ISENS
2025

International Symposium on Sensors

06-08 May 2025 | UNAM-Juriquilla Queretaro, Mexico

Book of Abstracts

International Symposium on Sensors

06-08 May, 2025

Chaired by:

Elodie Claire Strupiechonski

Gonzálo Ramírez-García

Eden Morales-Narváez

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Authorship. Aguilar, Javier; Alcantar-Peña, Jesús J.; Alemán Arce, Miguel Ángel; Alvarado-Muñoz, Estephanny J.; Álvarez Chávez, Nadia Estefanía; Álvarez Contreras, Lorena; Antaño López, Rene; Aragón, José L.; Avila, Remy; Avilés Bravo, José Juan; Ayala Fonseca, Alfredo; Becerra, Armando H; Bredic, Fausto; Buendia, Ricardo; Calleja-Arriaga, W.; Carreño-Vega, Osvaldo; Casanova, Jannu Ricardo; Casas, Victor; Castro-Beltrán, Rigoberto; Chávez Medina, Juan Marcos; Chávez-Urbiola, Iker Rodrigo; Cinti, Stefano; Colorado Garcia, Uriel; Cordero García, Pablo Daniel; Cortes Muñoz, Juan Luis; Cortés Sarabia, Karen; Coutino-Gonzalez, Eduardo; Crisóstomo-Rodríguez, Tamara Jennifer; Cruz, Roel; Cruz-Zabalegui, Alexis; Cuate-Gomez; Cuanalo, Juan; De Anda-Reyes, M. E.; Díaz-Barba; Díaz Cervantes, Erik; Diaz Coratella, Bruno; Díaz González, Jan-Carlo Miguel; Domínguez-Juárez, Jorge L.; Dunare, Camelia; Dutt, Ateet; Enrriquez, Haggeo Desirena; Escobar, Jordan; Esparza-García, A.; Fernández García, Alonso; Ferrer, Jesús Salvador Jaime; Ferrusca R., Daniel; Flores, Mariana G.; Flores, Victor; Flores-Ruiz, Francisco J.; Flores-Ventura, María Fernanda; Frausto Avila, Christian Mateo; García Avellaneda, María Fernanda; García-Fernández, Tupak; García Figueroa, Ericka Yatzil; García-Guzmán, Cecilia; García-Rivera, Luz Ma.; Gallegos Mendoza, Juan Carlos; Garzon-Roman; Gomez Duran, Cesar Fernando Azael; Gomez-Montaño, Francisco J.; Gómez Solis, Cristian; Gonzalez Jassoa, Laura Sarahi; González López, María del Carmen; González-Vega, Arturo; Gregoire, J.; Guerra Balcázar, Minerva; Gutiérrez-Alejandre, Aída; Hautefeuille, Mathieu; Hernandez Como, Norberto; Hernández-Cuenca, Ximena Aurora; Hernandez-Garcia, Armando; Hernández Padrón Genoveva; Hernández Velázquez, Emmanuel Alejandro; Herrera-Celis, Jose; Horta-Velázquez, Amauri; Ibarra, Ilich A.; Jiménez Sánchez, Arturo; Juarez-Moreno, Karla; Ledesma, S.; León Montiel, Roberto de Jesús; Lev-Contreras, Víctor Ulises; Liu, Ming; Lomax, Peter; Lopez-Lugo, Jonathan David; López Marín, Luz María; Lujan-Cabrera, I.A.; Luna López, José Alberto; Luna Trujillo, Mayra; Manríquez Amavizca, Jose Pablo; Mansurova, Svetlana; Maria Gravagnuolo, Alfredo; Martínez, Jesús Miguel Germán; Martínez-Borquez, Alejandro; Martínez-Ramos, Ismael; Martínez-Sanmiguel, Juan José; Martínez Tolibia, Shirlley; Mavil-Guerrero, Elizabeth; Méndez Jerónimo, Gabriela; Mercado Mendiola, Iram Roberto; Molina González, Jorge Alberto; Molina Reyes, Joel; Montiel, H.; Montoya Cano, Katherine; Morales-Narváez, Eden; Morales Sánchez, Alfredo; Moreno-Guerrero, A. A.; Moreno Moreno, Mario; Mota-Morales, Josué D.; Navarro, Lourdes, Nicasio-Navarro, Anet G.; Obeso, Juan L.; Ochoa Elías, Monserrat; Orduña Diaz, Abdú; Ortiz-Ricardo, Erasto; Oza, Goldie; Palestino, Gabriela; Palma-Nicolas, José P.; Patiño Cárdenas, Juan; Peto-Gutiérrez, Cindy; Pinzón-Escobar, E. F.; Ponce-Hernández, Juan; Quintero-Torres, Rafael; Quiñonez-Angulo, Priscila; Quiroz Juárez, Mario Alan; Ramírez García, Gonzalo; Ramirez Rios, Juan Federico; Ramírez Salinas, Marco Antonio; Ramos-Ortiz, Gabriel; Ramos, Rubén; Ramos Vilchis, Carlos D.; Rangel Miranda, Domingo; Reyes Domíngez, Iván Alejandro; Reynoso de La Cruz, Héctor M.; Rivera, G.; Rocha Aguilera, Daniel; Rodriguez, Cesar Ivan; Rohokale, Apurva; Romero-López, A.; Romero, Josué E.;Romo-Herrera, José Manuel; Rosas-Román, Ignacio Raúl; Ruiz Rocha, Juan Emmanuel; S. Roldan, K. Paola; Salas Castillo, Pedro; Salinas, Rafael; Sánchez-Aké, Citlali: Sanchez-Mora, E.; Santana, Guillermo; Solis-Ibarra, Diego; Solís Tinoco, Verónica Iraís; Soltero, A. J. Félix; Strupiechonski, Elodie; Suélia de Siqueira Rodrigues Fleury, Rosa; Tanguy, Nicolas; Terry, Jonathan G.; Torres, M.; Torres, S.; Underwood, Ian; Urdiales-Mena, R. Saraí; Valdés Hernández, Jesús; Vargas-Nolasco, Ulises; Vargas-Zamarripa, Marlene; Vazquez-Sanchez, Humberto; Vázquez-Victorio, Genaro; Velázquez Arjona, Walter Noé; Vences-Velázquez, Amalia; Vilasó Cadre,

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Name of the Event. International Symposium of Sensors, ISENS 2025 **Date.** 06-08 May, 2025

Location. UNAM Juriquilla, Querétaro, México

Sponsorship. The event and digital content was funded by AC Max, Silvera, CTR, Merck,Site; the Universidad Nacional Autónoma de México through the Dirección General de Asuntos del Personal Académico (DGAPA) por los proyectos PAPIIT IT100124 e IA100424) y la Secretaría de Ciencias, Humanidades, Tecnología e Innovación (SECIHTI) por el proyecto CBF2023-2024-1041/C-549/2024.

Edition: 1, 2025

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Publisher. Universidad Nacional Autónoma de México, Centro de Física Aplicada y Tecnología Avanzada, Campus UNAM-Juriquilla, Boulevard Juriquilla No. 3001, Santiago de Querétaro, Querétaro, C.P. 76230, México.

Citation. Strupiechonski, E. C., Ramírez-García, G. & Morales-Narváez, E. (Eds.) (06-08 de mayo de 2025). *Book of Abstracts International Symposium on Sensors, 06-08 May, 2025.* Universidad Nacional Autónoma de México, Centro de Física Aplicada y Tecnología Avanzada. Querétaro, México.

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Book of Abstracts *International Symposium on Sensors, 06-08 May 2025*
UNAM-Juriquilla, Querétaro, Mexico

It is with great enthusiasm that we present the **Book of Abstracts for ISENS 2025**, the International Symposium on Sensors, held at the Centro Académico Cultural UNAM-Juriquilla. This document captures the breadth and depth of contributions that define the vibrant and rapidly evolving field of sensor science and technology.

The abstracts compiled here reflect the diversity and excellence of the ISENS 2025 program, which includes **cutting-edge keynote lectures**, **oral presentations**, and **poster sessions** spanning a wide range of topics—from **biosensors, photonic and electrochemical detection platforms**, to **flexible electronics, nanostructured materials, artificial intelligence integration**, and **applications in healthcare, environmental monitoring, and quantum sensing**.

We are particularly proud of the international and interdisciplinary nature of this event. The contributions from students, early-career researchers, and established experts alike demonstrate the collaborative spirit and global momentum behind sensor innovation. Notably, this edition features talks and posters that push the frontiers of **paper-based diagnostics, CRISPR-based detection systems, high-throughput epidemiological monitoring**, and **novel optical and electrochemical sensing architectures**.

We are also proud to declare that all abstracts were peer-reviewed following the ethical guidelines recommended by IEEE and IOP Publishing, ensuring a rigorous and transparent evaluation process.

We hope that this book serves not only as a record of the symposium's scientific achievements but also as a source of inspiration for future collaborations, projects, and breakthroughs.

We thank all the contributors for their dedication and valuable work, and we warmly welcome all attendees to ISENS 2025. We are grateful to JPhys: Photonics for organizing a Focus Issue devoted to our event. We acknowledge the support of IEEE Queretaro Section and AMO, as well as the sponsorship of AC Max, Silvera, CTR, Merck and Site. The organizers also acknowledge financial support from DGAPA-UNAM (PAPIIT Grants IT100124 and IA100424) and SECIHTI (Grant CBF2023-2024-1041/C-549/2024)

Elodie Claire Strupiechonski, Gonzálo Ramírez-García, Eden Morales-Narváez
Chairs, ISENS 2025 Organizing Committee

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How Paper-based Diagnostics changed Measurement Science

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Abstract

Despite substantial advances in sensing technologies, the development, preparation, and use of self-testing devices is still confined to specialist laboratories and users. Decentralized analytical devices will enormously impact daily lives, enabling people to analyze diverse clinical, environmental, and food samples, evaluate them and make predictions to improve quality of life, particularly in remote, resource-scarce areas. In recent years, paper-based analytical tools have attracted a great deal of attention; the well-known properties of paper, such as abundance, affordability, lightness, and biodegradability, combined with features of printed electrochemical sensors, have enabled the development of sustainable devices that drive (bio)sensors beyond the state of the art. Their blindness toward colored/turbid matrices (i.e., blood, soil), their portability, and the capacity of paper to autonomously filter/purge/react with target species make such devices powerful in establishing point-of-need tools for use by non-specialists. Depending on analytical requisites, different types of paper (filter, office) and configurations (1D, 2D, 3D) can be adopted. A wide overview regarding application ranging from nucleic acids to heavy metals, through pesticides detection will be provided, with the aim in showing the potentialities of paper-based electrochemical biosensors for improving society involvement in monitoring. In addition, a novel approach for pre-concentration is reported. The use of a disposable paper-based architectures and origami, opportunely configured, represents the first examples of horizontal and vertical pre-concentrations. It highlights the suitability of producing a novel electroanalytical platform that does not require expertise-required tasks. The talk is aimed to provide general basis regarding the development of smart electrochemical strips for multiple applications. However, it should be noted that the term “paper” is too general: chromatographic paper, office paper and nanocellulose are only some of the paper-based substrates that can be exploited. The main question from non-experts is: which kind of support should I use? The best answer is “it depends”!

Keywords

Paper-based, Biosensors, Biomedical Diagnostics, Point-of-Care Testing, Origami

3D Cancer Models for Real-Time Biosensing in Drug Screening

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Abstract

The development of 3D cancer models integrated with real-time biosensing technologies is revolutionizing preclinical drug screening by bridging the gap between traditional 2D cultures and in vivo tumor environments. These models provide physiologically relevant tumor microenvironments, enabling dynamic and continuous monitoring of cellular responses to anticancer agents. By incorporating bio sensing techniques, 3D cancer models enhance the accuracy of drug efficacy and toxicity assessments, offering a more predictive alternative to conventional screening approaches. In this study, we present an advanced 3D cell culture platform embedded with electrochemical and optical biosensors for real-time analysis of drug induced cytotoxicity. The platform utilizes electrochemical and fluorescence-based biosensing to track key biomarkers such as cell viability, metabolic activity, and oxidative stress levels. Additionally, the integration of perovskite oxide nanoparticles enhances sensor sensitivity, allowing precise and rapid detection of biochemical changes in the tumor microenvironment. The 3D tumor models were developed using breast cancer spheroids, co-cultured with stromal and endothelial cells to mimic native tissue architecture. Drug exposure studies revealed real time cellular responses, demonstrating how biosensor integration provides kinetic data that conventional endpoint assays fail to capture. The system's high-throughput capabilities and label-free monitoring make it a powerful tool for accelerating drug discovery and optimizing personalized medicine strategies. We would like to highlight the synergistic potential of 3D cancer models and biosensing technologies in advancing precision oncology. Future research will focus on integrating multi-organ systems and AI-driven analysis for predictive, patient specific drug screening applications.

Keywords
3D cancer models, spheroids, microfluidics, electrochemical, optical

Record-Breaking H2S Capture and ppm-Level Sensing with a Chemically Stable Porous Organic Cage

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Abstract

The first experimental investigation of a porous organic cage (POC) for the challenging task of H_2S capture is reported. The N-containing cage molecular material, a tertiary amine POC (6FT-RCC3), demonstrates the highest H_2S(hydrogen sulfide) capture (record capacity) for a porous material at room temperature and atmospheric pressure (20.6 mmol H_2S g^{-1} ; 25 H_2S molecules per cage) combined with excellent reversibility for at least five adsorption–desorption cycles. *In situ* FTIR spectroscopy, solid-state ^{13}C, and ^{15}N CP MAS NMR spectroscopy experiments are applied to investigate the adsorption mechanism, identifying relatively weak interactions *via* hydrogen bonding. In addition, the fluorescence performances of this POC material are evaluated for the detection and sensing of H_2S, where a clear H_2S selectivity is observed over other gases. Remarkably, the limit of detection (LOD) is calculated to be 0.13 mm (≈ 4.43 ppm) in a tetrahydrofuran (THF) solution of H_2S.

Keywords

Adsorption, Chemical Stability, H_2S, Porous Organic Cages, POCs

Growth of 1-D ZnO nanostructures and their applications in health sectors

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Abstract

Our research centers on the growth of nanomaterials, particularly hybrid Au-ZnO nanowires, to explore their potential in chemical and biosensing applications. We seek to understand how the size and shape of these nanostructures influence their properties. The combination of gold and zinc oxide in these nanowires results in unique properties that enable the development of highly efficient and sensitive sensing platforms. In one study, we evaluated the effectiveness of 1D ZnO nanoplatforms for rapid cancer biomarker detection, examining their nanoscale integration with receptors to produce reliable photoluminescent output signals. Additionally, we demonstrated a modulation of photoluminescence signals that responded effectively to analyte concentrations ranging from 1×10^2 to 1×10^8 CFU mL^{-1}, allowing direct visualization of targeted bacterial cells on 1D ZnO structures. The design of this nano biosensor emphasizes real-time contact-based detection, significantly reducing processing and response times and making it suitable for emergency pathogen detection scenarios. We aim to advance their practical applications in various medical fields by understanding and controlling these nanostructures' properties.

Keywords

ZnO, Quantum Dots, Nanomaterials, Biosensors, nanowires

Revolutionizing Healthcare: The Transformative Role of Sensors in Medical Equipment

Development and Biomedical Engineering

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Objectives: This presentation aims to explore the critical role of sensors in the development of medical equipment and their transformative impact on the field of biomedical engineering. It seeks to highlight how advancements in sensor technologies are enhancing the capabilities of medical devices and improving patient outcomes.

Methods: A review of current sensor technologies used in medical devices is presented, focusing on types such as pressure sensors, temperature sensors, pH sensors, and biosensors. The paper examines how these sensors are integrated into medical equipment to enable continuous, non-invasive monitoring and real-time data collection. Additionally, case studies of innovative devices such as Organ-on-a-Chip, wearable health monitors, and biofeedback systems are analyzed.

Results: The integration of sensors has led to significant improvements in diagnostics, patient monitoring, and personalized treatment. Key findings include enhanced precision in detecting health conditions, real-time health data collection, and more accurate therapeutic interventions. The development of portable and wearable medical devices has expanded patient access to continuous care, facilitating early detection of diseases and chronic condition management.

Conclusions: Sensors are integral to the advancement of biomedical engineering, driving innovation in medical equipment and transforming healthcare practices. Their application has enhanced the accuracy of diagnostics, personalized treatment plans, and patient outcomes. The discussion at this symposium will provide valuable insights into future trends in sensor technologies, the challenges of integrating these systems into medical practice, and their potential to revolutionize healthcare. This presentation emphasizes the importance of continued research and development to unlock the full potential of sensors in medical applications.

Key-words

Biomedical technology; translational research; designs, equipment; innovation diffusion; community health servisse.

Silver clusters into zeolite composites for optical and electrochemical biosensing

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Abstract

An optical immunoassay based on luminescent silver nanoclusters that offers biodetection in a single step, avoiding washing/separation procedures will be discussed. At immunocomplex formation, the increasing emission intensity of silver clusters may be attributed to an antenna effect, caused by modifications in the electronic environment surrounding the clusters. This immunosensor was evaluated for the detection of two distinct analytes: human-IgG antibodies and Escherichia coli bacteria, obtaining the optimal response at 20 minutes of immunocomplex interaction by detecting human-IgG antibodies and 5 minutes when detecting E. coli bacteria, demonstrating in this manner its high capacity for sensing in a quick and wash-free manner by responding to external stimuli [1].

On the other hand, we explore the use of silver clusters embedded in zeolites as an electroactive material that enhances electrode-analyte interactions in disposable electrochemical strips made of plastic or paper. In this context, two detection mechanisms were investigated: the oxidative-reductive property of zeolites embedding silver clusters for chloride ion detection, and their electrocatalytic activity in glucose sensing in the presence of glucose oxidase. These findings contribute to the development of simple and cost-effective electroactive materials for modifying portable electrochemical sensors [2].

Keywords

Biosensing, immunosensing, silver clusters, photoluminescence, portable device.

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Antibodies as bioreagents for the analysis of the reproductive health

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Abstract

Bacterial vaginosis is the main vaginal dysbiosis associated with the overgrowth of anaerobe bacteria. *Gardnerella vaginalis* is a Gram-negative bacterium that produces several virulence factors, such as biofilm, vaginosis, and sialidase. The sialidase are enzymes that are responsible for the removal of α-glycosidically linked sialic acid residues and promote the degradation of the mucus barrier in the vagina. The conventional diagnostic is performed considering the Nugent score and Amsel criteria that depend on the clinical analysis of the sample, which is commonly subjective and can have errors associated with the analyst's experience. Objective: The production of antibodies against the sialidase of G. vaginalis could be an enjoyable alternative for detecting the enzyme in biological samples. Methods: We produced antibodies against the three sialidases of *G. vaginalis* by the immunization of Balb/c mice with the recombinant N-terminal domains of NanH1, NanH2, and NanH3 and characterized the generated immune response and obtained antibodies by immunological methods. Results: We observed high antibody titters in the immunized mice for all the N-terminal domains, specifically, the presence of IgG subclasses (IgG1, IgG2a, and IgG2b) after 75 days post-immunization. Antibodies were able to recognize the recombinant domain by Western blot and ELISA and the complete enzyme in vaginal swab samples derived from women with normal microbiota and bacterial vaginosis. Conclusion: Antibodies could be a powerful tool for the detection of metabolites produced by microorganisms associated with the development of bacterial vaginosis.

Keywords

Antibodies, monoclonal antibodies, bacterial vaginosis

Acoustic Tweezers for bio-chemical and bio-photonics applications

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Abstract

Acoustic Tweezers offer a groundbreaking platform for controlling and manipulating samples without physical contact. This innovative technology presents a unique opportunity to characterize hazardous samples and those focused on photonics, such as levitated microlasers. Both applications have tremendous potential in bio-chemical technologies.

On the one hand, monitoring the evaporation rate of water-based mixtures (microdroplets) allows us to calculate their diffusion coefficients, relating them to inherent sample properties. Similarly, external laser excitation of levitated samples can accelerate chemical reactions or eliminate drugs and microplastics through photothermal energy conversion mechanisms. On the other hand, levitated microlasers with spherical cavity shapes sustain whispering gallery electromagnetic modes, which resonate inside the cavity and amplify laser light. By modifying their shapes, these microlasers can exhibit different resonating properties, directly affecting their directional lasing emissions. This breakthrough opens new avenues in bio-photonics, enabling the optical excitation of distinct regions with varying purposes, for example, detection or far-field material characterization. This work showcases Acoustic Tweezers as a novel tool for touchless sample manipulation, with applications in biochemical and bio photonic fields. We also present our recent findings in both areas.

Keywords

Acoustic Tweezers, hazardous samples and photonics

An electrochemical sensor based on a gold electrode modified with a titanium oxocluster-chitosan composite for thallium quantification

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Abstract

Thallium is a metal known for its toxicity. The presence of this element in water and soil is of concern as it can be very dangerous, with lethal consequences at very low concentrations. Therefore, it is necessary to monitor this metal in ecosystems. However, the quantification of thallium in minerals and in mining processes and related environments is important because they are potential sources of thallium contamination with high mobility, which occurs not only through natural processes but also through the transportation of mining products. Methods for quantifying thallium are expensive since they are generally based on absorption or atomic emission spectroscopy. However, electrochemical sensors are cheaper and more versatile analytical tools for environmental and industrial analysis. This work presents an electrochemical sensor based on a gold electrode modified with a titanium oxocluster and chitosan composite for the determination of thallium in mining samples using anodic stripping voltammetry. Both Tl(I) and Tl(III) presented the same peaks by cyclic voltammetry, indicating that the sensor allows the quantification of total thallium when both species are present in a sample. The pH of the best electrochemical response was 3.2. Anodic stripping voltammetric parameters showed -1.0 V as the optimal deposition potential, 80 s deposition time, 600 rpm stirring, 10 Hz frequency, 1 mV potential step, and 25 mV pulse amplitude. The sensor responded linearly from 4.98 to 20.84 ppm thallium ($R^2 = 0.9939$). The detection limit was 2.26 ppm. The sensor response was repeatable with RSD between 1.25 and 2.59% depending on the thallium concentration. In addition, the anodic stripping response was reproducible for three sensors. The proposed electrochemical sensor is an alternative for the determination of thallium in mineral samples where the concentration of this metal can exceed 20 ppm, being more accessible and cheaper than the commonly used instrumental methods.

Keywords

Thallium, Titanium oxocluster, Chitosan, Gold electrode, Mining industry

Biosensors based on CRISPR-Cas Systems for Genetic Detection

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Abstract

CRISPR-Cas systems are very promising for developing diagnostic methods that are very sensitive, specific, fast and cheap

CRISPR-Cas-based diagnostic methods have emerged as powerful tools for pathogen detection, achieving sensitivity and specificity comparable to RT-qPCR. However, improvements in detection speed and efficiency are still needed. Here, we present various strategies leveraging the advantages of CRISPR-Cas12a systems that result in faster and more sensitive detection assays. When coupled with isothermal amplification, these approaches can detect as few as 10 viral copies of SARS-CoV-2 within few minutes using fluorescence or lateral flow. These findings highlight the potential of CRISPR diagnostics for decentralized and field-deployable pathogen detection.

Keywords

CRISPR-Cas, genetic biosensors, pathogen detection, SARS-CoV-2, isothermal amplification, guide RNA, Cas12a, molecular diagnostics, lateral flow assay, fluorescence detection.

Advancing Chemiluminescence-based Sensing for Harsh Environments: Development of a Novel Silicon Carbide Photodetector

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Abstract

Industrial workplaces, such as oil and gas refineries, sewage plants, and pulp and paper factories, often present hazardous environments, particularly due to hydrogen sulfide (H2S) exposure. Inadvertent exposure to this highly toxic gas is a common concern in these industries, with health effects ranging from respiratory issues to severe conditions like unconsciousness and cardiac arrest. While current H2S sensor-based detection systems offer advantages such as high resolution and linearity, they face challenges such as long response times, cross-sensitivity, and aging effects.

This study introduces a novel miniature photodetector designed for selective, fast, and robust detection of H2S-specific chemiluminescence (CL). The sensor is based on a silicon metal-oxide-semiconductor (Si-MOS) tunneling structure, featuring a vertical optical window, an integrated catalyst layer, and a robust substrate. It was fabricated using standard microfabrication techniques, including photolithography and metal deposition, and characterized through voltage-current and capacitance-voltage measurements. Silicon carbide (4H-SiC) has proven reliable in harsh industrial environments, and offers remarkable optical absorption in the UV, making it an ideal substrate for the sensor. Its electrical and optical performance were validated through TCAD simulations. A Luminol-based solution, mimicking H2S catalytic oxidation, was used to test the sensor's optical performance. Proof-of-concept experiments demonstrated a fast, linear response (less than 1 s), an average dark current below 20 nA, and optical gains of up to 22%. Although the test environment did not include interfering species, it is expected that optical transduction will benefit the sensor's selectivity. These results demonstrate the feasibility of the 4H-SiC photodetector for fast, highly selective, and portable H2S detection with enhanced resistance to harsh conditions. This work paves the way for industrial applications in chemiluminescence and improved H2S monitoring.

Keywords
Gas sensor, 4H-SiC Photodetector, Chemiluminescence, Luminol, TCAD Simulation.

Sub-stoichiometric co-sputtered silicon dioxide for photodetector devices

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Abstract

This study focuses on the photodetector devices based on sub-stoichiometric silicon dioxide (SiO_x) deposited by co-sputtering technique using silicon dioxide (SiO_2) and Si targets , which are biased with RF and DC sources, respectively. The studied devices are composed of the following elements: Indium-Tin-Oxide (ITO, 100 nm) as transparent top electrode, SiO_x (10 nm)/ Si (6 nm)/ SiO_x(5 nm) multilayers that function as absorbers, p-type silicon substrate (Si-p) as emitter, and Al (700 nm) as bottom electrode. The device is thus abbreviated as ITO/SiO_x/Si/SiO_x/Si-p/Al. To understand the effect of Si in the SiO_x layers, we used the same structure without co-sputtering as a reference, which is ITO/SiO_2/Si/SiO_2/Si-p/Al. Photoluminescence characterization of SiO_x/Si/SiO_x at 330 nm excitation light demonstrates a reduction in oxygen-related defects due to the incorporation of Si in the SiO_x layers during the co-sputtering process. Consequently, the short-circuit current and current during inversion polarization at visible-IR radiation is incremented. Furthermore, the sensitivity of the ITO/SiO_x/Si/SiO_x/Si-p/Al device at white light is three orders of magnitude. The findings therefore support the use of the ITO/SiO_x/Si/SiO_x/Si-p/Al device as a self-powered photodetector within the visible-IR spectrum.

Keywords
Silicon-based photodetectors, sub-stoichiometric silicon dioxide, visible-IR spectrum, self-powered photodetector, oxygen-related defects.

Synthesis of a sensor based Gd2O3:Er/naphtalamide nanoparticles for detection of glyphosate

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Abstract

Organophosphate pesticides, are a class of pesticides designed to affect the nervous system of insects, are of particular concern, with glyphosate (Gly) being notable for its high toxicity and widespread use in Mexico. The presence of Gly in water can lead to adverse health effects, such as gastrointestinal diseases, reproductive issues, and neurological disorders. Its extensive use in the state of San Luis Potosí has raised alarms among environmental agencies in recent years. For this reason, detecting contaminants has become increasingly important to mitigate the environmental and public health impacts they cause. This work aims to synthesize a sensor (Nps-NATP) based on gadolinium oxide nanoparticles doped with erbium (Nps), impregnated with the fluorescent unit naphthalimide-triphosphate (NATP). NMR, FTIR, TEM and fluorescence techniques were used for characterization. The NATP compound was immobilized on the surface of the Nps through coordination interactions, causing the fluorescence of the Nps to turn off due to energy transfer (ET) to NATP. After Gly replaces NATP on the nanoparticle surface, the NATP will detach into the solution containing the Gly, resulting in a fluorescence change in both the Nps and the solution in response to the presence of Gly. Energy transfer effect was observed between Nps and NATP. Experimental results demonstrated detection limit at 493 nM. These findings highlight the application of energy transfer between organic molecules and nanoparticles.

Keywords
organophosphate pesticides; gadolinium nanoparticles; energy transfer; glyphosate.

Advances in Flexible Electronics: Thin-Film Transistors for Sensor Applications

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Abstract

Recent advances in flexible electronics using thin-film transistors (TFTs) have enabled high-performance, wearable, and biocompatible sensors for healthcare, environmental monitoring, and robotics. Innovations in materials, such as 2D materials (e.g., graphene, MoS_2), organic semiconductors (e.g., P3HT, pentacene), and hybrid nanocomposites (e.g., MXenes, carbon-based materials), have enhanced flexibility, carrier mobility, and multimodal sensing capabilities. These advances support applications like epidermal sensors for real-time health monitoring (ECG, glucose, muscle activity), artificial skin with sub-millisecond tactile response, and gas sensors with parts-per-billion (ppb) sensitivity for NO_2 and NH_3 detection. Flexible TFTs enable stretchable, transparent, and low-power devices, improving human-machine interfaces and smart textiles. However, challenges remain in mechanical durability, stability, and cost-effective large-scale manufacturing. Addressing these will accelerate the adoption of TFT-based sensors for next-generation adaptive and sustainable technologies.

Fabrication of Polymeric Microneedles: Transducer for Continuous Glucose Monitoring

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Abstract

Diabetes mellitus is one of the most prevalent chronic diseases worldwide, affecting millions of people. Continuous glucose monitoring (CGM) is essential for maintaining glycemic control and preventing complications. This work presents the development of a microneedle-based subdermal transducer for CGM, offering a less invasive and more comfortable alternative for patients. The transducer utilizes polymeric microneedles fabricated through advanced manufacturing techniques. Glucose detection relies on an electrochemical sensor based on glucose oxidase (GOx), which catalyzes glucose to generate hydrogen peroxide (H2O2), detected electrochemically by a set of electrodes.

The development involved multiple phases: microneedle design and 3D printing, replication via micromolding in biocompatible polymers, metallization, penetration tests (force/distance), enzymatic functionalization with GOx, electrochemical characterization, biocompatibility testing, and device assembly. Microneedle models with pitches of 500, 700, and 1000 µm were successfully replicated. Penetration forces ranged from 0.3 to 0.7 N, with linear distance-force behavior while maintaining structural integrity. Functionalized films exhibited uniform lattice patterns for mechanical support. Electrochemical tests met precision standards, and interference tests confirmed accurate glucose detection in the presence of ascorbic acid, urea, creatinine, maltose, and glycine, with acceptable interference levels.

Biocompatibility tests, including cytotoxicity, genotoxicity, and leachate assays, showed cell viability above 70%. The successful integration of 3D printing, micromolding, and metallization enabled the fabrication of a robust, accurate, and safe transducer suitable for real-world use. This work advances the design and manufacturing of microneedle-based CGM devices, highlighting their potential for mass production and efficient diabetes management.

Keywords

Enzymatic Biosensors, Microneedles, GOx, Glucose Continuous Monitoring, Diabetes.

Sensing of Light-Liquid Interaction with Thermal Fingerprint

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Abstract

Here we show sensing as a temperature-induced index of refraction changes for thermalization processes in liquids. Light-liquid interaction is analyzed with the help of visible image changes of a diffraction patterns response using a pump-probe thermal lens spectroscopic system. The specific diffraction patterns may be considered as the optical signatures or fingerprints of the liquids studied. The technique proposed here is noninvasive and simple to implement with commercially available supercontinuum sources and digital cameras. The optical system is a dual femtosecond pulsed laser, using infrared as a pump and probing with visible light. The colinear infrared and visible light beams were focused on the cell of colorless liquids. Visibility and the number of rings depended on the laser power, dimensions of the cell, free convection, initial temperature conditions, and the light absorption of the liquid material. Therefore, the approach reported here can pave the way to the development of compact thermal lens instruments for a variety of practical applications.

Keywords

Properties of liquids, photothermal, diffraction patterns.

Sensing of Light-Liquid Interaction with Thermal Fingerprint

Dr. Jorge L. Domínguez-Juárez[1,2] Rafael Quintero-Torres,[1] Jose L. Aragón[1], Jesús Valdés Hernández[1], Mario A. Quiroz-Juárez [1] and Joel Villatoro[3,4]

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Abstract

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Keywords

Properties of liquids, photothermal, diffraction patterns.

Fluorescent Bioimaging of Complex Subcellular Dynamics

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Abstract

Understanding subcellular dynamics is essential for elucidating fundamental biological processes and disease mechanisms. However, current imaging tools lack the specificity and temporal resolution required to monitor intricate cellular events in real-time. In this talk, we present novel fluorescent bioimaging strategies that enable dynamic visualization of critical subcellular processes, including blebbing, lipid droplet (LD) dynamics, and mitochondrial targeting. We introduce the AztecBleb probes designed to selectively track cellular blebbing—a process central to apoptosis, cytokinesis, and migration. These probes incorporate a pregnenolone-based scaffold derived from abiraterone acetate, ensuring precise localization to blebs and microtubules without altering cellular function. Additionally, we present a fluorophore chemistry-based approach for *in vivo* LD dynamic monitoring. Furthermore, applying an optimized molecular probe to zebrafish models of pericardial and yolk-sac edema enables real-time tracking of disease progression and recovery, offering a dual strategy for biomedical applications. Lastly, we introduce a mitochondrial-targeting paradigm that optimizes probe retention by integrating Nernst potential (W) and partitioning (P) contributions. We try reveal a refined approach to mitochondrial localization, enhancing probe efficacy in primary cortical neurons under normoxia and oxygen–glucose deprivation. Together, these innovations establish new frontiers in fluorescent bioimaging.

Keywords

Fluorophore Chemistry, Bioimaging, Cell Dynamics, Molecular Diagnostics, Biosensors

Sensing platform based on spectral modulation of upconversion-gold nanoparticle hybrid

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Abstract

At present, there are several well-established and highly sensitive analytical techniques with very low detection limits, such as atomic absorption spectroscopy, atomic fluorescence spectrometry, or high-performance liquid chromatography. However, for pre-processing or screening applications, it is crucial to develop accessible, sensitive and specific methods, that allow early evaluation with accessible and easy-to-operate equipment. In this study, a hybrid nanosensor consisting of spherical gold nanoparticles (AuNP) and upconversion-emitting nanoparticles (UCNP) is presented. Both were synthesized by simple and reproducible methods, ensuring the homogeneity of the properties of the sensing platform. The hybrid fabrication was carried out thoroughly, combining both colloidal suspensions without the need for complex processes. The interaction between the particles was experimentally characterized by absorption, emission and Raman spectroscopy, as well as dynamic light scattering (DLS) and electron microscopy, complemented by DFT calculations to validate theoretical results. The analyses show that the high sensitivity of AuNPs to changes in their environment directly impacts their absorption spectrum, which in turn modulates the luminescent emission of UCNPs. This spectral modulation effect allows correlating spectral changes with the presence of an analyte, achieving detection of concentrations on the order of ppm or lower. As a proof of concept, the simple fabrication of the hybrid and its response to metal detection is demonstrated, reaching a sensitivity below 1 ppm, obtained by absorption and emission spectral analysis. This system stands out for its simplicity of synthesis, ease of analysis and high sensitivity, which positions it as a promising alternative for early detection of analytes at low concentrations with minimal equipment.

Keywords

Luminescent nanosensor, upconversion, gold nanoparticles

Portable UCNP-Based Platform for On-Site Glyphosate Detection Using a Xanthene Dye as a Quenching Modulator

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Abstract

The rising significance of monitoring agrochemicals like glyphosate, recognized as a potential risk to health and food safety, has spurred research into advanced detection strategies. In response, numerous studies have targeted the identification and measurement of this herbicide through diverse analytical techniques. Progress in these methods must prioritize transitioning analyses from laboratory settings to on-site applications via the design of compact, durable, and user-friendly platforms. This study demonstrates a portable analytical system employing a solid-phase substrate, requiring only 50 µL samples for glyphosate quantification. The approach relies on shifts in the luminescent emission of upconversion nanoparticles (UCNPs), driven by the interaction between a fluorescein-glyphosate complex and the nanoparticles. The mechanism underlying the UCNP-fluorescein interaction was investigated, revealing its role in selectively quenching the 520 nm upconverting emission band (turn-off effect). To enable quantification, specialized software was developed to process images of fluorescence patterns generated by UCNPs immobilized on Poly(vinylidene fluoride-co-hexafluoropropylene) (PVDF-HFP) nanofibers under 975 nm near-infrared (NIR) laser excitation. Key operational parameters were optimized for glyphosate detection, including a laser power of 224 mW, a UCNP concentration of 1.5 mg ml^{-1} cm^{-2}, and a fluorescein concentration of 1 x 10^{-3} M. The system's performance was assessed under simulated field conditions, incorporating potential interferents such as tap water, corn flour, and agricultural soil. A detection limit (LOD) of ~4 ppm was achieved, highlighting the platform's selectivity in complex matrices. These advancements support global efforts to deploy accessible technologies for monitoring chemical residues in food and environmental samples, ensuring safer agricultural practices. Future directions may involve integrating automated workflows or expanding the system's capability to detect multiple agrochemicals simultaneously, further enhancing its utility in real-world scenarios.

Keywords

Glyphosate, Upconverting nanoparticles, Portable sensor, automate Image analysis

Development and Characterization of a Luminescent Nanothermometer Based on $Y_2Te_5O_{13}$: Yb^{3+}/Er^{3+} for Remote Temperature Sensing

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Abstract

Accurate and efficient temperature detection is crucial for various industrial, environmental, and biomedical applications. In this study, we present the synthesis and characterization of a temperature sensor based on $Y_2Te_5O_{13}$ crystalline particles doped with Yb^{3+}/Er^{3+}, obtained via the solid-state reaction method. Higher concentrations of Er^{3+} enable more precise tuning of the material's spectral characteristics, optimizing the intensity and position of the emission bands for specific applications in thermal sensing and advanced optoelectronics. As the Er^{3+} concentration increases, the red emission band is enhanced, modifying the intensity ratio between emission bands and favoring its use in high-precision thermal sensors. The temperature generation in the system is determined by the $Y_2Te_5O_{13}$ crystalline matrix, whose structure influences the non-radiative energy transfer and the material's thermal dissipation. This phenomenon directly impacts the efficiency of the luminescent emission, modulating its thermal behavior and detection capability in advanced optoelectronic applications. Additionally, the material's low intrinsic thermal conductivity helps minimize heat dissipation, enhancing thermal stability and detection sensitivity. These factors suggest its feasibility as a luminescent nanothermometer for remote thermal sensing and advanced optoelectronic applications.

Keywords

Upconvertion, temperature sensing, nanomaterials, nanothermometer

Heightened Sensitivities: Advancing Nanotoxicology Through Complex Cellular Models

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Abstract

Nanotechnology's rapid advancement across multiple sectors requires a deeper understanding of nanoparticle-induced risks. Although straightforward and widely used, traditional two-dimensional (2D) cell culture models often fail to capture the structural complexity and physiological relevance required for accurate nanotoxicological assessments. Herein, we underscore the importance of three-dimensional (3D) cell models, such as spheroids, in revealing heightened sensitivities to nanomaterials. Using biological cellular strategies, we identified that silver nanoparticles (AgNPs) exhibit greater cytotoxicity in 3D spheroids than in 2D cell cultures, as evidenced by increased apoptosis, reactive oxygen species production, and genotoxicity. These findings highlight the need to explore diverse cellular architectures when evaluating nanoparticle safety and efficacy. Furthermore, emerging paradigms in nanotoxicology challenge traditional size-based risk assumptions. They may still elicit significant biological responses, underscoring the pivotal role of size, aspect ratio, and morphology in influencing cellular uptake and toxicity mechanisms. Herein we also present how metallic and oxide metallic nanoparticles can trigger distinct toxicity pathways, with nanoparticle surfaces and their released ions contributing to adverse effects. In addition, the protein corona and complex cellular environments play critical roles in mediating nanoparticle interactions. Beyond acute toxicity, prolonged or repeated exposures raise new questions about potential subchronic and chronic impacts, including transgenerational effects. Thus, nanotoxicology is transitioning toward integrative frameworks incorporating 3D cultures, aiming to develop celular scaffolds for cell tissue engineering and detection. We presented herein the importance of combining insights from comparative 2D and 3D toxicity evaluations with emerging considerations of morphology, size, and surface chemistry to design safer nanomaterials and enable sustainable technological progress.

Ultimately, this holistic approach to nanotoxicology paves the way for innovative strategies that harmonize nanotechnology's promise with the complexities of living systems. This integrative approach offers a helpful strategy for understanding and optimizing cellular responses. This synergy ensures a safer path for groundbreaking nanotechnological innovations.

Keywords

Nanotoxicology, Spheroids, Cell culture, Biodetection, Cellular Scaffolds

Photonic Detection Platforms for Healthcare Technologies

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Abstract

Real-time sensing technologies utilizing colorimetric, fluorescent, and photonic cristal biosensors are poised to revolutionize the next generation of clinical and point-of-care applications, including in vitro diagnostics, wearable devices, and implantable technologies.

In this talk, Dr. Yetisen will explore recent advances in the development of real-time photonic biochemical sensors that provide quantitative insights into clinically relevant biomarkers. He will present findings from pilot clinical studies, highlighting the potential impact of these biosensors on healthcare. The talk will also cover smartphone-based spectrophotometer platforms designed to enable low-cost point-of-care medical technologies. Additionally, attendees will gain valuable knowledge about the commercialization of biosensors and medical devices, with an emphasis on innovative startup companies.

Keywords
Biosensors, Photonics, Biomaterials, Diagnostics, Point-of-Care Devices

Neural network classification of SERS spectra with engineered features for agrochemical detection

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Abstract
Surface-Enhanced Raman Spectroscopy (SERS) is a promising method for detecting agrochemicals, but its analysis can be complex and requires advanced computational tools. This work presents a machine-learning model based on a feedforward neural network for rapid and accurate classification of SERS spectra. The model uses a compact neural network and feature engineering trained using SERS patterns from experimental measurements. The spectra were acquired using gold nanostar substrates deposited onto aluminum foil via drop-casting. The model uses a compact two-layer architecture, with five Leaky ReLU neurons in the hidden layer and four softmax neurons in the output layer. The model optimizes input data by derived 20 key features from transformation functions applied to SERS spectra. The model achieves high precision and recall values across all classes, with an overall classification accuracy of 98.5% for organophosphate pesticides and their mixtures. This approach offers reduced computational complexity while maintaining or exceeding the accuracy of more complex models, making it suitable for deployment in resource-limited environments.

Keywords
Photonic nanosensors, SERS substrates, machine learning, neural network, agrochemicals identification, organophosphate pesticides, environmental monitoring

Quantum Machine Learning for Identification of Light Sources

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Abstract

The identification of light sources is fundamental for the development of multiple photonic technologies. Traditionally, this task has relied on statistical methods that require an impractical number of observations. However, in recent years, it has been demonstrated that the use of machine learning enables the distinction of light sources up to ten thousand times faster compared to conventional methods. This advancement is promising and paves the way for the development of new photonic technologies.

Nonetheless, another computational paradigm has gained significant interest in recent decades: quantum computing. This emerging field leverages the principles of quantum mechanics to overcome the limitations of classical computers. In this context, the problem of identifying light sources has an intrinsically quantum nature, making quantum computing a suitable tool for processing this type of data.

In this work, a quantum artificial neuron was designed and implemented to classify coherent and thermal light sources. This machine learning model was trained and evaluated under different computing schemes, both classical and quantum. The results show that the quantum version presents a slight advantage compared to its classical counterpart. It is important to mention that IBM provided computing credits for this thesis project under the project title *"Identification of light sources using quantum machine learning"*, granting the equivalent of a total of 12 hours of computing time on their quantum computers.

Keywords
Photonic technologies, Quantum computing , Machine learning, Coherent light, Quantum Technologies

Advances in the development of a cryogenic characterization system for CMOS devices down to 0.35 Kelvin

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Abstract

CMOS technology (Complementary Metal-Oxide Semiconductor) has traditionally been a fundamental pillar in the design and manufacturing of electronic circuits. Its widespread use in devices such as microprocessors and sensors are due to its high energy efficiency, scalability, and low production cost. Until now, these devices have been extensively studied and characterized at room temperature.

However, advances in science and technology have introduced new challenges that require moving beyond conventional models. In this context, a new paradigm emerges: the use of CMOS devices at low temperatures. This innovation paves the way for a range of advanced applications in cutting-edge technologies, such as on-chip spectrometers, atmospheric filters, and interferometry for astrophotonics, low-noise CMOS amplifiers for radio astronomy, early developments in control electronics for quantum technology, and various types of sensors based on CMOS technology. A common characteristic among these applications is their operation at cryogenic temperatures.

Working under cryogenic conditions allows for the exploration of physical properties that are not observable at room temperature. This includes the reduction of thermal noise, the optimization of energy performance, and the enabling of quantum phenomena that need to be studied in these environments.

In this work, we present the advancements of the cryogenic measurement system we have developed in our laboratory, which operates between 3.7 Kelvin and 0.35 Kelvin, as well as some results from measurements conducted on semiconductor devices and other samples.

Timely Risk Assessment in Infectious Diseases Management via High Throughput Diagnostics

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Abstract

Objectives: Rapid evaluation of the risks associated with the spread of infection diseases are pivotal. It requires global molecular surveillance strategies to support public health control.

Methods: Between April 2020 and February 2021, the UK Lighthouse Labs Network at Alderley Park tested more than eight million nose and throat swab samples for the presence of SARS-CoV-2, via PCR. The assay targeted three genomic regions of the virus, namely: N; Orf1ab; S. Whole-genome next-generation sequencing confirmed positive PCR results. Positive results were also tracked in real-time tracking (24-48 h sample turnaround) using the postal district origin of samples, to assess the spread of a new variant in the United Kingdom.

Results: In mid-November 2020, the assay identified an increasing number of S gene negative, N and Orf1ab positive samples. In parallel, whole-genome sequencing demonstrated that the loss of S gene detection was due to the appearance of a SARS-CoV-2 lineage (B.1.1.7) characterised by some key mutations, designated as Variant of concern (VOC) 202012/01. By the beginning of January 2021, the new SARS-CoV-2 VOC comprised 70% of daily positive samples tested and >98% by the end of February 2021.

Conclusions: The real-time tracking identified the rapid spread of the new SARS-CoV-2 variant across England in December. Coupling high-throughput diagnostics with real-time molecular epidemiology of an emerging variant is an important new tool to inform decision-making authorities for risk mitigation. A tool for the timely response to the emergence and spread of a novel variant, allowed it to be associated with the enhanced transmission and the assignment of the “Variant of Concernt” (VOC) 202012/01.

Future perspectives: The data acquired by centralised PCR diagnostic centres, required large resources to achieve 24-48 sample turnaround. Lateral-flow tests, coupled with a Mobile App could potentially be more cost-efficient and faster. Nanotechnology could enable infectivity assessment in saliva.

Keywords
Real-time tracking, Mass Testing, Public Health, Epidemiological Surveillance, PCR

Optimization of integrated coplanar waveguide resonators for superconducting qubits

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Abstract

Superconducting coplanar waveguide resonators (CPWR) are microwave devices compatible with integrated circuit fabrication technology and suitable for applications in areas such as astronomical instrumentation and quantum information. Their low losses and high quality factors are convenient for sensing, detection, and measurement schemes that typically involve the observation of small frequency shifts when these devices interact with external systems or excitations, allowing the development of kinetic inductance detectors, single-photon, phonon, and temperature sensors, scanning microwave microscopy arrays, circuit quantum electrodynamics schemes for quantum computing and the study of quantum systems, among others.

In this work, initial steps for the development of undercoupled and overcoupled CPWR with high quality factors are presented, including their design, simulation, fabrication, measurement, and modeling. Basic guidelines for the design of capacitively coupled CPWR in the transmission mode are discussed, followed by finite-element simulations of the devices considering various temperature conditions, different capacitive couplings, and dielectric and superconducting thin films with varying thicknesses. The impact of these conditions on the resonance frequencies and quality factors or the resonators is discussed. An RLC equivalent circuit model and a model based on transmission line theory are used to estimate the contribution of the loaded and unloaded quality factors and coupling capacitances. Finally, ambient temperature measurements of fabricated samples, simulations and models are compared. Observed differences between experimental and theoretical data are attributed to an imperfect photolithographic definition of the critical dimensions of the CPWR, pointing out the relevance of fabrication processes for integrated circuits operating in the microwave regime. The resulting devices display resonance frequencies and quality factors suitable for the forementioned applications, particularly for quantum computing. The simulations considering different materials and film thicknesses allow the identification of suitable structures for devices that will be fabricated and measured in superconducting conditions in the near future.

Keywords
Coplanar waveguide, transmission line resonators, superconductivity, quantum computing

Advancing Smartphone-Based Colorimetric Sensing: Bridging Precision and Practicality

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Abstract

Smartphone-based colorimetric (bio)sensors provide a cost-effective, accessible solution for analytical testing in healthcare, food safety, and environmental monitoring. However, a key challenge is their susceptibility to inconsistent lighting conditions, often necessitating bulky housings with controlled illumination that undermine their affordability, deliverability, and ease of use. This study presents an innovative framework that advances smartphone-based colorimetric sensing by optimizing color space analysis, enabling precise and reliable measurements without additional hardware, even under diverse lighting environments. We assessed the capability of smartphone-derived colorimetric models to quantify monotonal color gradients spanning a broad visible spectrum, comparing their performance to absorbance-based models derived from a benchtop UV-Vis spectrophotometer. Our results reveal that smartphone sensing matches absorbance models in accuracy, precision, and detection limits while offering a wider dynamic range—ideal for practical applications. Comparing RGB, HSV, and CIELAB color spaces, we identified the a* and b* chromatic coordinates of CIELAB as exceptionally robust against illumination variations. We introduce Equichromatic Surfaces as a new concept to explain their illumination resilience, providing a foundational guide for designing housing-free, illumination-invariant optical (bio)sensors. This research aids in bridging the gap between advanced colorimetric sensing and practical applications, laying the groundwork for scalable, accessible on-site sensing technology solutions.

Keywords
optical sensing, colorimetry, point-of-care, on-site testing

Electrical Characterization of an 80 MHz SAW Biosensor with AD8302 Digital Phase Comparator

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Abstract

Surface Acoustic Wave (SAW) transducers are widely used in the development of filters and sensors due to their ability to make use of the properties of piezoelectric materials. These materials are highly sensitive to changes in their environment, such as the presence of molecules on their surface, making them ideal for biosensor applications.
At high frequencies, electrical characterization of SAW transducers requires highly sensitive techniques and equipment, specifically vector network analyzers such as the E5071C ENA from *Keysight*. However, these devices are often complicated and expensive.
In this work, we present the use of an AD8302 board from *Analog Devices* to electrically characterize SAW transducers in a delay line configuration on a 64°Y-cut $LiNbO_3$ piezoelectric substrate at a frequency of 80 MHz. Phase and gain variations were measured in response to different concentrations of glycerol diluted in tri-distilled water. When applied as 1 mm diameter droplets on the sensing area, these solutions induced a signal change. Thanks to its logarithmic amplifiers, the board detected signals across a wide amplitude range, allowing the SAW transducers' response to be linearly expressed in voltage values ranging from 0 V to 1.8 V.
The SAW transducers recorded an attenuation of -0.43 dB when a water droplet was applied, corresponding to an output of 1.722 V. Subsequent measurements with varying glycerol concentrations, along with the board's linear behavior, allowed estimation of the SAW transducers' sensitivity by correlating electrical variations, attenuation and phase, at approximately ≈28.5 mV/dB.
Characterizing SAW transducers using accessible and efficient techniques, such as the AD8302 board, validates their potential for high sensitivity biosensing applications. This approach is cost-effective for high-frequency signal analysis and enables design optimization for miniaturization and portability. This will facilitate the transfer of devices to controlled laboratory environments for sample preparation, improving disease monitoring and diagnosis in specialized settings.

Keywords
surface acoustic waves, transductor, phase detector, electrical characterization

From 3D scaffold of carboxylated bacterial nanocellulose to sensor for mammalian cells

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Abstract

Sensors based on plasmonic materials have attracted considerable attention due to their ability to provide high-accuracy, real-time detection of mammalian cell molecules and biomarkers. Selecting an appropriate detection method is crucial to achieve the desired performance, considering factors such as concentration, detection range, and selectivity. Sensors developed so far for biomedical applications are typically based on rigid and bulky materials, which can cause changes in cells or tissues and, in turn, trigger an inflammatory response. Therefore, in this research, we propose the design of a sensor based on a 3D scaffold of carboxylated bacterial nanocellulose (BNC) functionalized with carboxylic acid groups (-COOH) using Deep Eutectic Solvents (DES). The 3D BNC-COOH scaffold was extensively studied and characterized by FTIR, SEM, XRD, AFM, TGA, and rheological analysis. Furthermore, we demonstrate that the 3D BNC-COOH scaffold promotes the adhesion, proliferation, and differentiation of fibroblasts cultured in a 3D array. These results make it a biocompatible platform for the detection of molecules from in vitro cell cultures. Ongoing research focuses on decorating the scaffold with metallic particles to develop a platform that allows for the detection of molecules excreted by mammalian cells through SERS.

Keywords
3D cell scaffolds, carboxylated bacterial nanocellulose, nanotoxicology

Acknowledgment:
Mavil-Guerrero thanks SECITHI for the scholarship (CVU:1057815) and the Nanotechnology Department (CFATA-UNAM) for offering financial support to carry out the research. SECITHI contributed funding via project CF-2023-G-348. The authors acknowledge Manuel Franco, Gerardo Fonseca, and Beatriz Millan for their technical assistance.

Amorphous Cobalt-rich hybrid trilayers for magnetic sensors

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Abstract

Over the last three decades, Magnetic thin film heterostructures have gained attention due to spin transport phenomena and magnetoresistance effect, with applications in spintronic devices and magnetic sensors. We present an experimental comparative study of magnetic and electrical properties of amorphous Co-rich (VITROVAC6030) layer interaction with VITROVAC6030, Permalloy, and Niquel layers. Leica EM MED020 DC magnetron sputtering was employed to deposit VITROCAC/Au/Magnetic layers on a silica glass substratum, varying the VITROVAC thickness on the substratum for 30 nm, 62 nm, and 125 nm; a spacer Au layer with 5 nm of thickness; and 30 nm of ferromagnetic layer at the top.

The X-ray diffraction study of the VITROVAC6030 mono layer reveals that we preserve the amorphous state. Magnetic studies were measured using a vibrating sample magnetometer (VSM) and a ferromagnetic resonance (FMR). The hysteresis loops show three different couplings due to the interaction of magnetoelastic anisotropy and magneto crystalline anisotropy dependent on VITROVAC thickness on the substratum. The electrical measurements were carried out by four-probe method, where the resistivity as a function of VITROVAC thickness on substratum exhibit different behavior as result of different magnetic coupling. A magnetoresistance effect was observed in VITROVAC/Au/VITROVAC trilayers under magnetic fields between -4 Oe and 4 Oe, demonstrating promising potential for low magnetic field detection.

Keywords

Magnetic thin films, Amorphous magnetic alloys, Magnetic sensors, Magnetoresistance.

Fabrication of V2O5/porous silicon heterostructures by simple and low-cost methods and their application as gas sensor.

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Abstract

This research presents the fabrication of heterostructures based on V2O5/porous silicon, their morphological, optical, structural, and electrical characterization, and their application as gas sensor. The fabrication of these heterostructures was by using simple and low-cost methods. The porous silicon layers were synthesized using the electrochemical anodization method and the V2O5 structures were obtained with the solvothermal method, in this step the heterostructures were fabricated. The morphological characterization showed the formation of pores, these pores showed quasi-circular and irregular shapes, an average diameter of about 1.4 µm, and a pore length of around 22 µm perfectly aligned. The morphology of the V2O5 structures showed two morphologies a combination of concentric nanosheets and nanobelts with a thickness between 50 and 100 nm and a length greater than 10 µm for one sample and hollow microspheres with a diameter of about 5 µm for the second sample. The micro-Raman spectra demonstrated the formation of the orthorhombic V2O5 phase due to the Raman signals reported in the literature. The optical characterization by photoluminescence showed main bands centered at 550 nm for the PS and 707 nm for the V2O5 structures. Diffuse reflectance spectra together with the Kubelka-Munk method allowed us to estimate the optical bandgap which was 1.5 eV and about 2.1 eV for porous silicon and V2O5, respectively. Finally, electrical characterization under dark conditions and under methanol gas environment which showed rectifying and ohmic behaviors for the heterostructures. Moreover, I-t curves were performed to demonstrate the application of these heterostructures as a gas sensor by applying methanol gas.

Keywords

Nanomaterials, Gas sensors, Porous silicon, V2O5

Spectral Coupling-Based Quantification of Proteins Using Upconversion Nanoparticles: A Direct Approach for Bioconjugation and Protein Corona Analysis

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Abstract

The quantification of proteins and their interactions with luminescent nanomaterials is essential for applications in biosensing, diagnostics, and biomedical imaging. Accurate assessment of protein adsorption onto nanoparticles is crucial for understanding bioconjugation efficiency and characterizing the formation of protein coronas, which influence nanoparticle behavior in biological environments. Conventional protein quantification methods, such as the bicinchoninic acid (BCA) assay, rely on colorimetric changes induced by protein interactions. However, these approaches may be affected by background interference and require previous extraction steps. In this study, a direct protein quantification methodology was developed based on the spectral coupling between the upconversion luminescence of $NaYF_4$:Yb,Er nanoparticles and the absorption spectrum of bicinchoninic acid. This approach enables the quantification of proteins either in solution or conjugated to the nanoparticle surface without requiring extensive sample preparation. The results demonstrate a linear detection range from 0 to 400 μg/mL, with a detection limit of 25 μg/mL. Additionally, this method provides a straightforward means of assessing nanoparticle surface coverage, facilitating the characterization of both soft and hard protein coronas. The developed technique offers a label-free, sensitive, and reproducible strategy for protein quantification in complex media. By leveraging the unique optical properties of upconversion nanoparticles, this approach minimizes autofluorescence and improves detection accuracy compared to traditional methods. These findings highlight the potential of upconversion luminescence as a direct tool for analyzing protein interactions with nanomaterials, paving the way for enhanced studies on nanoparticle bioconjugation, biomolecular sensing, and nanomedicine applications.

Keywords

Protein corona, protein quantification, biofunctional nanomaterials.

Development of Lanthanide-Doped Metal Oxide Nanoparticles with Induced Photothermal Activity in the Near Infrared Region

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Abstract

The synthesis of nanomaterials with tailored properties to enhance light-matter interactions and facilitate the conversion of light energy into thermal energy has attracted considerable interest in recent years. These materials have a wide range of applications, particularly in theranostics, where they can function as thermal biosensors. This study presents the hydrothermal synthesis of lanthanide-doped metal oxide nanoparticles, specifically Ytterbium-doped zirconia (ZrO_2), designed to achieve efficient photothermal conversion through the optimization of multiple structural and physicochemical parameters. These nanoparticles were characterized using X-ray diffraction (XRD), Raman spectroscopy, and transmission electron microscopy (TEM) to assess their structural and morphological properties. Then, their photothermal response under near infrared (NIR) excitation (975 nm) was systematically investigated. The results demonstrated significant photothermal conversion efficiency, which is modulated by key factors, including dopant concentration, particle morphology and size, and crystalline structure. The optimization of the doped metal oxide system holds great potential for enhancing quantum efficiency, thereby enabling the development of biosensors for the detection of specific biomarkers in biological fluids. The integration of these nanoparticles into biosensor designs is expected to improve their efficiency and sensitivity, allowing for the detection of localized temperature variations or the activation of biochemical reactions, depending on their functionalization. Simultaneously, the photothermal response could trigger an activatable therapeutic action in specific regions of the body, leading to the development of new theranostic tools.

Keywords

Photothermal nanoparticles, lanthanide-doped materials, theranostics, thermal biosensors, photothermal conversion.

Electrochemical Sensor Modified with Bimetallic Nanomaterial CuZn for Creatinine Detection

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Abstract

The application of bimetallic nanomaterials in healthcare has been relevant for the detection of biomarkers associated with various diseases, such as uric acid, dopamine, ascorbic acid, glucose, and creatinine, among others. Creatinine is a nitrogenous molecule known as a waste product from the transamination of arginine and glycine in the kidneys. Quantifying creatinine is necessary for noninvasive early and advanced-stage monitoring of patients with kidney damage. Copper is a malleable, inexpensive, and nontoxic metal. Therefore, it has been used to modify non-enzymatic sensors, but it oxidizes easily. Therefore, metals such as zinc have been used to stabilize copper. This project presents the design of an interesting electrochemical sensor modified with CuZn to detect creatinine in real saliva. The sensor was manufactured using the electrodeposition technique. The results indicate the formation of copper-creatinine complexes with a LOD of 2.05 uM, ideal for diagnosis in the early stages of renal failure. However, the performance of the electrochemical sensor was validated using clinical samples, where a strong correlation with conventional diagnostic techniques was shown, offering a rapid, low-cost, optimal, sensitive, and noninvasive alternative for medical diagnosis.

Keywords

Electrochemical Sensor, Bimetallic, Creatinine, Nanomaterial, Kidney damage

New non-enzymatic electrochemical urea sensor for potential integration in hemodialysis systems

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Abstract

The development of electrochemical sensors for urea detection is essential for real-time monitoring of renal function, particularly in hemodialysis treatments. In this work, a non-enzymatic electrochemical sensor based on nickel-manganese layered double hydroxides (NiMn-LDH) modified electrode was synthesized and evaluated for urea detection in complex matrices. The bimetallic NiMn material was selected due to its enhanced stability, improved selectivity, and lower operational cost compared to enzymatic and monometallic (bio)sensors.

The modified electrode was tested in potassium hydroxide (KOH) solutions and simulated body fluid (SBF) using cyclic voltammetry and chronoamperometry to assess its electrochemical performance. Selectivity was evaluated in the presence of common blood interferents such as ascorbic acid, glucose, and uric acid. The results demonstrated a limit of detection (LOD) of 8.30 mM, a limit of quantification (LOQ) of 27.7 mM, and a linear range (LR) of 2 mM in KOH. In SBF, the sensor exhibited a LOD of 0.583 mM, a LOQ of 1.94 mM, and a LR of 15 mM, while in SBF with a thickening agent to simulate blood viscosity, the LOD and LOQ were 0.582 mM and 1.94 mM, respectively, maintaining a LR of 15 mM. These values align with the normal blood urea concentration range (12-54 mg/dL) but, given the sensor's application in hemodialysis, it is designed to operate at higher concentrations. These findings suggest that the NiMn-LDH-based sensor is a promising candidate for integration into hemodialysis systems, providing a cost effective alternative for continuous urea monitoring. Future work will focus on optimizing the electrode design and validating its performance in clinical samples.

Keywords

Nickel, Manganese, LDH, Urea, Electrochemical sensor, Hemodialysis

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Bench-top fabricated nanostructured microelectrodes as functional electrochemical sensors of endothelial cells-derived nitric oxide

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Abstract

Electrochemical biosensors are ideal devices for addressing biomarker detection needs in various situations like clinical diagnosis and in vitro cell culture monitoring, with the advantage of being easily miniaturized and controlled, making them portable and accessible at the point-of-need. There are several standardized methods for the fabrication of electrodes arrays, which constitute the transduction elements of electrochemical biosensors. We implemented a bench-top accesible method to fabricate arrays of nanostructured gold surface microelectrodes. Briefly, a thin layer of gold is deposited on a masked prestressed polymer sheet via magnetron sputtering. The polymer sheet shrinks when introduced in a conventional oven, inducing the coalescent nanowrinkling of the gold layer on top, thus reducing its electrical resistance. Nanowrinkled electrodes can be then used for electrical or electrochemical applications or can also be transferred to flexible substrates like polydimethylsiloxane slabs. In this work, arrays of so-fabricated electrodes were validated as electrochemical sensors with enhanced sensitivity, due to a larger electrochemically active surface area (EASA) compared to commonly used planar electrodes. We applied them as amperometric sensors for nitric oxide (NO) monitoring in aqueous solutions, in particular we have been able to detect NO released by stimulated endothelial cells in the low micromolar range. We believe this rapid, low cost prototyping method will enable application-specific electrochemical biosensors to be created on-demand.

Keywords

Amperometric biosensor, Nanostructuring, Bench-top fabrication, OoC monitoring, Shear stress

Development and characterization of a semiconductor based on cellulose/Graphene-TiO_2 for gas detection

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Abstract

This work reports the development of a hybrid material with a polymeric matrix reinforced with a graphene-based system functionalized with titanium dioxide (TiO_2). A semiconductor material has been synthesized with potential applications in chemoresistive gas sensors. The detection mechanism is based on the interaction between the charge carriers of the gas and the sensor material, leading to a change in its electrical conductivity. The influence of both the presence and the quantity of hydroxyl groups on the material's surface was observed to be fundamental in this process. To evaluate the material's feasibility, chemical characterizations such as Raman and Infrared spectroscopy, as well as electrical tests like dielectric spectroscopy, have been performed to confirm its potential application in gas detection.

Keywords

Hybrid material, cellulose, graphene, TiO_2, gas sensor.

Enhancing Lycopene Detection in Tomatoes with Graphene Oxide-Enhanced Raman Spectroscopy and Deep Learning Techniques

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Abstract

The agroindustry has experienced significant growth in recent decades, driven by the need to improve food quality, ensure food safety, and reduce waste. Lycopene, a natural pigment found in fruits such as tomatoes, melons, and guavas, has gained prominence in this area. Accurate detection of lycopene is crucial for standardizing protocols, assessing ripening periods, supplying nutritional information, prolonging shelf life, and improving quality standards.

Conventional techniques for lycopene detection, such as high-performance liquid chromatography (HPLC) and gas chromatography-mass spectrometry (GC-MS), require extensive sample pre-conditioning, hence extending analysis time and complicating results. Furthermore, the availability and accessibility of such devices are often limited.

In contrast, Raman spectroscopy presents a practical technique, as it requires no extensive pre-conditioning and offers considerably reduced analysis times and costs. In recent years, the utilization of novel materials to enhance the efficacy of Raman spectroscopy has significantly risen. The use of materials like graphene oxide (GO) has shown a positive impact on analytics, improving the quality of obtained spectra and detection limits.

This study employed graphene oxide (GO) to reduce the autofluorescence generated by lycopene during Raman spectroscopy, alongside automated deep learning algorithms to analyze and interpret the spectra more effectively. The results demonstrated a notable improvement in spectral quality, showcasing a clearer representation of the characteristic lycopene bands, reducing autofluorescence, and increasing the Raman signals intensity.

In conclusion, the amalgamation of materials such as GO with computational techniques represents a significant advancement in lycopene detection using Raman spectroscopy, particularly in genuine samples like fruits and vegetables, hence generating new prospects for the agroindustry.

Keywords:

Lycopene, Raman Spectroscopy, Graphene Oxide, Fluorescence

Characterizing Laser-Matter Interaction, Particularly Laser-Induced Plasma Generation, for Industrial Applications

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Abstract

Characterizing laser-matter interaction, particularly laser-induced plasma generation, is essential for certain industrial processes. This work proposes a simple capacitive sensor based on the variation of electric field flux caused by the interaction between a laser-induced plasma and an external electric field. The objectives were to interpret the physical meaning of the signals obtained by the sensor and to correlate its parameters with those of the laser pulse (energy and duration). A parallel-plate capacitor was used in an electrical circuit with a high-voltage source. A plasma generated by nanosecond laser pulses perturbed the sensor's electric field, causing a voltage drop across a resistor. Theoretical analysis showed that the electrical signal reflects changes in the electric field flux, providing a physical interpretation of the phenomenon. Experimentally, the time integral of this variation allowed for determining the pulse duration up to its peak value. Additionally, within a defined range, the laser energy was estimated from the maximum variation in electric field flux. Unlike commercial sensors, the proposed sensor demonstrated dual functionality, simultaneously measuring energy and duration after proper calibration. It offers a robust and cost-effective solution for laser pulse diagnostics, with high potential for industrial applications. Its ability to measure multiple parameters in real time makes it ideal for applications such as laser drilling and micro-engraving, where precise pulse control is essential.

Keywords

Laser-induced plasma, Capacitive sensor, Electric field flux, Real-time measurement, Laser drilling

Development of 3D-printed microfluidic platforms inspired by human veins for mixing applications

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Abstract

The controlled mixing of substances in regulated environments is a key process in various disciplines such as medicine, chemistry, and pharmacology. In blood clinical analysis, reactions are induced to assess physiological responses; however, the conventional procedure for sample handling is exposed to significant risks, such as direct contact with blood, rapid coagulation of samples, and possible exposure to environmental factors.

This work presents the development of a lab-on-a-chip microfluidic device, which combines stereolithography and replica techniques with the polymer polydimethylsiloxane (PDMS) to design, manufacture, and characterize a microfluidic chip based on the structure and dimensions of human veins for substance mixing.

The geometry design is carried out in Inventor-Autodesk, followed by the creation of a 3D resin mold for subsequent replication using PDMS. Thisreplica is permanently bonded to a glass surface through air plasma and temperature treatment.

Using this methodology, chips with an area of 896 mm^2 can be created, featuring microchannels 500 µm in width and height. The geometry is inspired by venous distribution to induce turbulence and optimize the mixing technique.

For validation, a solution of glycerin, water, and red dye was used, with rheological properties like blood, such as density. The density of blood is 1.055 g/cm^3, while the glycerin-water mixture achieved a density of 1.161 g/cm^3. The results confirm the feasibility of the fabricated microfluidic chip to replicate blood mixing conditions in a time of 65.4 s, reducing the drawbacks of conventional methods and offering pressure values that do not exceed human central venous pressure, which ranges from 2 mmHg to 8 mmHg, while keeping the pressure within the microchannel below 0.25 mmHg to avoid stressing blood cells.

This development represents an advancement in portable devices for bioanalysis studies and clinical diagnostics, enabling more precise and reproducible experiments with minimal handling of biological samples.

Keywords

lab-on-a-chip, mixing, stereolithography, microfluidics.

Design and synthesis of core-shell upconversion particles for optical trapping and imaging applications

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Abstract

Optical tweezers are a powerful tool that utilize highly focused laser beams to trap and manipulate microscopic particles with nanometer-scale precision. By exerting radiation forces on dielectric materials, optical tweezers enable non-contact control of single particles, making them invaluable in fields such as biophysics, materials science, and nanotechnology. Thereby, the integration of luminescent materials with optical tweezers could enhance their functionality by allowing simultaneous trapping and optical detection, opening new possibilities for real-time tracking, sensing and imaging applications. In this work, $NaYF_4$:Yb,Er upconverting nanoparticles (UCNPs) were synthesized and embedded into SiO_2 shells, yielding spherical hybrid materials with average size of 870 nm ± 93 nm, making them suitable for optical trapping experiments. When introduced those UCNPs SiO_2 into the optical field of a focused laser beam, the particles experienced radiation forces that directed them toward the beam waist. At this focal point, a sudden flash of green light confirmed the material's upconversion luminescence. Furthermore, at sufficiently low laser power, individual particles were stably trapped and manipulated within the optical tweezers. Therefore, this study demonstrates the feasibility of stable optical trapping while simultaneously detecting luminescence from the trapped particles. The developed material holds potential as a contrast agent in biological experiments, enabling real-time tracking of trapped particles, and the development sensors that can be directed toward specific regions in confined environments. Moreover, the developed setup allows particle detection without requiring precise knowledge of the laser beam's position, simplifying experimental procedures in optical manipulation and imaging.

Keywords

Upconverting nanomaterials, Optical Tweezers, Optical trapping.

Photonic Hydrogels: Mechanical Densification as a Key to Tunable Optical Properties for strain sensors

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Abstract.

The integration of photonic crystals into hydrogels has led to the development of photonic hydrogels, materials whose optical properties can be modulated by physical (e.g., mechanical deformation) or chemical stimuli (e.g., exposure to salts). This emerging class of materials holds great promise for next-generation stretchable devices capable of detecting physiological variables such as movement and sweat. Cellulose nanocrystals (CNCs) can spontaneously self-assemble into a cholesteric phase, where the periodic arrangement of stacked CNC layers produces characteristic birefringence. In this work, we demonstrate that mechanical densification of polyvinyl alcohol (PVA)/CNCs hydrogels modifies the interlayer spacing of the CNCs, thereby tuning the birefringence response of the material. The effectiveness of this approach was validated by applying densified hydrogel composites as strain sensors. Mechanical deformation of the hydrogels induced measurable changes in their birefringence, enabling optical detection of strain. Compared to conventional PVA hydrogels, the developed composites exhibit a broader and tunable light-response range, expanding their potential for use in advanced optical strain-sensing applications

Keywords

Photonic hydrogel, cellulose nanocrystals, polyvinyl alcohol, densification, birefringence.

Structural test of a wing aircraft using Fiber Bragg Gratings sensors

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Abstract

This work reports the in-situ instrumentation of a Cessna 182 aircraft wing by Fiber Bragg Gratings sensors. First, CFD analysis was carried out to estimate the aerodynamic reaction on a specific flight configuration. Then, FEM numerical simulations were practiced to identify anchor points, critical stress zones, and wing displacements to optimize the test bench configuration. The aircraft wing was set on cantilever configuration, with one hydraulic actuator to apply the load. Micron Optics® si155 Standard 1400 interrogator and nine (9) os1100 FBG sensors were used for experimentation to monitor strain all along the wing during test. After collecting and processing the data, comparison with the numerical results was made to verify the correct simulation/test correlation. Overall, for all the results, the general trend is consistent; as the displacement increases, the strain also increases. Indeed, the greater the displacement, the greater the stresses exerted on the wing, which leads to greater deformation, clearly visible at the wing-root.

Applications of the SPR System in the Development of Early-Stage Cancer Biosensors: Pancreas and Lung

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Abstract

Lung cancer remains the leading cause of cancer-related deaths, while pancreatic cancer presents challenges in early diagnosis. Traditional diagnostic tools like ultrasound, MRI, and biopsies are insufficient for detecting cancer at its earliest stages, as they focus on the tumor's visible characteristics rather than its underlying biology. In this study, we applied computational modeling (Docking Simulation and Molecular Dynamics) to analyze lung cancer biomarkers and identify the most promising ones based on their binding energy. For early detection of pancreatic ductal adenocarcinoma (PDAC), we focused on epigenetic mRNA biomarkers such as Glypican-1, overexpressed in early disease stages, and miRNA-206, which suppresses tumor growth and migration. In lung cancer, key KRAS mutations (G12C and G12V) associated with tobacco carcinogens were identified. To enhance detection specificity, we used CRISPR (dCAS13a and dCAS9), aptamers, and ssDNA probes to create selective biological receptors. For high-sensitivity detection, we will employ surface plasmon resonance (SPR) in phase interrogation mode, known for its superior signal-to-noise ratios and real-time analysis capabilities. This SPR-based biosensor will be integrated into a rapid, ultra-sensitive cancer detection system.

Keywords

Early Cancer Detection, Computational Modeling, Epigenetics Biomarkers, CRISPR, Plasmonic Biosensor.

Breath Analysis using Surface-Enhanced Raman Spectroscopy

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Abstract

Breath analysis (BA) is a non-invasive and rapid diagnostic tool that detects volatile organic compounds (VOCs) in exhaled air, providing information on physiological and pathological processes. However, the low concentrations of these biomarkers (in parts per billion or trillion) require highly sensitive and specific analytical methods. Surface-Enhanced Raman Spectroscopy (SERS) has emerged as a promising technique for this purpose, due to the amplification of the Raman effect using metallic nanoparticles, enabling precise detection and differentiation of biomarkers in complex matrices such as breath. SERS has revolutionized medical diagnostics by enabling the early detection of diseases such as cancer, diabetes, and respiratory infections, offering a faster and less invasive alternative. The integration of SERS with portable systems and artificial intelligence algorithms has further enhanced its accuracy and clinical applicability. An overview on this exciting field will be offered in this poster.

Keywords

Point-of-care, Nanophotonics, Molecular sensors, Vibrational spectroscopy, Functional materials

Application of Aggregation-Induced Emission as a Tool for Protein Detection and Quantification

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Abstract

The detection and quantification of proteins plays a crucial role in biomedicine, clinical diagnostics, and research. However, current techniques present limitations in terms of equipment, cost, and complexity. Aggregation-induced emission (AIE) is a novel photophysical phenomenon in which specific fluorophores, known as AIEgens, exhibit enhanced fluorescence upon aggregation. This characteristic provides high sensitivity and resistance to quenching effects, making AIE an ideal mechanism for biosensor development. A critical overview on this emerging field will be offered in this poster.

The detection and quantification of proteins plays a crucial role in biomedicine, clinical diagnostics, and research. However, current techniques present limitations in terms of equipment, cost, and complexity. Aggregation-induced emission (AIE) is a novel photophysical phenomenon in which specific fluorophores, known as AIEgens, exhibit enhanced fluorescence upon aggregation. This characteristic provides high sensitivity and resistance to quenching effects, making AIE an ideal mechanism for biosensor development. A critical overview on this emerging field will be offered in this poster.

Keywords

Biosensors, Biomedical Diagnostics, Aggregation-Induced Emission, Protein detection, fluorescence.

1DZnO nanowires as a biodetection platform for identifying Salmonella Typhimurium.

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Abstract

Nanobiotechnology serves as a versatile tool, functioning in a multidisciplinary context across various sectors, with particular emphasis on medicine and identifying infectious agents, among the most significant fields in contemporary research. This study focuses on applying one-dimensional ZnO nanostructures grown by the Vapor-Liquid-Solid (VLS) technique with the assistance of a catalyst metal as a detection platform for Salmonella Typhimurium. The immobilization strategy employed for anti-Salmonella antibodies (the bioreceptor) facilitates detection within five minutes without necessitating extended contact enrichment times, subsequently enabling reduced processing durations that enhance the capacity for analyses while conserving resources. The characterization of the nanostructures was conducted employing Fourier Transform Infrared Spectroscopy (FTIR), X-ray diffraction (XRD), and Scanning Electron Microscopy (SEM), which indicated high homogeneity, characteristic signals of the stretching bond (Zn-O), and the crystallographic planes about the wurtzite-type structure. Furthermore, as part of a verification strategy, following successful detection, the samples underwent an Enzyme-Linked Immunosorbent Assay (ELISA) in situ, confirming that the nanostructures do not interfere with the overall efficacy of the verification technique. Additionally, a concentration sweep ($1x10^6$-$1x10^1$) was conducted to validate the sensitivity of the proposed methodology by simultaneously implementing an optical technique as a verification tool, enabling the observation of changes as a function of CFU/mL concentration.

Keywords

1DZnO, Salmonella, Detection, VLS, Biodetection

Efficient One-Step Immobilization of DNA Probes on 1DZnO Nanoplatforms Targeting a Low-Mutation Region of SARS-CoV-2

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Abstract

Fabricating cost-effective biosensors with rapid response times is highly desirable during pandemic scenarios, where accuracy, swift detection, and portability are crucial for making prompt decisions. The design and conceptualization of these devices at early stages are critical for enhancing their output responses. In this work, we implemented 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 select a highly conserved region (L28-A36) among SARS-CoV-2 subvariants using bioinformatic analysis. Theoretically, phosphate groups from DNA have been associated to the binding affinity over ZnO surface, which is important to verify between the DNA/ZnO interface. We performed experiments to evaluate the adsorption behavior of DNA probes to obtain suitable DNA immobilization efficiencies. Hence, immobilization and target detection were confirmed by FTIR, photoluminescence (PL), transmission electron microscopy (TEM), and elemental mapping, corroborating the adsorption of DNA across the entire 1DZnO surface. Intense peaks related to C-C, C=C, C=N, P-O, and N-H were identified as the most important by FTIR characterizations, whereas PL showed a distinctive shift in Deep Level Emission band (DLE) between 520- 530 nm, with a partial quenching of the Near Band Emission signal, obtaining as well variations in the calculated bandgap. In summary, it is suggested that structural oxygen vacancies of 1DZnO nanoplatforms provide a significant proportion of active available sites for an easy and strong interaction with the phosphate backbone of DNA, enhancing physical adsorption. Furthermore, molecular validation by PCR confirmed the long-term stability of immobilized DNA probes, probing their suitability for further biosensing devices.

Keywords

SARS CoV-2, 1DZnO, DNA, adsorption, stability

Dual-Emission Hybrid Upconversion Nanoparticles decorated with Gold Nanoclusters for Advanced Photonic Nanosensors

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Abstract

Hybrid systems combining upconversion nanoparticles (UCNPs) with gold nanostructures have attracted significant attention for their potential in developing advanced photonic sensors. These hybrid materials leverage resonance energy transfer (RET) mechanisms to enhance sensor sensitivity and functionality, particularly in biomedical applications. Additionally, bimodal materials that exhibit both upconversion and downconversion emission properties are valuable for developing dual response nanosensors or improving selectivity in auto-calibrated strategies, offering versatile detection capabilities. In this study, a novel method was developed to synthesize UCNPs decorated with gold nanoclusters on their surface. The process involved three steps: i) thermal decomposition of the UCNPs, ii) ion exchange between lanthanides and gold ions, and iii) growth of the gold nanoclusters. The formation of gold clusters (1.5 to 2 nm) was optimized by heating the reaction mixture to 50°C for 1 hour. This treatment modulated both the upconversion emission of the UCNP cores and the downconversion emission from the gold clusters. Upconversion emissions in the green and red regions were verified using steady-state fluorescence spectroscopy and lifetime analysis upon excitation at 975 nm, while visible downconversion emission at 650 nm was observed upon excitation at 350 nm. The ability to control both upconversion and downconversion emissions enhances the sensitivity and versatility of sensors for detecting biomedical analytes. The hybrid UCNP-AuNC system enables the development of turn-on/off sensors based on the unique luminescent properties of the materials. These dual-emission materials improve photonic nanosensors by increasing versatility, and the ability to detect multiple analytes simultaneously. They also reduce background interference, enable real time, non-invasive monitoring, and are compatible with existing techniques, making them ideal for advanced biosensing and diagnostic applications.

Keywords:

Upconversion Nanoparticles, Gold Nanoclusters, Dual Emissions,

A turn-on luminescence and wavelength shifting dual-mode sensor for the determination of 2,4-pentanedione based on Schiff base formation with amino-terpyridine derivatives

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Abstract

2,4-pentanedione, also known as acetylacetone (AcAc), is a versatile organic compound found in various natural and engineering processes. In this work, we synthesized 4'-(4-N aminoethylenephenyl)-2,2':6',2''-terpyridine (TpyPhEDA) and conducted a comprehensive investigation of its structural and photoluminescent properties, emphasizing its application as a sensor for AcAc and the elucidation of the detection mechanism. The analytical response was initially assessed in various common organic solvents and ketones of different chemical nature, demonstrating a selective response for AcAc. This response was characterized by rapid reaction kinetics, enhanced emission intensity, band broadening, shortening of emission lifetime, and a shift in the emission wavelengths with increasing concentrations. This behavior is primarily driven by the Schiff base formation between TpyPhEDA and AcAc, involving a tautomeric equilibrium, as demonstrated by Nuclear Magnetic Resonance (NMR) and Density Functional Theory (DFT) calculations. Consequently, the resulting Schiff base is stabilized in its keto-enamine form, and its charge density distribution demonstrated through molecular electrostatic potential surface (MEPS) facilitates intramolecular charge transfer (ICT), enhancing both emission intensity and wavelength shifting. After optimizing the analytical parameters, a second-order polynomial relationship was identified between the integrated emission area and AcAc concentration, providing a highly robust and selective sensor suitable for applications related to industrial safety and environmental analysis.

Non-destructive testing based on the integration of terahertz technology and artificial intelligence

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Abstract

Terahertz (THz) technology is an emerging field with numerous applications in areas such as testing and quality inspection in the industrial sector. This work presents the development and characterization of a THz imaging system based on a frequency-modulated continuous wave (FMCW) radar, as well as its limitations and advantages. The proposed system contains a radar acting as the THz source and a set of lenses, designed and manufactured, whose focal length was subsequently characterized. The object under study is scanned, and the acquired signals are used for image reconstruction. The spot size and two practical cases were analyzed: a 1951 USAF resolution test chart and a box of pills. Preliminary results demonstrate the system's capability to generate THz images of objects such as packaged goods. These preliminary results highlight the effectiveness of the method in extracting features in different practical cases and in generating databases for further analysis. The collected data can be used to train artificial intelligence algorithms for detecting defects in materials or for achieving super-resolution imaging.

Keywords

THz technology, THz imaging system, FMCW radar, Artificial Intelligence.

Lipid-Coated Gold Nanoparticles for Plasmonic Detection of Tuberculosis-Associated Antibodies

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Abstract:

With over ten million individuals contracting tuberculosis (TB) annually, and nearly 3 million cases remaining undiagnosed, the development of label-free screening methods stands as a critical global health imperative. Leveraging the optical properties and appropriate biofunctionalization of gold nanoparticles (AuNPs), we herein detail the creation of a plasmonic system geared towards detecting TB-associated antibodies. The process involved synthesizing and modifying AuNPs to present antigenic lipid glycans from bacteria responsible for TB. Through straightforward self-assembly techniques, mycobacterial phosphatidylinositol mannoside (PIM)-containing unilamellar liposomes were formed and supported to gold surfaces using thiol chemistry. Comprehensive physicochemical characterization of the resulting nanostructures was conducted, employing techniques such as transmission electron microscopy (TEM), dynamic light scattering (DLS), zeta potential (ζ), and infrared spectroscopy (FT-IR). The functional hybrid nanoparticles exhibited shifts in Localized Surface Plasmon Resonance (LSPR) of up to 3 nm upon interaction with specific antibodies, demonstrating their capability for optically transducing antigen-antibody reactions. Furthermore, the system's practical utility was validated through the analysis of 12 human samples, including seven cases of pulmonary TB. Notably, this study presents the inaugural biomimetic nanogold-lipid system utilizing lipids as immunosensing reagents for plasmonic TB detection and diagnosis.

Keywords: Tuberculosis, Bioactive lipids, Immunosensing, Localized Surface Plasmon Resonance, Gold Nanoparticles.

The authors thank the excellent technical assistance from Lourdes Palma (INB, UNAM), Luz María Avilés (CINVESTAV- IPN Campus Querétaro), and the Microscopy and Spectroscopy settings at the National Laboratory for Materials Characterization (LaNCaM)-CFATA, UNAM. A.H.B. is a doctoral student from the Programa de Doctorado en Ciencias Biomédicas, Universidad Nacional Autónoma de México (UNAM), and has received SECIHTI fellowship 710525. Donation of serum samples by COESIDA/CAPASITS, Oaxaca, is greatly appreciated.