM



NON-ENZYMATIC GLUCOSE DETECTION USING GOLD ELECTRODES MODIFIED WITH GRAPHENE OXIDE

Autor: Jacob Adrián Collazo Vazquez¹

Coautores: José Luis Flores Arciniega²; Iker Chávez²; Gilberto Martínez³; Mildred Quintana²; Osvaldo Del Pozo¹; Edgar Cerda¹

¹ *IICO-UASLP*

² *CICSaB-UASLP*

³ *CIDESI*

Autor responsable de la comunicación: a252809@alumnos.uaslp.mx

Accurate and reliable glucose monitoring is essential for the effective management of diabetes. Nonenzymatic sensors based on nanomaterials have emerged as promising alternatives to traditional enzymatic methods due to their improved stability and sensitivity. This study evaluates the performance of gold electrodes modified with graphene oxide (GO), reduced graphene oxide (rGO), and partially reduced graphene oxide (prGO) for non-enzymatic glucose detection. The objective was to compare the glucose sensing efficiency of these nanomaterial-modified electrodes and identify the most effective configuration. The modified electrodes were characterized using Raman spectroscopy, optical microscopy, UV-Vis absorbance spectroscopy, cyclic voltammetry, and amperometry to assess their structural, optical, and electrochemical properties. Results showed that GO-modified electrodes exhibited the highest sensitivity to glucose, outperforming both rGO and prGO variants as well as unmodified gold electrodes. The enhanced performance of GO is attributed to its high surface area and abundance of oxygen-containing functional groups, which facilitate glucose oxidation. These findings suggest that the degree of reduction of graphene oxide significantly influences sensor performance, with non-reduced GO offering superior detection capabilities. This insight provides a valuable basis for the future design of non-enzymatic glucose sensors, with potential applications in continuous glucose monitoring systems for diabetic patients. The use of GO as a sensing material represents a promising approach for developing stable, sensitive, and enzyme-free glucose sensors, which could improve disease management and patient quality of life. Further research is encouraged to explore the long-term stability and real-world applicability of these sensors in clinical settings.

Keywords:

Non-enzymatic glucose sensor, Graphene oxide (GO)

Reference:

Phetsang, S., Kidkhunthod, P., Chanlek, N. et al. Copper/reduced graphene oxide film modified electrode for non-enzymatic glucose sensing application. *Sci Rep* 11, 9302 (2021).

Ris work was supported by:

SECIHTI PhD grant.



FeRh THIN FILMS OBTAINED BY PULSED LASER ABLATION

Autor: Maria de Lourdes Arreguin Hernandez¹

Coautores: Cesar Fidel Sanchez Valdes ²; Jose Luis Sanchez Llamazares ³; Luis Alejandro Arce Saldaña ¹; Noemi Abundiz Cisneros ⁴; Oscar Raymond Herrera ¹; Roberto Machorro Mejía ⁵; Roberto Sangines ⁶; Subhash Sharma¹

¹ CNYN

² Universidad Autónoma de Ciudad Juárez

³ IPICYT

⁴ CONAHCyT, Centro de Nanociencias y Nanotecnología, UNAM

⁵ Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México

⁶ SECIHTI, Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México

Autor responsable de la comunicación: maria.arreguin@ens.cnyn.unam.mx

The FeRh alloy has garnered significant attention since 1938 due to giant magnetocaloric effect (GMCE), which arises from a first-order phase transition (FOPT) near room temperature (RT). This transition involves a reversible switch between antiferromagnetic (AFM) and ferromagnetic (FM) phases without altering the crystallographic symmetry of the chemically ordered CsCl-type (B2 or α' phase) structure. However, it is accompanied by a $\sim 1\%$ lattice volume expansion, modifying the interatomic distances between Fe atoms. Near-equiatomic FeRh alloys exhibit enhanced caloric effects, including elastocaloric and barocaloric effects. Owing to these properties, FeRh alloys hold great promise for applications in magnetic cooling, magnetic recording devices, and magnetic sensors. Recent studies have shown growing interest in FeRh thin films owing to their magneto-optical properties and potential applications in heat-assisted magnetic recording, spin-valve devices, and microelectromechanical systems (MEMS). For such films, precise control of thickness and chemical composition is essential, as interfacial stress between the film and substrate significantly alters magnetic behavior and shifts transition temperatures.

In this study, we report the deposition of FeRh thin films via pulsed laser deposition (PLD) using a PL PLUS system (Continuum Electro-Optics, 266 nm wavelength) on Si substrates. By systematically optimizing deposition time, temperature, and post-growth annealing, we aim to achieve thin films exhibiting robust magnetic, electric, and magnetocaloric properties near room temperature, paving the way for their integration into magneto-electric multilayer heterostructures.

Keywords:

Magnetocaloric Materials Thin films, Pulsed Laser Deposition, FeRh

Reference:

- A.I. Zakharov, Soviet Physic JETP Vol. 19 (1964)
- M.P. Belov, Phys. Rev. B 101 (2020)
- S. Dodd, Sci. Rep. 15 (2025)
- A. Aubert, ACS Appl. Mater. Interface 16 (2024)

Ris work was supported by:

This work was partially supported by PAPIITDGAPA- UNAM Grant IT100525 and DGAPA-UNAM post-doctoral scholarship. The authors thank the technical support of Eloisa Aparicio, Israel Gradilla and Pedro Casillas, and LINAN-IPICyT.



SCIENCE OUTREACH

CHAIRMEN

Dra. Dalia Alejandra Mazón Montijo (SECIHTI, TECNOL-CIIT), dalia.mm@nuevoleon.tecnm.mx

Dr. Wilfrido Calleja Arriaga (INAOE), wcalleja@inaoep.mx

SMCTSM:

20 años de Divulgación de la Ciencia

Una labor completa en investigación científica se cumple cuando se complementa con actividades de **divulgación de la ciencia**. La divulgación de la ciencia tiene como finalidad proporcionar un panorama general a toda la sociedad sobre los diferentes desarrollos científicos y tecnológicos que se realizan en el país. Para los investigadores, es una herramienta útil para promover sus investigaciones y alentar, principalmente a los jóvenes, a interesarse por el quehacer científico; para la sociedad, es una forma de enterarse/conocer sobre los avances científicos que se realizan en su país y como estos pueden contribuir a un beneficio común.

En el año 2005, siendo sedes la ciudad de Zacatecas y la Universidad Autónoma de Zacatecas (UAZ), la SMCTSM celebró su XXV Congreso Nacional y XXV aniversario de creación y **dentro del programa oficial, por primera vez se incluyó el “Simposio de Divulgación de la Ciencia”**, evento que se desarrolló con la colaboración del grupo Quark de Zacatecas. Desde entonces, la SMCTSM se propuso fomentar estas actividades dándole continuidad al **Simposio de Divulgación de la Ciencia y Tecnología** que cada año tiene lugar dentro del marco del Congreso Internacional y que tiene presencia en diferentes instituciones de educación locales como sedes oficiales y que se ha convertido en un vínculo directo entre la sociedad civil y los núcleos científicos de la SMCTSM.

SIMPOSIO

DE DIVULGACIÓN DE LA CIENCIA Y TECNOLOGÍA

Puebla 2025

El cual incluye temáticas variadas de ciencia básica, ingeniería y tecnología de materiales. Las ponencias son, principalmente, dirigidas a estudiantes de nivel medio superior y superior con el fin de incentivar la curiosidad de los jóvenes en este ámbito y que, en el futuro próximo, vean a la ciencia/tecnología como una opción de desarrollo profesional que los lleve a formar la nueva generación de científicos mexicanos en el desarrollo y aplicaciones de los materiales.



DE LA NATURALEZA A LA TECNOLOGÍA: INSPIRACIÓN NANOMÉTRICA PARA MATERIALES DEL FUTURO

Autor: Liliana Licea-Jiménez¹

¹ Centro de Investigación en Materiales Avanzados S.C. (CIMAV), Subsede Monterrey, Parque PIIT, Alianza Norte 202, Apodaca, N.L. CP 66628, México

Autor responsable de la comunicación: liliana.licea@cimav.edu.mx

En la naturaleza existen estructuras a escala nanométrica que han evolucionado para conferir propiedades extraordinarias a diversos organismos. Estas nanoestructuras permiten funciones como adhesión, resistencia, flexibilidad, coloración estructural y control de la humedad o la luz. Su estudio no solo revela la sofisticación de los sistemas biológicos, sino que ofrece rutas claras para el diseño de materiales con funcionalidades avanzadas. Diversas superficies vivas poseen patrones jerárquicos que permiten una adhesión reversible sin adhesivos químicos. Otras muestran colores intensos y metálicos generados por la interacción de la luz con estructuras periódicas, y no por pigmentos. Asimismo, existen fibras naturales cuya arquitectura interna combina fases cristalinas y amorfas que brindan una resistencia mecánica y elasticidad difícil de alcanzar con materiales sintéticos actuales. Estas estructuras naturales han inspirado avances significativos en ingeniería de materiales. Hoy se desarrollan adhesivos secos que imitan superficies biológicas; recubrimientos ópticos que reproducen la coloración estructural de algunos organismos; y fibras de alto rendimiento que emulan la arquitectura interna de filamentos naturales. La clave está en entender cómo la organización a nanoescala determina propiedades macroscópicas, y en trasladar ese conocimiento a contextos tecnológicos. El estudio sistemático de estos sistemas naturales impulsa una convergencia entre biología, física de materiales e ingeniería. Esta presentación abordará ejemplos clave de nanoestructuras presentes en sistemas vivos, analizará sus mecanismos funcionales, y mostrará cómo estos principios se aplican en el diseño de nuevos materiales. Además, se destacará la importancia de una visión interdisciplinaria para aprovechar plenamente el potencial de la nanociencia inspirada en la naturaleza.

Keywords:

Nanomateriales naturales, Nanociencia bioinspirada, Funcionalidad estructural, Materiales Avanzados.

Ris work was supported by:

The Army Research Laboratory and the Army Research Office under contract/grant number W911NF2310301



LA SUSTANCIA MÁS EXTRAORDINARIA

Autor: Mario Fidel García Sánchez¹

¹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas*

Autor responsable de la comunicación: mgarciasan@ipn.mx

Cuando escuchamos la palabra extraordinaria, se espera se espera algo poco común. Muchos seguramente se sorprenderán de saber que esta plática se refiere al agua. Esto indica que sabemos poco de este líquido con increíbles propiedades, sin las cuales no existiríamos ni los seres humanos ni el planeta tal cual lo conocemos. En esta plática se comentarán preguntas poco comunes como cuantos tipos de agua hay y como una sustancia tan sencilla y común puede ser tan increíble. Se comentarán algunas propiedades termodinámicas del agua que explican, por ejemplo, por qué los hielos flotan y el impacto que esto tiene en el planeta. Presentaremos las diferencias entre el agua de mar, de los ríos y de lluvia, y qué características tiene el agua potable. Y por supuesto, comentaremos la importancia del cuidado del agua y de contar con un agua de calidad para tener una buena calidad de vida.

Keywords:

propiedades del agua, tratamientos del agua, calidad del agua

Reference:

1. "Degradación electroquímica: una alternativa para el tratamiento de contaminantes emergentes en aguas" R. E. Palma Goyes, I. C. Romero Ibarra, M. F. García Sánchez, J. G. Vázquez Arenas. *Materiales Avanzados* 30 (2019) 72-75.

Ris work was supported by:

Se agradece el apoyo del Instituto Politécnico Nacional a través del proyecto SIP 20250260.



ILUMINA TU MUNDO: EL FASCINANTE MUNDO DE LOS SEMICONDUCTORES Y LOS DISPOSITIVOS EMISORES DE LUZ

Autor: Francisco Aguirre Tostado¹

¹ *Cimav, Unidad Monterrey*

Autor responsable de la comunicación: servando.aguirre@cimav.edu.mx

¿Te has preguntado cómo una pequeña luz LED puede iluminar una habitación, una pantalla o incluso una ciudad entera? Detrás de esa luz hay una historia fascinante de ciencia, tecnología y materiales inteligentes.

En esta plática descubriremos cómo funcionan los diodos emisores de luz (LEDs), qué papel juegan los semiconductores en su magia luminosa, y por qué han revolucionado la forma en que usamos la electricidad y la luz. Exploraremos conceptos clave de física y química de manera sencilla, con ejemplos cotidianos y demostraciones visuales.

Si te interesa la ciencia, la electrónica o simplemente quieres entender mejor cómo funciona el mundo a tu alrededor, esta charla es para ti. ¡Ven a encender tu curiosidad!

Keywords:

Semiconductores, Luz, LEDs

Ris work was supported by:

Apoyo a través del proyecto SECIHTI CBF2023-2024-3089.



PEQUEÑOS MATERIALES, GRANDES SOLUCIONES PARA EL MEDIO AMBIENTE

Autor: Anel Robles¹

Coautores: DANIEL FLORES RAMÍREZ²; Issis Claudette Romero Ibarra³; Jose Ortiz Landeros⁴; Lissette Medina de la Rosa⁵

¹ *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas-IPN*

² *UPIITA-IPN*

³ *IPN*

⁴ *ESIQIE*

⁵ *Escuela Superior de Ingeniería Química e Industrias Extractivas (ESIQIE)*

Autor responsable de la comunicación: anivo.roblesster@gmail.com

La ciencia de los materiales desempeña un papel fundamental en el desarrollo de tecnologías sostenibles, especialmente en el contexto de los retos ambientales actuales. En este trabajo se aborda el uso de nanomateriales aplicados a la remediación ambiental, con énfasis en el tratamiento de aguas contaminadas. Se exploran diversas estrategias basadas en nanomateriales como óxidos metálicos y nanocompuestos con capacidad para remover contaminantes emergentes, entre ellos fármacos, colorantes y microplásticos. Estos materiales ofrecen propiedades únicas como alta superficie específica, reactividad química y funcionalización selectiva, que los convierten en herramientas prometedoras para la eliminación eficiente de sustancias nocivas del agua. Asimismo, se reflexiona sobre los beneficios y desafíos de implementar este tipo de tecnologías en contextos reales, considerando su impacto ambiental y social. Esta propuesta destaca la importancia de generar soluciones tecnológicas innovadoras desde la ciencia de los materiales para avanzar hacia una gestión más sostenible de los recursos hídricos.

Keywords:

Nanomateriales, Remediación ambiental, Ciencia de los materiales, Contaminación, Sostenibilidad,

Reference:

Xu, Y., Zhang, et al., (2018). Env. Sci. Tec., 52(21), 12300-12313. <https://doi.org/10.1021/acs.est.7b05559>

Ris work was supported by:

UPIITA-IPN,



¡LUZ QUE TRANSFORMA! ¿CÓMO LOS LÁSERES NOS AYUDAN A CREAR Y MODIFICAR MATERIALES?

Autor: Laura Patricia Rivera Reséndiz¹

¹ *Universidad de Guadalajara*

Autor responsable de la comunicación: laura.rivera@academicos.udg.mx

¿Sabías que un rayo láser no solo sirve para cortar metales o leer códigos de barras, sino también para crear y transformar materiales a nivel microscópico? En esta charla descubriremos cómo los científicos usamos la luz de un láser para modificar la materia de formas sorprendentes.

Hablaremos de tres aplicaciones principales: primero, veremos cómo un láser puede extraer material de un sólido y depositarlo en forma de capas delgadísimas sobre otra superficie, lo que permite fabricar lo que llamamos películas delgadas. Luego, exploraremos cómo al disparar un láser dentro de un líquido que contiene un sólido, se generan nanopartículas, es decir, partículas tan pequeñas que solo pueden observarse con microscopios especiales. Finalmente, conoceremos cómo los láseres también pueden modificar la superficie de un material, cambiando su textura o sus propiedades sin necesidad de contacto físico.

A través de ejemplos sencillos, imágenes y videos, veremos cómo el uso del láser en la síntesis y modificación de materiales está abriendo nuevas posibilidades en áreas como la electrónica, la medicina y la energía. Una muestra de cómo la ciencia convierte la luz en herramienta de transformación.

Keywords:

Láser, PLD, Nanomateriales, ALSL, Modificación superficial

Reference:

Sin referencia

Ris work was supported by:

Universidad de Guadalajara



HISTORIA DE LA COLORIMETRÍA

Autor: Juana Medina Márquez¹

¹ *Instituto Nacional de Astrofísica, Óptica y Electrónica*

Autor responsable de la comunicación: jmedina@inaoep.mx

En esta charla se hace un recorrido cronológico desde Aristóteles, hasta Munsell pasando por todos los investigadores que en su época contribuyeron con sus teorías, postulados e ideas tratando de explicar qué era eso del color y cómo es que los humanos lo percibíamos. Se menciona también cómo es que Munsell clasificó al color y cómo esta clasificación ha permanecido hasta nuestros días aplicado en la evaluación de color sobre todo de a través de un instrumento. Se explica, por ende, el surgimiento del diagrama cromático XYZ, y cómo se ha utilizado sobre todo para usos y aplicaciones en color digital, también se menciona como a partir de este diagrama, surgen otros que se usan actualmente en la medición del color en varios ramos de la industria.

Keywords: colorimetría, color



SUPERCAPACITORES SIN MASA: ENERGÍA ESTRUCTURAL PARA EL FUTURO DIARIO

Autor: Sergio Alfonso Pérez García¹

¹ *Centro de Investigación en Materiales Avanzados S. C.*

Autor responsable de la comunicación: alfonso.perez@cimav.edu.mx

Uno de los principales desafíos tecnológicos actuales no radica solamente en cómo obtener energía, sino en cómo almacenarla de forma eficiente, ligera y sostenible. Los supercapacitores sin masa (por su nombre en inglés) ofrecen una solución innovadora al integrar el almacenamiento de energía directamente en materiales estructurales. Esto permite que partes de objetos cotidianos (como una carcasa/funda, un chasis o un textil) cumplan simultáneamente funciones mecánicas y energéticas, sin aumentar peso ni volumen.

Estos sistemas están compuestos por materiales avanzados como fibras de carbono, polímeros conductores y compuestos porosos diseñados a escala nanométrica. Su arquitectura interna les permite acumular y liberar energía en tiempos muy cortos, soportar miles de ciclos sin degradación significativa y mantener propiedades mecánicas como flexibilidad y resistencia. Gracias a estas características, ya se emplean en aplicaciones como transporte eléctrico ultraligero, dispositivos móviles con almacenamiento integrado, textiles energéticamente activos y electrónica portátil autosuficiente.

Más allá de la eficiencia energética, estos supercapacitores representan un nuevo paradigma en ciencia de materiales: el diseño de soluciones multifuncionales donde un solo componente realiza diversas tareas. Esta integración reduce peso, volumen y complejidad, facilitando la creación de dispositivos más compactos, autónomos y sostenibles. El enfoque combina ingeniería de materiales, nanotecnología, química de superficies y diseño estructural para lograr dispositivos que son tanto soporte como fuente de energía.

A medida que las necesidades tecnológicas demandan mayor autonomía y reducción de componentes, los supercapacitores sin masa se perfilan como una alternativa clave. Su estudio impulsa avances en materiales inteligentes y promueve una transición energética más eficiente, aplicable tanto en sistemas de transporte como en objetos de uso cotidiano.

Keywords:

Supercapacitores estructurales, Materiales Inteligentes, Desafíos del almacenamiento de energía

Ris work was supported by:

Acknowledgment: This research was supported by the Army Research Laboratory and the Army Research Office under contract/grant number W911NF2310301.



A 100 AÑOS DEL INICIO DE LA MECÁNICA CUÁNTICA: CELDA SOLARES UNA APLICACIÓN COTIDIANA DE LA MECÁNICA CUÁNTICA.

Autor: Miguel Meléndez-Lira¹

¹ *Departamento de Física, Cinvestav*

Autor responsable de la comunicación: miguel.melendez@cinvestav.mx

La mecánica cuántica ha permitido entender principios fundamentales de la ciencia de materiales. En particular en el caso de los semiconductores ha permitido el desarrollo de dispositivos como el transistor, láseres de estado sólido, dispositivos fotovoltaicos, procesadores ultrarrápidos, etc. Los dispositivos basados en semiconductores son aplicados en desarrollos tecnológicos de vanguardia tales como la inteligencia artificial pero también para aportar soluciones en problemas muy relevantes para la humanidad como el calentamiento global.

La producción de celdas solares es sumamente importante y a pesar de que actualmente se tienen tecnologías con aplicaciones comerciales basadas en Si y CdTe es sumamente importante investigar nuevos materiales. La física básica juega un papel relevante en la investigación de nuevos materiales para celdas solares los cuales deben ser amigables con el medio ambiente, de amplia disponibilidad y por tanto de bajo costo.

En la plática se presentará una visión general de los semiconductores y sus aplicaciones en la mitigación de problemas que contribuyen al calentamiento global haciendo énfasis en las celdas solares. Además, se presentará una breve descripción del trabajo que se realiza en mis laboratorios en la búsqueda de nuevos materiales fotovoltaicos.

Keywords

calentamiento global, semiconductores, películas delgadas, ciencia de materiales

Reference:

Gurevich Y. y Melendez-Lira M. (2013). Fenómenos de contacto y sus aplicaciones en celdas solares. Fondo de Cultura Económica.

Ris work was supported by:

parcialmente por CONAHCyT



SCIENCE OUTREACH / 37

LA IMPORTANCIA DE LOS MATERIALES SEMICONDUCTORES Y SU USO EN LA FABRICACIÓN DE CHIPS

Autor: Wilfrido Calleja Arriaga¹

¹ INAOE

Autor responsable de la comunicación: gwcallejajamail@gmail.com

Actualmente la industria Electrónica es bastante amplia y su desarrollo se fortalece con base en las modernas tecnologías de los circuitos integrados o chips. La gran mayoría de los instrumentos electrónicos de uso cotidiano, tal como los teléfonos y otros accesorios personales, se ensamblan combinando algún tipo de chip con programas de computadora, o software. Este tipo de productos se llaman sistemas electrónicos. Actualmente, con la tecnología de los chips, diversos sistemas electrónicos, sobre todo portátiles, ya son de uso cotidiano. Como ejemplos se tienen los equipos de localización (GPS), tabletas, pantallas inteligentes, los relojes de pulso que monitorean signos vitales, por mencionar algunos. Como se puede percibir, ahora nuevos sistemas a base de chips y sensores se usan con gran impacto positivo en el sector salud. En esta charla se abordan conceptos básicos de química y física que tienen relación con los semiconductores y la tecnología de los chips.

Keywords:

Conductores, Aislantes, Semiconductores, Transistores, Chips

Reference:

Revista Ciencia y Desarrollo

Ris work was supported by:

SECIHTI



NANOMUNDO: DE LOS SECRETOS ANTIGUOS A LAS TECNOLOGÍAS DEL FUTURO

Autor: OSVALDO de Melo¹

¹ *Escuela Superior de Física y Matemáticas, escuela Superior de Ingeniería Mecánica y Eléctrica, Instituto Politécnico Nacional*

Autor responsable de la comunicación: odemelo@gmail.com

Se ofrece un recorrido fascinante por la escala nanométrica, donde los objetos miden entre 1 y 100 nanómetros, abarcando desde átomos individuales (~0.1 nm) hasta virus (200-300 nm) y nanotubos de carbono. Sorprendentemente, la nanotecnología tiene raíces históricas: el acero de Damasco contenía nanotubos de carbono que le daban su legendaria dureza, los romanos usaban nanopartículas de oro y plata en la Taza de Lycurgus para crear efectos ópticos, y el pigmento Azul Maya empleaba moléculas de índigo atrapadas en nanoestructuras de arcilla. Para explorar este mundo, se han desarrollado herramientas revolucionarias como el microscopio de efecto túnel (STM), que permite visualizar y manipular átomos individuales, y técnicas como la epitaxia de haces moleculares para fabricar nanoestructuras controladas como pirámides de germanio. Hoy, materiales nanoestructurados como el grafeno, los puntos cuánticos y los nanohilos están impulsando avances en energía (baterías más eficientes, celdas solares), medicina (administración dirigida de fármacos) y tecnología (discos duros con mayor capacidad). Aplicaciones futuras prometen incluso materiales “invisibles” y soluciones para desafíos globales como la purificación del agua. Como reflexión final, el seminario retoma las palabras de Richard Feynman: “Hay mucho espacio en el fondo”, recordando que el nanomundo, pese a su pequeñez, alberga un potencial inmenso para transformar nuestra vida.

Keywords:

nanociencia, nanotecnología



LOS POLÍMEROS MÁS QUE PLÁSTICOS, UN CAMINO HACIA LA ELECTRÓNICA DEL FUTURO

Autor: Beatriz Reyes Veloz¹

Coautor: Liliana Licea Jiménez ¹

¹ *Centro de Investigación en Materiales Avanzados*

Autor responsable de la comunicación: beatriz.reyes@cimav.edu.mx

En la actualidad la creación de nuevas tecnologías presenta una tendencia enfocada en la integración de la electrónica en aparatos cotidianos para ello se requiere que los dispositivos electrónicos sean cada vez más ligeros, flexibles y eficientes. Por esta razón toma relevancia la elección de materiales adecuados que puedan proporcionar dichas características requeridas para el desarrollo de la electrónica del futuro.

Normalmente la palabra plásticos se asocia a materiales que cuentan con la capacidad de ser moldeables y que además son flexibles, ligeros y baratos es por esto que comúnmente son usados en la fabricación de envases, juguetes, productos desechables, etc. Sin embargo, los plásticos son solo una categoría dentro de un grupo amplio de materiales conocidos como polímeros. Los polímeros son macromoléculas formadas por la unión de una o más unidades estructurales llamadas monómeros, la capacidad de modificar su estructura y composición química a partir de dichos monómeros permite que puedan diseñarse polímeros con propiedades muy diversas llegando incluso a que dichos materiales puedan conducir electricidad o que puedan combinarse con nanomateriales dando lugar a sistemas con alto rendimiento eléctrico y mecánico características esenciales que los hace atractivos para su aplicación en dispositivos electrónicos.

Es por ello que la investigación actual gira en torno del uso de polímeros conductores en aplicaciones novedosa como son pantallas flexibles, dispositivos plegables, ropa inteligente y dispositivos de seguimiento de actividad física o de monitoreo de signos vitales buscando que a la vez que sean flexibles, ligeros y accesibles para su uso futuro en la electrónica portátil.

Keywords:

polímeros conductores, nanocompuestos, electrónica flexible

Reference:

Shahid, M. A. et al. (2025) 'Advances in Conductive Polymer-Based Flexible Electronics for Multifunctional Applications', *Journal of Composites Science*, 9(1), pp. 1–34. doi: 10.3390/jcs9010042.

Ris work was supported by:

SECIHTI



FOTOGRAFÍA MULTIESPECTRAL SOBRE CAMPOS AGRÍCOLAS DE NOPAL EN LA CIUDAD DE MÉXICO

Autor: Juan Hernández-Rosas¹

Coautores: David Flores Vasconcelos²; Francisco Hernández-Rosas³; Noé Sierra-Romero¹; Rodolfo Vera Amaro¹

¹ *Instituto Politécnico Nacional UPIITA*

² *Instituto Politécnico Nacional*

³ *Colegio de Postgraduados, Campus Córdoba*

Autor responsable de la comunicación: juhernandezro@ipn.mx

Dentro de la alcaldía Milpa Alta se produce casi el 22% del cultivo total nacional del nopal verdura en la zona periurbana de la Ciudad de México. Además del nopal, existen otros cultivos entre los que destacan porque se encuentran entre los 10 primeros a nivel nacional, el amaranto, pera, rosas y frambuesa. Sin embargo, el nopal es el cultivo más extendido, y por lo mismo existen problemáticas debido a enfermedades ocasionadas por la propagación de insectos plaga, hongos, u otros más. A pesar de que México es potencia exportadora en diversas variedades vegetales, el manejo agronómico utilizando las herramientas propias de la agricultura de precisión es un área de oportunidad en las prácticas agrícolas de nuestro país, incluyendo a la misma Ciudad de México. Una vertiente importante de la agricultura de precisión es aprovechar el desarrollo de herramientas de la industria 4.0 para diagnosticar el progreso temprano de una enfermedad en un cultivo o por deficiencias nutrimentales, que por inspección visual es ineficiente para identificar de manera oportuna. Diagnosticar de manera preventiva la aparición de fenómenos fitosanitarios antes de que se propaguen de manera irreversible sobre los cultivos de nopal en la Alcaldía Milpa Alta utilizando fotografía multiespectral tomadas vía aérea, mediante un vehículo aéreo no tripulado (VANT) es parte de nuestra propuesta para hacer de la agricultura una actividad sustentable.

Keywords:

imagen multiespectral, entomopatógeno, zeolitas, plagas insectiles, fenómenos sanitarios

Reference:

A. Terentev et al, Sensors 22, 757 (2022)

Ris work was supported by:

Proyecto SIP 20250665 del Instituto Politécnico Nacional



PUNTOS CUÁNTICOS, NANOTECNOLOGÍA Y NANOBOTS: UN VIAJE HACIA LO INFINITAMENTE PEQUEÑO.

Autor: Leticia Ithsmel Espinosa Vega¹

Coautores: Irving E. Cortes-Mestizo ²; Victor Hugo Mendez Garcia ³

¹ *Coordinación para la Innovación y Aplicación de la Ciencia y la Tecnología (CIACYT), Universidad Autónoma de San Luis Potosí*

² *SECIHTI-UASLP*

³ *Universidad Autónoma de San Luis Potosí*

Autor responsable de la comunicación: leticia.espinosa@uaslp.mx

En las últimas décadas, la humanidad ha iniciado una travesía fascinante hacia el dominio del mundo a escala nanométrica. Esta aventura ha sido posible gracias a la convergencia de conocimientos en física, química, biología e ingeniería, dando lugar a una disciplina revolucionaria: la nanotecnología. Dentro de este universo minúsculo, destacan dos protagonistas que están transformando nuestra manera de entender y manipular la materia: los puntos cuánticos y los nanobots. Los puntos cuánticos son diminutas estructuras semiconductoras, tan pequeñas que el comportamiento de sus electrones se rige por las leyes de la mecánica cuántica. Esto les otorga propiedades ópticas y electrónicas únicas. Estas características los han convertido en herramientas poderosas en campos tan diversos como la bioimagenología, la optoelectrónica y la detección de enfermedades a nivel celular. Por otro lado, los nanobots (robots a escala nanométrica) representan un sueño tecnológico que paulatinamente se vuelve realidad. Imaginemos máquinas capaces de navegar por nuestro torrente sanguíneo, identificando células cancerígenas y eliminándolas con precisión quirúrgica, sin dañar tejidos sanos. Para lograr esto, se requiere no solo de materiales avanzados, sino de una comprensión profunda de las interacciones a nivel atómico y molecular, terreno donde la nanotecnología es esencial. En esta plática abordaremos la simbiosis entre mecánica cuántica, puntos cuánticos, nanotecnología y nanorobótica. Lo más emocionante es que todo esto ya no pertenece a la ciencia ficción. El autoensamblaje molecular a nivel cuántico es una realidad, y los prototipos de nanobots empiezan a ser probados en aplicaciones médicas reales. La exploración del nanomundo apenas comienza, y los jóvenes estudiantes de hoy tienen la oportunidad de ser los pioneros de esta nueva era. Entender cómo interactúan la luz, la materia y la información a escalas diminutas no solo es un reto intelectual, sino una puerta hacia tecnologías que cambiarán nuestra salud, nuestras comunicaciones y nuestro entorno.

Keywords:

Puntos cuánticos, nanotecnología, nanorobótica, semiconductores

Ris work was supported by:

The Laboratorio Nacional de Análisis Físicos, Químicos y Biológicos/UASLP, and financial support from COPOCyT Fideicomiso 23871, SECIHTI CF-2023-I-1300, and Investigadoras e Investigadores por México.



MATERIALES AVANZADOS COMO CATALIZADORES HETEROGÉNEOS EN APLICACIONES ENERGÉTICO-AMBIENTALES DESDE LA ECONOMÍA CIRCULAR.

Autor: Issis Claudette Romero Ibarra¹

¹ IPN

Autor responsable de la comunicación: iromero@ipn.mx

Una de las grandes problemáticas que enfrentamos en la actualidad es el aumento de las emisiones de gases de efecto invernadero (GEI) en la atmósfera. Este aumento en la contaminación proviene principalmente del desbalance generado por motores de combustión interna y diversos procesos industriales (quema de combustibles fósiles como: carbón, petróleo y gas; el autotransporte, las plantas industriales, deforestación y actividades agrícolas, etc.), lo cual afecta el medio ambiente y la salud humana. Para mitigar estos problemas es necesario el desarrollo y uso de nuevos materiales aplicables a tecnologías enfocadas en energías limpias y sostenibles. Esta plática versará sobre el diseño, síntesis y evaluación de nuevos materiales que por medio de un proceso de quimisorción puedan capturar CO₂ y que funcionen como catalizadores heterogéneos en la generación de energéticos limpios (biodiesel, bioetanol y gas de síntesis, CO + H₂). Asimismo, este tipo de catalizadores se aplican en la degradación de contaminantes emergentes para el tratamiento de agua. Los resultados de la evaluación de los materiales en diversas aplicaciones energéticas y ambientales desde una perspectiva de economía circular suman esfuerzos para el cumplimiento de los Objetivos de Desarrollo Sostenible de la ONU, el Plan Nacional de Desarrollo, Programa de Acción Climática 2021-2030 y la Estrategia Local de Acción Climática 2021-2050, entre otros.

Agradecemos a los proyectos SIP MULTI-IPN 2275, SIP 20250118 y al proyecto “Sustentabilidad hídrica en la Ciudad de México” CVN/CESA-002/2024.

Keywords:

Materiales avanzados, catalizadores heterogéneos, biocombustibles, tratamiento de agua, sustentabilidad,

Reference:

Mijangos, G. E., Cuautli, C., Romero-Ibarra, I. C., Vazquez-Arenas, J., Santolalla-Vargas, C. E., Santes, V., Pfeiffer, H. Renewable Energy, 184, 845-856. (2022).

Ris work was supported by:

Projets SIP-IPN 2275 and SIP module 20250118. Also, “Sustentabilidad hídrica en la Ciudad de México” CVN/CESA-002/2024 Project



EL PODER DE LOS SEMICONDUCTORES Y EL GRAFENO PARA TRANSFORMAR NUESTRO MUNDO

Autor: Yenny Lucero Casallas-Moreno¹

¹ *Secihti-UPHITA-IPN*

Autor responsable de la comunicación: ycasallasm@ipn.mx

En el corazón de muchas tecnologías que usamos a diario, desde los LEDs hasta las celdas solares, se encuentran materiales invisibles a simple vista pero fascinantes, como los semiconductores. Algunos de los más destacados pertenecen a la familia del grupo III-V de la tabla periódica, conocidos por su capacidad para generar, guiar y detectar luz con gran eficiencia. Gracias a estas propiedades, han sido pieza clave para transformar áreas tan vitales como las comunicaciones, la medicina, la energía y el medio ambiente. Sin embargo, la historia no termina con los semiconductores. Hoy la ciencia avanza hacia nuevas fronteras al combinarlos con materiales ultradelgados como el grafeno. Este material, el más delgado conocido hasta el momento, flexible y casi transparente, puede actuar como un puente ideal entre diferentes materiales semiconductores. Esta unión abre la puerta al desarrollo de dispositivos más ligeros, flexibles, rápidos y eficientes, fundamentales para la tecnología del futuro. En esta charla exploraremos cómo ha evolucionado el camino de los semiconductores hasta llegar a las tecnologías avanzadas que hoy conocemos. Descubriremos el impacto que han tenido los semiconductores del grupo III-V en nuestra vida cotidiana, el papel que juega el grafeno para potenciar su eficiencia, y algunas aplicaciones que prometen cambiar nuestro mundo de formas que aún nos cuesta imaginar.

Keywords:

semiconductores, grafeno, dispositivos

Reference:

A.L. Martínez-López, J.J. Cruz-Bueno, R. Trejo-Hernández, et. Al., Impact of graphene as 2D interlayer on the growth of GaAs by CSVT on Si (100) and GaAs (100) substrates, *Materials Science in Semicon- ductor Processing*, 181, 2024, <https://doi.org/10.1016/j.mssp.2024.108605>.

Ris work was supported by:

Y.L. Casallas-Moreno thank the IPN and SECIHTI for their financial support in this work. We particularly thank SIP 20253723, SIP 20254808, PRORED 20254785, and the Frontier Science projects SECIHTI CF-2023-I-1117 and SECIHTI CBF-2025-I-3719.



DISPOSITIVOS MÉDICOS **con**CIENCIA: INNOVACIÓN BASADA EN MICROSENSORES

Autor: Daniela Díaz Alonso¹

¹ *Instituto Nacional de Astrofísica Óptica y Electrónica*

Autor responsable de la comunicación: dandiaz488@gmail.com

En un mundo donde la tecnología avanza rápidamente, los dispositivos médicos siguen siendo piezas fundamentales en la mejora de la atención en salud. A medida que surgen nuevas necesidades en este sector, también se desarrollan soluciones innovadoras que requieren el trabajo conjunto de distintas disciplinas, como la medicina, la electrónica, la física y los nuevos materiales. Gracias a los avances científicos, hoy es posible fabricar sensores diminutos (tan pequeños como el grosor de un cabello) que se convierten en herramientas clave para detectar enfermedades, dar seguimiento a tratamientos y cuidar la salud de forma continua y menos invasiva. Sin embargo, para que estos dispositivos lleguen de forma segura a las personas, es necesario cumplir con reglas y evaluaciones que aseguren su adecuado funcionamiento y su confiabilidad. Conocer cómo se desarrolla un dispositivo médico, desde su diseño hasta las pruebas necesarias antes de usarse con pacientes, permite entender por qué la regulación sanitaria es tan importante. Solo así se garantiza que estas tecnologías realmente ayuden sin poner en riesgo la salud. El trabajo en equipo entre científicos, médicos, ingenieros, académicos y autoridades gubernamentales es fundamental para lograr un desarrollo seguro y responsable. Esta colaboración entre diferentes sectores, permite que la ciencia y la tecnología lleguen a quienes más lo necesitan, mejorando la calidad de vida y fortaleciendo los sistemas de salud.

Keywords:

Dispositivos Médicos, Microsensores



Ciencia y Tecnología

Secretaría de Ciencia, Humanidades, Tecnología e Innovación



EDINBURGH
INSTRUMENTS



Malvern
Panalytical



AcMax
solución estratégica

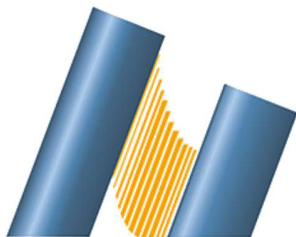
IOP
Institute of Physics

Fleming
FARMACIAS UNIVERSITARIAS®
LAS MÁS COMPLETAS

nanociencias
de México

EDWARDS

INTERCOVAMEX



CENTRO DE NANOCIENCIAS
Y NANOTECNOLOGÍA



upiita-ipn



Cinvestav

XVII International Conference on **Surfaces, Materials and Vacuum 2025**

Sociedad Mexicana de Ciencia y Tecnología de Superficies y Materiales A.C.

 **Ciencia y Tecnología**
Secretaría de Ciencia, Tecnología e Innovación



Ciencia y Tecnología
Secretaría de Ciencia, Tecnología e Innovación



BUAP®