8TH INTERNATIONAL SYMPOSIUM ON DIELECTRIC MATERIALS AND APPLICATIONS (ISYDMA'8)

https://isydma8.sciencesconf.org/

ORLANDO, FL, USA, MAY 12-16, 2024

CONFERENCE CHAIR:

Prof. Dr. Ashok Vaseashta
International Clean Water Institute, Manassas, VA USA
Academy of Science of Moldova, Chisinau, Moldova

ISyDMA'8

ORGANIZED BY

INTERNATIONAL CLEAN WATER INSTITUTE
APPLIED RESEARCH DIVISION, MANASSAS, VA USA

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CONFERENCE VENUE

Holiday Inn & Suites Across From Universal Orlando
5916 Caravan Ct, Orlando, FL 32819, USA

ISyDMA'8

CITY OF ORLANDO

May 12, 2024

As Mayor of the City of Orlando, I am happy to help welcome you to our community for the International Symposium on Dielectric Materials and Applications (ISyDMA'8). It's wonderful that this event is being held in Orlando and that researchers and practitioners from around the globe are coming together to learn, share and connect.

Orlando is vibrant, inclusive and welcoming. During your time here for the symposium, I invite you to explore our community, which has so much to offer visitors.

I am certain that you know about our world-class theme parks and attractions, which are places where imagination becomes reality. But you may not know that Orlando is also filled with authentic experiences. I am proud of our city's arts and cultural offerings, always growing and diverse food scene, recreational amenities, sports events and thriving small business districts that are located throughout our community.

There's something for everyone in Orlando, giving you endless possibilities to have fun and create unforgettable memories.

I hope that you find the event rewarding and can also create opportunities to enjoy some of the many experiences that help make Orlando unbelievably real.

Sincerely,

Buddy Dyer
Mayor

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Book of Abstracts

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Preface

The ISyDMA conference is an international event focused on recent developments in dielectric materials and their applications. It is aimed at PhD students, post-docs, researchers, and engineers from public and private research organizations concerned with innovations in advanced dielectric materials for biomedical, biotechnological, and industrial applications. The conference is aimed at materials specialists, physicists, chemists, biologists, and engineers engaged in fundamental and applied research on dielectric materials and their innovative applications.

ISyDMA is open to a large scientific community since it brings together between 150 and 200 researchers and industrialists of 20 to 25 different nationalities. This is the 8th edition, with the previous having taken place in Kenitra and Rabat (Morocco) in 2016, in Bucharest (Romania) in 2017, in Beni-Mellal (Morocco) in 2018, in Amman (Jordan) in 2019 and in virtual mode in 2020 due to the health context. ISyDMA'6 was organized in 2022 in person and virtually, as conferences, oral communications, and poster sessions. ISyDMA'7 was organized primarily online, to accommodate the influx of people from Ukraine due to regional conflict. After much consideration and discussion, ISyDMA'8 was planned to be hosted in Florida, USA. The location would bring friends and families together to enjoy a few days of new ideas while having the opportunity to visit Orlando and its world-famous nearby attractions. In addition to several attractions, there are many fine restaurants on the International Drive that the conference attendees may wish to visit. The conference site also offers a full-service restaurant, swimming pools, and a fully equipped gym with a wide range of activities.

Furthermore, to promote scientific collegiality, it is expected that all participants maintain the spirit of collective friendship and mutual respect. Florida is full of reservations and hence all Cultural identities must be acknowledged, celebrated, and respected. to preserve the tradition. In addition, consistent with green initiatives, collectively, it is expected to conserve, reduce wastage, recycle plastics and paper, and keep the surroundings as clean as possible.

Disclaimers: The abstracts are published with minimal editing and are not checked for similarity. The editor does not assume any responsibility for the content. Also, the opinions expressed are those of the authors and do not necessarily align with those of editors and/or sponsors. Lastly, the editors and sponsors do not promote any commercial product, that may be mentioned in the abstracts.

For the ISyDMA'8 committees

Ashok Vaseashta

Prof. Dr. Ashok Vaseashta, Acad.
Manassas, VA USA
Chairs of ISyDMA'8

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- University Sultan Molay Slimane Faculty of Sciences et Technics Beni Mellal, Morocco
- University of Bucharest, Romania
- Academy of Sciences, Chisinau, Moldova

Scope and Topics

Presentations cover a broad range of topics from basic to applied sciences related to major issues such as energy, environment, biotechnology, electronics, and optoelectronics. The presentation organized in four sections will focus on the following topics:

Section 1: Dielectric materials for electronics and photonics

- Dielectric, piezoelectric, pyroelectric, ferroelectric, and multiferroic materials
- Ceramics, thin films, polymers, glasses, composites and nanostructures
- Impedance spectroscopy to electrochemical and dielectric phenomena
- Dielectric properties, polarization phenomena, and applications
- Surface and interfacial phenomena
- Physics of space charge in non-conductive materials
- Space charge and its effects on dielectrics
- Advanced characterization
- Modeling and Theory
- Applications of multiferroics

Section 2: Applications of insulators

- High voltage insulation design using computer; based analysis
- Partial discharges in insulation: detection methods and impact on aging
- Monitoring and diagnostic methods for electrical insulation degradation
- Electrical insulation in high-voltage power equipment and cables
- Ageing, partial discharges, and life expectancy of HV insulation
- Electrical conduction and breakdown in dielectrics liquids
- Gaseous electrical breakdown and discharges

Section 3: Dielectric devices for biotechnological and industrial applications

- Biodielectrics for environmental applications and bioengineering systems
- Biomedical engineering
- Tunable microwave devices
- Electrical energy storage, supercapacitors, electrostatic capacitors, electrolyzers, batteries
- Electrical energy generation, Solid Oxide Fuell Cell
- Nanodielectrics for Industrial applications
- Dielectrics for superconducting applications
- Measurement techniques
- Electrocaloric materials, Thermoelectrics, Photovoltaics

Section 4: Emerging materials and devices

- Metamaterials
- Nanocomposite dielectric polymers
- New diagnostic applications for dielectrics
- New and functional dielectrics for electrical systems
- Topological insulators
- Composite materials
- Other related dielectric phenomena and techniques.

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Detailed Conference Program

Session ID	Time	Details (subject to change - an updated version will be posted during the first week in May)	Speaker	Location
		May 12, 2024 - Day 0: Arrivals: Holiday Inn Across from Universal, 5916 Caravan Ct | Orlando, FL 32819		
Registration	16:00 - 20:00			Corridor
	18:00 - 20:00	Light reception and networking		Foyer/pool
		May 13, 2024 - Day 1		
Breakfast	7:00 - 9:00			TGIF
Registration	8:00 - 10:00	Setting up poster Group 1		Corridor
	8:45 - 9:30	Opening of the ISYDMA'8: Conference Co-Chairs		Ballroom
		Opening Remarks: Prof. Achour, Prof Mabrouki, Dr. Boukheir, Prof. Popov, Prof. Touahni and Prof. Tenne		
		Logistics and Operations: Prof. Vaseashta		
Keynote 1	9:30-10:30	Chairs: Vaseashta, Popov		Ballroom
KN1	9:30 - 10:00	Inorganic nanotubes: From WS2 to "misfit" layered compounds	Prof. Tenne	
KN2	10:00 - 10:30	Designing polymer systems with enhanced dielectric response	Prof. Bobnar	
Coffee/Tea	10:30-11:00	Coffee Break, ISYDMA'8 Cake and group photo		Corridor or pool
Invited 1	11:00 - 13:00	Chair: Balazsi, C., Petkov		Ballroom
IS1	11:00 - 11:20	Enhancement of room temperature magnetoelectric coupling in Na 0.5 Bi 0.5 TiO 3 –BaFe 12 O 19 based flexible polymer film	Prof. Phanjoubam	
IS2	11:20 - 11:40	Enhancement of ferroelectric, dielectric and electrocaloric properties in relaxor ceramics through processing-related microstructural features	Dr. Rozic	
IS3	11:40- 12:00	Nanocomposite Ceramics for Novel Biomechanical Energy Harvesting and Dielectric Cooling	Prof. Kutnjak	
Stretch break				
IS4	12:10 - 12:30	Exploring dielectric properties of TiO2 Co-Doped with Nb and Mg for energy storage	Dr. Soreto	
IS5	12:30 - 12:50	Structural Characterization of Gd-Doped Ceria Powders and Ceramics: A Comprehensive Study of Composition and Thermal Treatment Effects	Prof. Petkova	

Lunch	**13:00 - 14:30**	**5 minutes walk to Miller House**		**Miller House**
OL1	**14:30 - 15:00**	Broad band dielectric spectroscopy - challenges and results	Prof. Banys	**Online link**
Keynote 2	**15:00 - 16:00**	**Chairs: Phanjoubam, Mabrouki**		**Ballroom**
KN3	**15:00 - 15:30**	Carbon Nanophases in Silicon Nitride	Prof. C. Balazsi	
KN4	**15:30 - 16:00**	Diamond Photonic devices	Prof. Popov	
Invited 2	**16:00 - 17:30**	**Chairs: Kotru, Petkova**		**Ballroom**
IS6	**16:00 - 16:20**	Pressureless Post-sintering on the Hot Isostatic Pressed Alumina Prepared from the Oxidized AlN Powder	Prof. K. Balazsi	
IS7	**16:20 - 16:40**	Carbon Dots: New Fluorescent Nanoparticles for Advanced Optical Application	Prof. Striccoli	
IS8	**16:40 - 17:00**	Intermediate phase glasses of the As-S-Ge ternary: self-organization, properties and applications in programmable metallization cells	Prof. Tsiulyanu	
Stretch break	**17:00 - 17:10**			
IS9	**17:10 - 17:30**	Study of thermoelectric Bismuth Chalcogenides	Prof. Petkov	
Speakers I	**17:30 -18:10**	**Chair: Boukheir, Oueriagli**		**Ballroom**
SP1	**17:30 - 17:40**	Advancements in Carbon Fiber 3D Printing for Energy Research	Dr. Palwai	
SP2	**17:40 - 17:50**	Synthesis and developing a new Mn1-xCuxMoO4 inorganic chromophores by using sol-gel method and exploring their properties	Ms. Moukhfi	
SP3	**17:50 - 18:00**	Hygrometric Investigation of the Influence of Cadmium, Magnesium, and Ferric Ions on the Thermodynamic Activities of Phosphoric Acid Solutions at T=333.15 K	Mr. Makka	
SP4	**18:00 - 18:15**	Experimental investigation of electrical properties of BaSrTiO3/α-Fe2O3 compounds for storage energy	Prof. Jomni*	
Poster I	**10:00 - 18:10**	**Chairs: Soto, Palwai**		**Easles**

PO1	**Poster 1**	Structural, optical and electrical characteristics of of kesterite (CZTS) for Solar Cells Applications	Dr. Nkhaili
PO2	**Poster 2**	Effects of La dopant on diffused ferroelectric phase transition and electrical properties of lead-free SrBi2Ta2O9 ceramics	Dr. Belhimira*
PO3	**Poster 3**	Study of the efficiency of layered double hydroxide-based corrosion inhibitors on mild steel in chemical pickling in HCl medium	Mr. Salim Ayoub
PO4	**Poster 4**	Experimental and computational studies of crystal violet removal from aqueous solution using sulfonated graphene oxide	Dr. Oluwasina
PO5	**Poster 5**	Dielectric Spectroscopy of melt-extruded polypropylene carbon nanofiber composites	Dr. Samir*

RF1	**18:00 - 18:15**	**Rapidfire presentations**	

Day 1: Concludes and Dinner on your own

May 14, 2024 - Day 2

Breakfast	**7:00 - 9:00**			**TGIF**
Registration	**8:00 - 10:00**	**Setting up poster Group 2**		**Corridor**
Keynote 3	**9:00-10:20**	**Chairs: Jouiad, Silva**		**Ballroom**
KN5	**9:00 - 9:30**	Magneto-polaron effects on resonant Raman scattering in transition metal dichalcogenides	Prof. Fomin	
KN6	**9:30 - 10:00**	Heat-Assisted Ferroelectric Reading for High Speed Scanning Nonlinear Dielectric Microscopy Ultrahigh-Density Ferroelectric Data Storage	Prof. Cho	
IS10	**10:00 - 10:20**	Microstructural Investigation of Polarization and Domain Structures in Piezoelectric Films Using Scanning Nonlinear Dielectric Microscopy	Prof. Ogadawa	
Stretch Break	**10:20- 10:30**			
OL2	**10:30 - 10:45**	Synthesis and Characterization of Metal-based Materials for Opto-electronic Applications	Dr. Al Balushi	Online Link
	10:45 - 11:00	Synthesis characterization and performance of tetrafunctionnal epoxy resin as a potential anticorrosion protection for mild steel in 0.5 M H2SO4 solution. Computational approaches	Dr. Hsissou	
Invited 3	**11:00 - 13:00**	**Chair: Cho, Fomin**		**Ballroom**
IS11	**11:00 - 11:20**	Laser-power dependence effects on the structural stability of nanocomposite catalysts studied by Raman spectroscopy	Dr. Silva	
IS12	**11:20 - 11:40**	Effects of 1D and 2D nanomaterials on Dielectric Relaxation and AC Conductivity in PVA Based Nanocomposites: A Havriliak-Negami Fitting Approach	Dr. Dey	

1S13	**11:40 - 12:00**	Lead-free ferroelectric materials for high temperature Energy storage capacitors	Prof. Lahmar	
Stretch break				
IS14	**12:10 - 12:30**	Suppression of higher acoustic harmonics via a metastructure for nondestructive evaluation of dielectric materials	Prof. Choi	
IS15	**12:30 - 12:50**	New functions of a semiconductor photodetector with a high-resistivity layer	Prof. Khudaverdyan	
Lunch	**13:00 - 14:30**	**5 minutes walk to Miller House**		**Miller House**
OL3	**14:30 - 14:45**	The Effect of Pollution on High Voltage Power Line Insulators	Prof. Hamouda	**Online Link**
OL4	**14:45 - 15:00**	m-GGA Calculations of the Optical and Electronic Properties of Pristine and N-doped pentagraphene	Prof. Villagracia	**Online Link**
Keynote 4	**15:00 - 16:00**	**Chairs: Petkov, Fasquelle**		**Ballroom**
KN7	**15:00 - 15:30**	Enhancement of Energy Storage Performance in Lead-Free Ferroic materials	Prof. Marssi	
KN8	**15:30 - 16:00**	Measurements of thermal diffusivity using atomic force microscopy	Prof. Mabrouki	
Invited 4	**16:00 - 17:00**	**Chairs: Kotru, Petkova**		**Ballroom**
IS16	**16:00 - 16:20**	Lanthanum-Doped Lead Zirconate Titanate Films for UV Sensing Applications	Prof. Kotru	
IS17	**16:20 - 16:40**	3D Printed Microwave Absorber	Dr. Le Sage	
IS18	**16:40 - 17:00**	Zeolite-modified electrodes for electrochemical sensing: Surface and Interfacial Phenomena	Prof. Idoulhi	
Speakers 2	**17:00 -18:10**	**Chair: Boukheir, Oueriagli**		**Ballroom**
SP5	**17:00 - 17:10**	Eco-Friendly Chalcogenides Semiconductors Cu2XSnS4 (X: Zn, Ni, Fe, Co): Elaboration, Characterization and Solar Cells Application	Dr. El Kissani	
SP6	**17:10 - 17:20**	Dielectric behavior and AC electrical conductivity of poly(methylmethacrylate)/Polypyrrole-doped composites	Ms. Barnoss	
SP7	**17:20 - 17:30**	Multi-Faceted Approach: QSAR, Molecular Docking, Molecular Dynamics Simulations, and ADMET Evaluation for Enhanced Binding of SARS-CoV 3CLpro Derivatives as Potent Peptidomimetic Inhibitors	Mr. Soufi	
SP8	**17:30 - 17:40**	Substitution Effects in Oxide Semiconductors (BIMEVOX) on Chemical, Physical, Electrical, Optical, and Microstructural Properties. Photocatalytic Applications on Pharmaceutical Products	Dr. Mhaira	
SP9	**17:40 - 17:50**	Green synthesis of magnesium oxide nanoparticles from leaf extract and modeling of Adsorption for the Removal of Bemacid Red using BBD-RSM and ANN approach	Ms. Hamidallah	

SP10	**17:50 - 18:00**	Dielectric relaxation of polyester-based composites reinforced with Argan Nut Shell Powders	Ms. Kreit	
SP11	**18:00 - 18:10**	Recent advancements in the electrolytic water-splitting process for hydrogen production	Mr. Mabrak	
Poster 2	**10:00 - 18:00**	**Chairs: Soto, Palwai**		**Easles**
PO6	**Poster 6**	Structural, electrical, optical and microstructural properties of Bi4V2-xCux/2Sbx/2O11-3x/4	Dr. Mhaira	
PO7	**Poster 7**	Psychoemotional State Sensors and Measurements for Risk Factors Identification	Dr. Sidorenko	
PO8	**Poster 8**	Dynamic simulations of thermal performance of a building based on earth bricks in six climatic zones of Morocco	Mr. Benfars	
PO9	**Poster 9**	Smart Nanocomposites for Energy Harvesting & Biomedical Sensing Applications	Ms. Davis	
PO10	**Poster 10**	Recycling of Office Wastepaper in Eco-Friendly Clay Bricks for Sustainable Manufacturing to Enhance the Thermal Properties of the Clay-Paper Composite Material	Mr. Alioui	
RF2	**18:00 - 18:15**	**Rapidfire presentations**		
		Day 2: Concludes and Dinner on your own		
		May 15, 2024 - Day 3		
Breakfast	**7:00 - 9:00**			**TGIF**
Registration	**8:00 - 10:00**	**Setting up poster Group 3**		**Corridor**
Keynote 5	**9:00-10:00**	**Chairs: Achour, Mabrouki**		**Ballroom**
KN9	**9:00 - 9:300**	Dielectric Barrier Discharge: Generation and Enhancement of Hydrogen Peroxide Action	Prof. Duca	
KN10	**9:30 - 10:00**	Contribution of multiferroic nanomaterials to enhancing photocatalytic properties	Prof. Jouid	
Coffee/Tea	**10:00 -10:15**			
Invited 5	**10:15 - 13:00**	**Chair: Le Sage, Striccoli**		**Ballroom**
IS19	**10:15 - 10:30**	Two-step magnetron sputtering and annealing process for the synthesis of high crystalline and single phase CZTS and CZTSe absorber layers	Dr. Zaki	
IS20	**10:30 - 10:45**	Electrocatalytic materials for anion exchange membrane fuel cells	Dr. Hu	

IS21	**10:45 - 11:00**	3D and 4D Printed Nanocomposite Contact Lenses for Ocular Health Management	Dr. Butt*	
1S22	**11:00 - 11:15**	Experimental investigations on electrical properties of Al2O3 and Cyclic Olefin Copolymer composites	Dr. Ionete	
Stretch break				
IS23	**11:30 - 11:45**	Effects of change of chirality of green dielectric gold nanoparticles on the antimicrobial activity	Dr. Soto	
IS24	**11:45 - 12:00**	Vibrational Study of Hybrid Systems Based on carbon nanotubes for organic solar cells.	Prof. Rahmani	
OL5	**12:30 - 12:45**	Modeling of time, temperature, and composition effect variation upon the thermic treatment of aluminum-silicon alloys	Dr. Elhamzi	**Online Link**
OL6	**12:50 - 13:00**	Development and implementation of a blind source separation algorithm to extract the fetal electrocardiographic (ECG) signal in real time	Dr. Mekhfioui	**Online Link**
Lunch	**13:00 - 14:30**	**5 minutes walk to Miller House**		**Miller House**
OL7	**14:30 - 14:50**	Study of Spintronics and Spinquant 2D Structures Prepared by Laser Plasma Method	Prof. Kervalishvili	**Online Link**
OL8	**14:50 - 15:00**	Optical and Structural characterizations of the base schiff complexes for solar cells	Dr. Hnawi	**Online Link**
Keynote 6	**15:00 - 16:00**	**Chairs: El Haj, Rahmani**		**Ballroom**
KN11	**15:00 - 15:20**	Functional materials for electrical energy production: Applications to Metal-Supported Intermediate-Temperature Solid Oxide Fuel Cells (MS-IT-SOFCs)	Prof. Fasquelle	
IS25	**15:20 - 15:40**	Raspberry Nanoparticles and Thermally Controllable Dual-Scale Roughness for Superhydrophobic, Transparent, and Durable Coatings	Dr. Boukheir	
KN12	**15:40 - 16:10**	High K dielectrics in AI-Based Next Generation Sensors for Biomedical Applications	Prof. Vaseashta	
Invited 6	**16:15 - 17:00**	**Chairs: Noorali, Kavaz**		**Ballroom**
IS26	**16:15 - 16:30**	Green synthesis under microwave of the Knoevenagel-phospha-Michael Addition Reaction by Doped Natural Phosphate	Dr. Youness	
IS27	**16:30 - 16:45**	Green Synthesis and Doping Strategies for Enhanced ZnO Photocatalysts: Sustainable Approaches for Solar-Driven Dye Remediation	Prof. Kavaz*	
IS28	**16:45 - 17:00**	Artificial Intelligence-Based Next Generation Sensors for Biomedical Applications	Prof. Noorali / Dr. Baldwin	
Speakers 3	**17:00 - 18:00**	**Chair: Hu, Butt**		**Ballroom**
SP12	**17:00 - 17:10**	Effect of Annealing Time On the Properties of the CNTS Thin Films	Prof. Dris-El-Haj	

SP13	**17:10 - 17:20**	A natural coagulant from capers: characterization, optimization, potential use for water treatment and recovery of sludge in vitrification	Ms. Kouniba	
SP14	**17:20 - 17:30**	Harvesting Energy from Garden Compost Leachate through Microbial Fuel Cells for Tomorrow's Sustainable Power Generation	Ms. Elmazouzi	
SP15	**17:30 - 17:40**	Elaboration, characterization, and thermodynamic study of superphosphate in aqueous solutions at 313.15 K	Ms. Ghallali	
OL9	**17:40 - 17:50**	Energy harvesting efficiency analysis using artificial intelligence	Ms. Touari	**Online link**
OL10	**17:50 - 18:00**	Enhancing Piezoelectric Properties of PLA/GO Nanocomposite for Energy Harvesting Application	Ms. Oumghar	**Online link**

Poster 3	**10:00 - 18:00**	**Chairs: Soto, Palwai**		**Easles**
PO11	**Poster 11**	Platinum-functionalized CVD Growth Graphene Foam for Fuel Cells Applications	Dr. Ion-Ebrasu	
PO12	**Poster 12**	A comparative study on the chemical, structural, thermal and mechanical properties of polyester and epoxy resin reinforced by sisal fiber	Dr. Belhimria	
PO13	**Poster 13**	Mechanical Performance Evaluation of Adobe Bricks Manufactured Using Different Clay Soils Extracted from Northcentral of Morocco	Mr. Azalam	
PO14	**Poster 14**	Hybrid simulation method for dynamic energy harvesting systems	Ms. Touari	
PO15	**Poster 15**	AC electrical conductivity modeling of polypropylene-based composites melt-processed with carbon nanofibers	Dr. N. Aribou	

RF3	**18:00 - 18:30**	**Rapidfire presentations, Student Presentation awards and Clsoing Remark**

Closing	**Departure for local site visit and Dinner**
	May 16, 2024 - Departures - Free time on your own

Abstracts

Keynotes

KN1

Inorganic nanotubes: From WS_2 to "misfit" layered compounds

R. Tenne
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Abstract: An update on the synthesis and characterization of new inorganic nanotubes from 2D compounds, like WS_2, and from misfit-layered compounds (MLC) will be reported. The stability of nanotubes from 2D compounds will be discussed from theoretical and experimental perspectives. A few recent experiments encompassing the optical, electrical, electro-optical, and electromechanical effects of WS_2 (MoS_2) nanotubes will be discussed as well. Potential applications and concluding remarks will be given at the end of the presentation.

Keywords: 2D materials; inorganic nanotubes; misfit layer compounds; WS_2

KN2

Designing polymer systems with enhanced dielectric response

Vida Jurečič, Nikola Novak, and **Vid Bobnar**
Department of Condensed Matter Physics
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Abstract: The development of high dielectric permittivity materials has become one of the major scientific and technological issues, as the requirement for compact and low-cost systems, designed to control and store electrical charges, has increased substantially. Such materials are highly desirable for use not only as capacitor dielectrics but also in a broad range of advanced electromechanical applications. The input electric energy that can be converted into the strain energy is namely directly proportional to the dielectric permittivity of the electroactive material. Thus, by increasing the dielectric permittivity, the desired electromechanical response can be induced under a much reduced electric field.

The lecture will demonstrate, using various examples, that novel polymer materials with high dielectric response can efficiently be developed by taking into account some basic physical phenomena:
(i) In a heterogeneous system, composed of a dielectric matrix and electrically conductive inclusions, the charge accumulated at phase boundaries acts as a large electric dipole. Using this Maxwell-Wagner polarization we have effectively increased the dielectric permittivity of PVDF-based electroactive polymers and thus substantially reduced the electric field required for their giant electrostrictive response [1]. Analogously, we have fabricated flexible, eco-friendly composites from cellulose nanofibrils and graphene oxide [2] and, very recently, we have replaced graphene oxide with $Ti_3C_2T_x$ as a filler in cellulose-based composite films. $Ti_3C_2T_x$ belongs to a class of novel 2D transition metal carbides and nitrides, so-called MXenes. Not only that the lack of a large-scale and cost-effective method for synthesis still limits the use of graphene-based systems in high-performance electronics, some MXenes demonstrate even higher electrical conductivity than the solution-processed graphene.
(ii) An alternative approach is an operation under higher electric fields, i.e. increasing the dielectric breakdown strength without increasing the dielectric permittivity, which via Kramers-Kronig relations always inflates the dielectric losses. Moreover, the electric energy density is only linearly proportional to the dielectric permittivity, while its maximum value depends quadratically on the breakdown strength. We have demonstrated a significant enhancement of the dielectric breakdown strength in blends of polyetherimide with polyimide, which occurs due to strong electrostatic interactions between the phenyl groups of different polymer chains [3]. These interactions strongly reduce the number of accumulated space charges, which in weak points gain higher energies when accelerated by an applied electric field and initiate the breakdown at lower electric fields. The blending of properly matched polymers thus turned out as an outstanding strategy for realizing high energy density while maintaining low dielectric losses.

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KN3

Carbon Nanophases in Silicon Nitride

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Abstract: This research explores the use of a variety of carbon nanoparticles to impart electrical, thermal conductivity, and good frictional properties to silicon nitride matrices. We used the highly promising types of carbon as carbon nanotubes, exfoliated graphene, and carbon black nanograins. A high-efficiency attritor mill has also been used for the proper dispersion of second phases in the matrix. The sintered silicon nitride composites retained the mechanical robustness of the original systems. Bending strength as high as 700 MPa was maintained and an electrical conductivity of 10 S/m was achieved in the case of 3 wt% multiwall carbon nanotube addition. Electrically conductive silicon nitride ceramics were realized by using carbon nanophases. Examples of these systems, methods of fabrication, electrical percolation, and mechanical, thermal, and tribological properties are discussed.

Keywords: silicon nitride, graphene, carbon nanotube, electrical properties

KN4

Why Do We Need Diamond Photonic Nanostructures?

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Diamond is a material with several outstanding mechanical, optical, electrical, and chemical properties. In the last decades, it has additionally attracted the attention of scientists due to the promising properties of the color centers in its crystal lattice such as the nitrogen-vacancy (NV) and the silicon-vacancy (SiV) centers which can find applications in quantum information technology, quantum computing or quantum sensing. To increase the collection efficiency of the photons emitted from the color centers they should be incorporated in photonic structures. We demonstrate the fabrication of several types of single-crystal diamond (SCD) nanostructures, namely thin membranes, photonic crystals, and nanopillars.

Initially, he challenges the fabrication process of SCD membranes with various diameters and thicknesses, exhibiting a low surface roughness down to 0.2 nm, applying inductively coupled plasma reactive ion etching (ICP-RIE) will be presented. For SCD samples with an initial rms surface roughness of ~ 1.5 nm a significant roughness reduction can be achieved by using a combination of two distinct Ar/Cl_2 etching recipes as a planarization step before the actual structuring process, comprised out of alternating $Ar/Cl_2 + O_2$ etching steps. These planarized SCD membranes can be successfully bonded via van der Waals forces or PMMA on plane cavity mirrors and optically characterized in a fiber-based Fabry–Pérot microcavity system regarding their mode structure and finesse. Furthermore, the fabrication of 2D photonic crystals in SCD membranes by electron beam lithography (EBL) and ICP-RIE will be demonstrated as well as the first attempts for 1D nanobeams. Nanopillars with various diameters were prepared by ICP-RIE with oxygen plasma and incorporated with NV centers before the structuring. Finally, examples of hybrid approaches, i.e. combination of “top-down” and “bottom-up” methods, for fabrication of nanostructures with embedded SiV centers will be shown.

KN5

Magneto-polaron effects on resonant Raman scattering in transition metal dichalcogenides

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Abstract: First-order resonant Raman spectroscopy in an external magnetic field is a powerful method that allows for exploring configurations of energy levels towards device applications of two-dimensional transition metal dichalcogenide (TMD) semiconductors. We have unveiled the behavior of the magneto-polaron (MP) resonances as a function of the phonon symmetry inherent in monolayer TMDs [1]. A large number of avoided crossing points of energy branches involving the optical phonon in the MP spectrum, superposition of the electron and hole states in the excitation branches, and their relation with optical transitions in different scattering configurations are unique in these 2D structures. To analyze them, the MP resonant scattering in a monolayer TMD is evaluated as a function of the laser energy and the magnetic field. The MP resonant Raman intensity as a function of the magnetic field exhibits three resonant splittings of double avoided-crossing levels. The three excitation branches are present in the MP spectrum due to the coupling of electrons and holes Landau levels through an out-of-plane A_1 optical phonon mode. The energy gaps at the anticrossing points in the MP Raman spectrum are found as a function of the electron and hole deformation potential constants. An explicit expression for the evolution of the Raman scattering efficiency is reported, allowing for exploration of the relative electron and hole contribution to polaron formation in the magnetic field. The obtained results are a guideline for control over the MP effects in the magneto-optical properties of TMDs. We acknowledge fruitful discussions with G. E. Marques.

Keywords: magneto-polarons, resonant Raman scattering, transition metal dichalcogenides

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KN6

Heat-Assisted Ferroelectric Reading for High-Speed Scanning Nonlinear Dielectric Microscopy Ultrahigh-Density Ferroelectric Data Storage

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Abstract: We previously proposed ferroelectric data storage that uses scanning nonlinear dielectric microscopy (SNDM), called SNDM probe memory, as a next-generation ultrahigh-density information recording method. We confirmed an extremely high recording density and high-speed writing using $LiTaO_3$ single crystal media [1][2]. However, since reading is based on the detection of very small nonlinear dielectric constants of ferroelectric materials using the SNDM technique, slow playback speed (actually 2Mbps) hinders the practical use of SNDM probe memory [3]. To solve this problem, a material with a large nonlinear dielectric constant is required. Our basic experiments revealed that a nonlinear dielectric constant has an extremely large temperature dependence and is proportional to $(T_0\text{-}T)^{-3.5}$, where T is the medium temperature and T_0 is the Curie temperature[4]. This means that an increase in the nonlinear dielectric constant, which would enable ultrahigh-speed reading (Gbps or faster), can be easily obtained even in $LiTaO_3$ crystal by making T close to T0. However, simply increasing the medium temperature closer to the Curie temperature under thermal equilibrium degrades the polarization retention characteristics. Therefore, we propose a heat-assisted ferroelectric reading (HAFeR) method that increases the reading speed while maintaining the polarization retention characteristics. This is achieved by locally heating the medium for a very short time at the data reading position using laser pulse irradiation. We conducted a basic experiment and confirmed that laser pulse irradiation increased the SNDM signal strength much more. We also discuss the relationship between the maximum number of laser irradiation pulses and the optical pulse width for a medium heated to 550 °C (equivalent to a reading speed of 5 Gbps). The proposed method overcomes the fundamental problems of next-generation ultrahigh-density ferroelectric data storage.

Keywords: Ferroelectric data storage, High-speed read-out, Heat assisted ferroelectric reading, Scanning nonlinear dielectric microscopy

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KN7

Enhancement of Energy Storage Performance in Lead-Free Ferroic materials

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Abstract: The continuous rise in global energy demand, coupled with remarkable advancements in renewable energy sources, has underscored the critical necessity for energy storage systems. Solid-state dielectric capacitors, characterized by their ability to swiftly store and release electrical charges, offer distinct advantages over batteries and electrochemical capacitors, particularly in applications requiring high-power electronics. The imperative to reduce the size and cost of insulation technology in upcoming electronic devices highlights the significance of advancing dielectric thin films with exceptional energy storage density and efficiency. This becomes particularly crucial in scenarios involving low voltages and elevated temperatures. In this work, we will first discuss the enhancement of energy storage at room and high temperatures in bulk ferroelectric and relaxor ferroelectric Pb-free ceramics and flexible nanocomposites based on $BaTiO_3$ and $Na_{0.5}Bi_{0.5}TiO_3$ perovskite systems. Additionally, we will explore the influence of the substrate, size reduction, multilayering, chemistry, etc., in thin film heterostructures on significantly improving the energy storage density and efficiency under both low and high electric fields. Particularly, we will focus on high-quality epitaxial lead-free ferroic-based ($BaTiO_3$, $SrTiO_3$, $BaZrO_3$, $BiFeO_3$, etc.) superlattices grown using the pulsed laser deposition technique. In such superstructures, the role of interfaces and epitaxial strain is of great importance in optimizing the polarization, P-E loop shape, and dielectric breakdown strength, which are crucial for achieving an optimal energy storage response.

Keywords: Energy storage, Ferroelectric, Ceramics, Thin films, Epitaxial strain, Superlattices.

KN8

Measurements of thermal diffusivity using atomic force microscopy

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Abstract: Since its introduction in 1986, the atomic force microscopy[1] (AFM) technique has emerged as an extraordinary tool with many applications in the field of surface science. Initially, the AFM was developed to overcome the inability of the scanning tunneling microscope (STM) to image the surface of non-conducting materials[1]. Later on, AFM was applied extensively to characterize biological[2,2,] and organic materials. The AFM was also combined with many existing techniques to produce variants[4-6]. For example, the scanning electrochemical microscope is a variant focused on nano-scale electrochemistry. In other applications of AFM (Chemical force microscopy), specific changes were made to the tip to permit chemical identification of molecules anchored to the surface[7] or to achieve high-resolution imaging by using carbon nanotube[8]. Nowadays, AFM is widely used to probe intermolecular forces[9] as well as the electronic properties of single molecules[10]. Force spectroscopy is used to investigate the properties of materials including the elasticity, surface charge densities, etc. In this study, we have used AFM to locally sense both the acoustic and the thermal waves induced by light absorption.

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KN9

Dielectric Barrier Discharge: Mechanism and Spectrum of Applications

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Abstract: This paper provides an overview of the specifics and applications of technologies based on the dielectric barrier discharge (DBD) producing cold plasma. Although this phenomenon was discovered almost two hundred years ago, its practical applications have been proposed only in the last couple of decades, and this trend has grown exponentially. Cold plasma technologies cover such areas as electronics and polymer materials, the food industry, biomedical usage, wastewater treatment, and hydrogen peroxide production. Cold plasma has proven to be effective for the inactivation of various pathogens and spoilage organisms without adversely affecting product quality, including foodstuffs. Cold plasma treatment of water enables pesticide decomposition, discoloration of dyes, and general disinfection. Experimental work conducted recently at several major universities, research centers, and companies around the world demonstrates that plasma can be used in a variety of medical applications. Due to the generation of plasma under normal atmospheric pressure and temperatures (below 37°C), a new frontier of applications has evolved, including biomedical aspects. Medical usage of cold plasma includes sterilization, wound healing, disease treatments, and even more. It is already widely used in surgeries and endoscopic procedures and has been shown to control the properties of cellular and tissue matrices, including the biocompatibility of various substrates. Non-thermal plasma has been demonstrated to deactivate dangerous pathogens to stop bleeding without damaging healthy tissue and to treat cancer. Although cold plasma technology has shown promising results, it requires further studies to better understand the reactive gas chemistry as well as the toxicological, ecological, and economic impacts. We realize that mechanisms of plasma interaction with complex natural systems, especially with living tissues, must not be very simple, because of the complexity of both: plasma itself and treated objects. So, the discovery of a unified mechanism is unlikely. While investigating DBD further, a parallel study is under progress to assess the primary cause of the healing capability of hydrogen peroxide, along with the production of other forms of active oxygen and its reactive species (radicals and non-radicals), charged particles, photons, and electric fields, which have impactful biological effects.

Keywords. Dielectric barrier discharge, biomedical application, wastewater purification, active radicals, hydrogen peroxide.

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KN10

Contribution Of Multiferroic Nanomaterials to Enhancing Photocatalytic Properties

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Abstract: Oxide perovskite materials (PMs) have received great attention due to their distinctive electrochemical and photophysical properties owing to their dual properties, such as having an appropriate band gap for WS and intrinsic polarization to drive the water-splitting reaction. These properties have opened the door to this class of materials to further development strategies to improve their photocatalytic properties. The present talk addresses the latest developments in the use of low dimensional oxide perovskites as an efficient photoelectrocatalyst with a special focus on the development of composite-based oxide perovskites nanomaterials toward green hydrogen production.

KN11

Functional materials for electrical energy production: Applications to Metal-Supported Intermediate-Temperature Solid Oxide Fuel Cells (MS-IT-SOFCs)

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Abstract: Solid oxide fuel cells (**SOFCs**) are promising devices for energy-conversion applications due to their high electrical efficiency and eco-friendly behavior. Nowadays, commercial SOFCs are electrically efficient at high operating temperatures, typically between 800 and 1000°C. This high-temperature range restricts their real-life applications, but also their lifetime. Our basic goal deals with reducing the operating temperature by working in the range from 500 to 700°C. Among SOFCs, metal-supported intermediate-temperature solid oxide fuel cells (**MS-IT-SOFCs**) may provide very cheap SOFC cells with increased lifetime and reduced operating temperature. In view to develop highly efficient electrodes and fuel cells, this presentation will be divided into 2 parts. The first part focuses on the physical and electrical characterizations of porous **GDC-backbones** which have been impregnated with **LSCF** sol-gel solutions and NiO solutions, for composite cathodes and anodes, respectively. The porosity of the backbone was controlled by the addition of different pore-formers. The performance of different samples was compared by studying the evolution of the electrical resistivity in the function of temperature. An important effect has been demonstrated: whatever the temperature, from **500 to 700°C**, the resistivity can be tuned both by the solution viscosity and by the kind of pore-former. The second part is dedicated to the complete fabrication of **Metal-Supported Intermediate-Temperature SOFCs** (MS-IT-SOFCs). These cells were studied from **600 to 750°C**. In function of the developed structures and test conditions, we have measured values of the **power density** ranging from **150 to 520 mW/cm^2**. These highly interesting results will be presented during the ISYDMA conference in Orlando.

***Key Words**:* GDC, LSCF, pore-former, oxide, cathode, anode, MS-IT-SOFC.

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KN12

Strategic Integration of Hybrid high-*k* Dielectric Materials in Artificial Intelligence of Things Devices

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Abstract: Two-dimensional (2D) semiconductors are effective materials for next-generation devices, especially for sensing applications. Yet, it is particularly challenging to integrate ultrathin and uniform high-κ dielectrics on 2D semiconductors to fabricate MOSFETs with large gate capacitance. Using a strategic and versatile two-step method to integrate high-quality hybrid dielectric films as buffer layers, thus forming a high-quality oxide-to-semiconductor interface, with minimum equivalent oxide thickness (EOT) on these semiconductors. We present a choice of materials for MOSFETS and an anticipated ON/OFF ratio for high gating efficiency. While such devices are being realized, integrating artificial intelligence with the Internet of Things (AIoTs) offers significant advantages in medical diagnostics, wearable electronics, critical infrastructure protection, and homeland security. We present an overview of potential applications using these 2D semiconductors with hybrid high-*k* materials in low-power ultra-scaling electronics.

Keywords: high-*k*, AI, AIoT, hybrid, MOSFETS, 2D semiconductors

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Invited

IS1

Enhancement of Room Temperature Magnetoelectric Coupling in $Na_{0.5}Bi_{0.5}TiO_3$ – $BaFe_{12}O_{19}$-Based Flexible Polymer Film

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Abstract: Multiferroic $Na_{0.5}Bi_{0.5}TiO_3$ –$BaFe_{12}O_{19}$ composite was synthesized using a solid-state route which was further blended with PVDF to form flexible films using solution casting method to study its magnetoelectric and energy harvesting properties. A systematic study of the various properties was carried out. Structural and morphological studies were performed using Rietveld refinement and Scanning electron microscope. Electrical properties such as dielectric, AC conductivity, and impedance analysis were investigated. The dielectric properties showed the dominance of interfacial polarization at lower frequencies. The conduction mechanism, studied from the AC conductivity data using the Jonschers power law, was observed to be governed by the Non-overlapping Small Polaron Tunnelling model. Impedance studies with Cole-Cole fittings at different temperatures were performed to analyze the grain and grain boundary contribution to the total electrical property of the system. The multiferroic nature was confirmed from the PE and MH loops at room temperature and the degree of interaction between the electric and magnetic phase was investigated from the magnetoelectric(ME) coupling coefficient. The observed high ME value of ~25mV/cmOe for the ceramic composite was found to be greatly enhanced in the polymer film up to ~ 600mV/cmOe which can be attributed to better connectivity between the different phases with the addition of the polymer matrix. The produced film was subjected to a finger-tapping force to investigate the energy harvesting property, and this produced an open circuit voltage of about 10V. With further engineering and better design, the fabricated composite material appears to have a bright future in magnetoelectric sensors, pressure sensors, and mechanical energy harvesters.

Keywords: dielectric, magnetoelectric, flexible, energy harvesting

IS2

Enhancement Of Ferroelectric, Dielectric, And Electrocaloric Properties In Relaxor Ceramics Through Processing-Related Microstructural Features

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Abstract: The impact of synthesis-mediated microstructural features such as grain size and shape on dielectric, ferroelectric, piezoelectric, and electrocaloric properties is reviewed. It is shown that a substantial enhancement of the electrocaloric (EC) effect can be achieved with a properly engineered ceramic microstructure in PMN-xPT relaxors [1,2]. It is shown by dielectric, PFM, and direct electrocaloric measurements that growth rate controlled stoichiometry of fiber crystals could result in optimized lead-free BCZT crystals with enhanced energy storage, piezoelectric and electrocaloric properties [3]. We demonstrate that the microstructural features, such as increased ceramics' grain boundary conductance caused by an electric-field-induced phase transformation to a ferroelectric phase, are directly responsible for the electrocaloric fatigue [4]. The method of avoiding such fatigue is also discussed.

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IS3

Nanocomposite Ceramics for Novel Biomechanical Energy Harvesting and Dielectric Cooling

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Abstract: The request for greener heat-management technologies has recently developed a significant interest in new electrocaloric effect (ECE)-based dielectric cooling devices that can replace the existing cooling techniques [1]. An overview of experimental and theoretical investigations of the large ECE and piezoelectric response in ferroelectric lead-free ceramic composites and ceramics near antiferroelectric transition will be presented in this contribution. Specifically, the large ECE response observed by direct experiments in lead-free BCTZ-based ceramics will be reviewed, including biocompatible polymer composites' large energy harvesting potential [2]. Besides, it is demonstrated that negative and positive EC responses can be arbitrarily invoked in antiferroelectric materials by adequately controlling the electric field and temperature, which enables electrocaloric cooling power enhancement for up to 100%.

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IS4

Exploring dielectric properties of TiO_2 Co-Doped with Nb and Mg for energy storage

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Abstract: As the global demand for efficient and sustainable energy storage solutions continues to rise, researchers are increasingly turning their attention to the unique properties of materials with promising dielectric characteristics. The pursuit of materials with colossal permittivity (CP) stands as a prominent focus within the dielectrics field, driven by their prospective applications in microelectronic devices and high-energy-density storage [1], [2]. Titanium oxide (TiO_2), a versatile compound, has emerged as a compelling candidate for energy storage applications due to its distinctive attributes such as its common availability, chemical stability, nontoxicity, optical-electronic properties, low cost, and high photocatalytic properties [3]. A CP material, co-doped rutile TiO_2 material, incorporating both indium (In) and niobium (Nb)[4], satisfying the requirements to be used as energy storage material ($\varepsilon' > 10^3$, low dielectric losses ($<10^{-1}$) and nearly temperature and frequency-independent dielectric properties. Several theories have been proposed to explain the CP in Co-doped TiO_2: electron-pinned defect-dipole (EPDD) clusters, grain-boundary effects, hopping conductivity, interfacial electrode polarization, microscopic inhomogeneities, and polaronic relaxation. Despite ongoing debates surrounding the specific mechanism, it has been consensus that the CP should be linked to defects in ceramics rather than bulk materials. Nevertheless, it presents a complexity and sensitivity of polarization mechanisms of defect in CP materials which are essential to investigate their properties mainly in co-doped TiO_2 through the combination of substituted ions [1]. The present work investigates the TiO_2 co-doped with niobium and magnesium, prepared by the sol-gel method, evaluating the influence of their different percentages (1-10%) in the structural, morphological, and electrical properties. Structural properties were carried out by X-ray diffraction (XRD) and Raman spectroscopy, the surface morphology by scanning electron microscopy and energy-dispersive X-ray spectroscopy (SEM-EDS). The electrical properties were investigated by impedance spectroscopy (IS) in the range of frequency (40 to 10^6 Hz) and temperature (200-370 K). The co-doped has influenced the dielectric properties: the increase of niobium and magnesium of 10% leads to a decrease of dielectric constant (≈100), nevertheless still high and independent with the frequency, and of loss tangent (≈10^{-4}) when compared to TiO_2, being a promising material for energy storage applications.

Keywords: Titanium Dioxide; Sol-gel; Dielectric properties; Energy storage.

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IS5

Structural Characterization of Gd-Doped Ceria Powders and Ceramics: A Comprehensive Study of Composition and Thermal Treatment Effects

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Abstract: Cerium oxide, which has a cubic fluorite structure, is a desirable insulating material for capacitors and buffer layers of superconducting materials due to its high relative permittivity and chemical stability. CeO_2 doped with different cations is utilized as electrode material in solid oxide fuel cells and gas sensors. Its physicochemical properties can be altered by doping it with other elements, which provides a means of fine-tuning them to meet the needs of particular applications, especially energy conversion and storage systems. Among the aliovalent dopants studied, gadolinium (Gd) emerged as a promising candidate. This provides opportunities to enhance the performance of cerium-based materials for the aforementioned application, as the replacement of Ce4+ in the cationic sublattice with an appropriate amount of trivalent rare earths facilitates the formation of oxygen vacancies in the parent oxide via charge compensation and promotes the diffusion of oxygen atoms throughout the CeO_2 crystal lattice. $Ce_{1-x}GdxO_{2-x/2}$ powders with different Gd contents were synthesized by the process of ion gelation (IG) followed by thermal treatment of the gel to obtain solid solutions of $Ce_{1-x}GdxO_{2-x/2\ -x/2}$. (LT samples). The powder was pressed into tablets and fired at an elevated temperature of 1400 C to produce ceramics (HT samples). To clarify the influence of heat treatment and gadolinium substitution on the structural properties of the resulting solid solutions, the results obtained for Gd-doped powders and compact ceramics were compared and analyzed. Cerium can exist as an oxide (CeO_2) with valence 3+ or 4+. Ce is believed to remain Ce4+ in $Ce_{1-x}GdxO_{2-x/2}$ solid solutions synthesized under oxidation conditions. To preserve the electroneutrality of the material, oxygen vacancies are created when trivalent dopant cations, such as Gd3+, replace the Ce4+ sites. The reduction in the amount of oxygen ions leads to a hyposteochiometric state of the solid solution. Using Rietveld refinement, the crystal lattice parameters were determined based on the XRD data. Scanning electron microscopy (SEM) and infrared spectroscopy (IR) were used for structural and morphological studies. The EPR method was used to determine the changes after gadolinium substitution. X-ray photoelectron spectroscopy (XPS) was used to evaluate the electronic structure of $Ce_{1-x}GdxO_{2-x/2}$ ceramics and powders.

Acknowledgments: This work was financially supported by the National Science Fund of the Bulgarian Ministry of Education (project KP 06 PN 59/13/2021) and by the National Scientific Infrastructure “Energy Storage and Hydrogen Energy (ESHER)”

IS6

Pressureless Post-sintering on the Hot Isostatic Pressed Alumina Prepared from the Oxidized AlN Powder

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Abstract: The effect of the pressureless post-sintering in hydrogen on the structural and mechanical properties of the hot isostatic pressed Al2O3 prepared by oxidized AlN powder has been studied. The micrometer size AlN powder has been oxidized in air at 900° C and sintered by hot isostatic pressing (HIP) at 1700°C, 20 MPa nitrogen atmosphere for 5h. Pressureless sintering (PS) has been applied for all HIP sintered samples in H_2 gas at 1800° C for 10 hours. It has been shown that the oxidation caused a core-shell AlN/Al2O3 structure and the amount of Al_2O_3 increased with increasing the oxidation time of the AlN powder. For the first time, the green samples obtained from oxidized AlN powder were successfully sintered first by HIP followed by post-sintering by PS under hydrogen without adding any sintering additives. All post-sintered samples exhibited the main α-Al_2O_3 phase. Sintering in H_2 caused the full transformation of AlN to α-Al_2O_3 phase and their better densification. Therefore, the hardness values of post-sintered samples have been increased to 17-18 GPa having apparent densities between 3.11 and 3.39 g/cm^3.

Keywords: AlN, alumina, sintering

IS7

Carbon Dots: New Fluorescent Nanoparticles for Advanced Optical Applications

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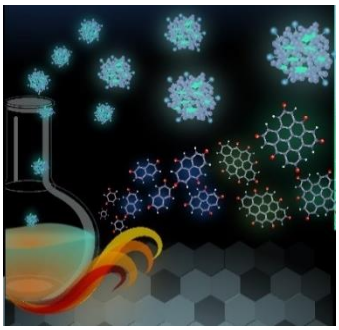
Abstract: Carbon dots (CDs) are novel fluorescent nanoparticles that combine intense emission of visible light with eco-friendly and inexpensive carbon-based composition. While carbon is generally regarded as an optically black material, CDs possess surprising light emitting capabilities; their intense absorption bands can be photoexcited to express a bright fluorescence occurring in the whole range of the visible spectrum, often associated to high quantum yields [1]. Being composed of elements such as carbon, oxygen, hydrogen, and nitrogen, CDs are regarded as inexpensive and biocompatible nanoparticles. Bottom-up strategies for CDs synthesis frequently involve controlled high-temperature carbonization of selected organic molecules [1, 3]. Such synthetic processes yield the formation of polyheterocyclic structures, or molecular fluorophores, that are then the actual emissive centers responsible for the fluorescence displayed by the CDs [1, 3, 5]. However, despite the large experimental effort currently put in developing reproducible CDs synthetic methods, challenges persist in the control of the optical properties of the generated nanoparticles. Furthermore, obtaining CDs with highly efficient emission in the red region is a widespread current issue. Here, the synthesis and the main optical properties of this extraordinary organic nanostructured fluorophores will be illustrated [2,5], in the perspective of their application in appealing nanocomposites for color converting white emitting devices [3]. Furthermore, highly luminescent nanoparticles can be produced starting from organic dyes, showing improved resistance to photobleaching [4] under UV excitation and emission from solid-state. Finally, dye-based CDs demonstrated efficient and stable lasing emission in the red region, thank to the protective effect of the carbonaceous matrix [5]



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IS8

Intermediate phase glasses of the As-S-Ge ternary: self-organization, properties and applications in programmable metallization cells

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Abstract: A brief review is given of the modern elastic constraint theory applicable to chalcogenide glasses (ChG) and its experimental proving on the ChG from the region of intermediate phase (IP) of the As-S-Ge ternary is shown. To reveal the reasons in charge of features of the middle range order (MRO) structure and ultrasound propagation in bulk and thin films from the IP of these materials the light Raman scattering has been studied and analyzed thoroughly. The last has been performed via deconvolution of Raman bands and analyzing their evolution with the composition along the IP tie-line $(GeS_4)_x(AsS_3)_{1-x}$. Such an approach allowed the revealing of the vibrational modes of the main structural blocks of the glass network and their scattering strength. It was pointed out that the scattering strength of the Raman modes strongly varies with composition change, at that the mode 336 cm^{-1} associated with symmetric stretch in flexible QT $S=As(S_{1/2})_3$ in charge of structural self - organization of the glass reaches its maximal value in the composition corresponding to x = 0.33 ($Ge_{7.7}As_{15.3}S_{77}$), but suddenly decreases in neighbor compositions. These results correlate with compositional dependence of the physical-chemical and elastic properties of the glass, as at the above-mentioned composition, corresponding to strong self-organized glass, the MRO parameters and elastic modulus reach either minimum or maximum values respectively. Further, it appeared that the light-induced solid state reaction between metallic Ag and ChG from the IP region (photo-dissolution) exhibits a maximal rate using namely the maximal self-organized glass, i. e. the composition $Ge_{7.7}As_{15.3}S_{77}$. As the photo-dissolution phenomenon results in the formation of solid electrolytes with a mixed electronic and ionic conductivity we have fabricated such electrolytes using the ChG from IP of the As-S-Ge ternary that further were used as active parts of the programmable memory cells. It turned out that the self - organization of the glass structure leads to a significant increase in the electrical conductivity of solid electrolytes based on them, which in turn significantly reduces the switching time of the memory cells. The given results unambiguity reveal the positive effect of structural self-organization of the GhG on its physical properties for different applications.

Keywords: Chalcogenide glasses, Raman scattering, self-organization, memory cells

IS9

Study of Termoelctric Bismuth Chalcogenides

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Thermoelectric materials are known for the direct conversion of thermal energy into electrical energy and vice versa according to the Seebeck effect and Peltier effect, respectively. These materials challenge a large interest due to their potential sustainable energy solutions. In addition, devices based on this technology can be manufactured in very small sizes, which enables the application to very local areas with precise temperature control. Bi_2 (Te, Se)$_3$ thermoelectric bulk materials have shown a large Seebeck coefficient that exhibits a high applicability in thermoelectric refrigeration. Crystalline bulk compositions of Bi_2 $(Se_{1-x}Te_x)_3$ system, were prepared using the conventional melting method. Thin films were deposited from the bulk samples using vacuum thermal evaporation and pulsed laser deposition techniques. Physicochemical properties such as compactness, molar volume, and free volume percentage were calculated for the alloys based on the experimentally calculated densities. The structural properties of the bulk samples and the as-deposited thin films have been studied using XRD, TEM, SEM, and IR analyses. XRD patterns show that the prepared samples are crystalline materials with a single phase for the respective composition. The grain size calculations were performed using the Scherer equation. Lattice parameters were also identified. Surface morphology and grain size of the bulk alloys as well as thin films were investigated using SEM and TEM characterization. The influence of bismuth content on the thermoelectric properties of thin films was discussed.

Keywords: Thermoelectrics; Bismuth chalcogenides; Thin films, Lattice parameters; Grain size; Compactness; Free volume percentage; Molar volume.

Acknowledgments: This work is developed as part of contract №: BG-RRP-2.004-0002-C01, project name: BiOrgaMCT, Procedure BG-RRP-2.004 “Establishing of a network of research higher education institutions in Bulgaria”, funded by Bulgarian National Recovery and Resilience Plan.

IS10

Microstructural Investigation of Polarization and Domain Structures in Piezoelectric Films Using Scanning Nonlinear Dielectric Microscopy

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Abstract: Piezoelectric materials such as PZT, AlN, and ZnO are widely used in ultrasonic devices such as surface acoustic wave and bulk acoustic wave filters, sensors, actuators, and so on. Recently, the use of polarity-inverted structures has been applied to those devices to improve the electromechanical coupling coefficient and high velocity of acoustic waves for high-frequency communication devices. Therefore, the measurement of these polarization structures is an important research subject. In addition, ultrasonic transducers using sol-gel composite material have features such as flexibility and high-temperature operation, and they are applied to various sensors and nondestructive inspection of factories, etc. They are fabricated from a mixture of ferroelectric powder and so-gel solution. By combining powder materials and solutions, piezoelectric materials with various features are expected to be obtained. To improve the characteristics, it is necessary to clarify their fine structure and how the material related to the powder and sol-gel solution is distributed. This paper describes several measurement results of piezoelectric domain structures and distribution of the material related to ferroelectric powder and sol-gel solutions in sol-gel composite PZT film using scanning nonlinear dielectric microscopy.

Keywords: Piezoelectric materials, Polarization inverted structure, Domain measurement, Sol-gel composite films

IS11

Laser-Power Dependence Effects on The Structural Stability Of Nanocomposite Catalysts Studied By Raman Spectroscopy

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Abstract: The rapid growth in nanotechnology has driven the interest in studies on the structural properties of nanosized systems to expand their technological applications in catalysts. Structural properties of binary CeAl, CeMn, NiAl, CeZr, SnTi, and ZrMn nanocomposite oxide catalysts were monitored towards the Laser Raman spectroscopy investigations providing new insights to control catalytic applications upon temperature ranges at which the laser power was varied. The vibrational properties were investigated by varying the incident laser power during Raman measurements from 0.017 mW to 4.0 mW. The effects of the anharmonicity and phonons confinement should be considered when studying local laser heating-inducing spectral feature changes in nanostructured oxides. The temperature-dependent anharmonic behavior of the phonon modes is a result of the anharmonic interactions providing changes in the phonon population with consequent variations in the nanostructured oxide lattice parameters [1]. Previous studies on the local laser heating effects on samples have demonstrated that the stability of nanomaterials deteriorated due to thermal effects. This implies the formation of undesired phases and leaching of the active sites in catalytic nanomaterials [2]. Even though there is a great advance for *in situ* catalytic system operations in current years, these systems often do not enable monitoring the stability of the active sites under heating the solids during the reactions. This work deals with applying laser power heating to observe its effects on the vibrational properties of binary nanocomposite oxide catalysts. Laser induced local heating upon varying laser power values from 0.017 to 4.0 mW reaching temperatures between 60 and 223 ^{o}C. Structural changes in nanocomposites were achieved upon increasing laser power, which induced local heating disorder causing the sintering of CeMn, SnTi, and ZrMn nanocomposites. The laser-power dependence effects on the structural stability of CeAl, NiAl, and CeZr were observed with high amounts of oxygen vacancy defects over CeAl upon laser power heating. Both CeMn and ZrMn exhibited phase transitions from MnO_2 to α-Mn_2O_3 being the use of the latter nanocomposites limited to work at 1.1 mW. The CeAl catalyst oxide exhibited high structural stability when compared to other binary oxides studied.

Keywords: Nanocomposite, Catalysts, Raman spectroscopy, Laser heating effects

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IS12

Effects of 1D and 2D nanomaterials on Dielectric Relaxation and AC Conductivity in PVA Based Nanocomposites: A Havriliak-Negami Fitting Approach

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Abstract: This study examines the influence of one-dimensional (1D) and two-dimensional (2D) nanomaterials on the dielectric and electrical conductivity of polyvinyl alcohol (PVA) nanocomposites. Through the application of Havriliak-Negami (HN) fitting techniques, the study explores the modifications in the electrical properties induced by these nanomaterials within the PVA matrix. The study focuses on understanding the phenomena of polarization, dielectric relaxation, and the distribution of relaxation times for deeper insights. The study identifies significant modifications in both dielectric behavior and conductivity, which are attributed to the distinctive interfacial interactions and polarization mechanisms introduced by the inclusion of 1D and 2D fillers. This research provides critical insights into the development of PVA-based nanocomposites with improved electrical performance thus broadening their potential applications in the fields of advanced energy storage and electronic devices.

Keywords: Polyvinyl alcohol (PVA), One-dimensional materials, Two-dimensional materials, Dielectric relaxation, Electrical conductivity, Havriliak-Negami fitting.

IS13

Lead-free ferroelectric materials for high-temperature Energy storage capacitors

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Abstract: Dielectric capacitors are prone to very high power density with ultra-fast discharge time, making them potential candidates for pulsed power supply technologies. Unfortunately, the low energy density hinders their technological applications. To overcome this drawback, a revival competition toward shaping low-cost dielectric capacitors with high polarization and high breakdown strength for energy stockpiling applications has been seen in the last decade. Further, dielectric materials are known for their stability at high temperatures which makes them very promising to operate at high temperatures where energy storage is required. In the present work, we show that materials based on Bi0.5Na0.5TiO3 in the morphotropic phase boundary region, including ceramics and thin films, afford interesting properties promising for high-temperature dielectric capacitors for energy storage applications. The influence of the material form, the impact of the preparation method, and the evaluation of the temperature-dependent dielectric stability in the electrostatic energy storage performance were presented. Promising examples will be presented in this talk, in the context of the improvement of recoverable energy, density, and efficiency.

Keywords: Bismuth titanate, Dielectric materials, Energy storage capacitors, High-temperature application

IS14

Suppression of Higher Acoustic Harmonics Via A Metastructure for Nondestructive Evaluation of Dielectric Materials

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Abstract: Over the last decades, the nondestructive evaluation (NDE) using ultrasound, ranging from 1 MHz to 5 MHz, has been widely used in various industrial fields as the most powerful way to evaluate structural changes in materials (e.g., dielectric materials) and accumulated damage or degradation in the material properties for the early-stage detection of structural failure. The structure's linear mechanical properties and defects can be determined by measuring acoustic parameters, such as sound speed, attenuation, transmission, and reflection coefficients. The existing defects can alter the amplitude and phase of the propagating signal as it passes through structures. Although NDE is sensitive to gross defects or cracks, it is less sensitive to material degradation, fatigue, or microcracks because the scale is much less than the wavelength. The nonlinear ultrasonics (NLU) nondestructive evaluation method was recently introduced to overcome these limitations. Unlike the existing linear NDE, NLU is sensitive to the microscopic discontinuities or imperfections that correlate to the second harmonic generation (SHG). However, there is a critical setback due to the technique being affected by the sample's nonlinearity and the measuring device's nonlinearity. This study deals with this problem and focuses on developing a metamaterial band filter by blocking the inherent device's nonlinearity. We propose a one-dimensional acoustic metamaterial, a superlattice (SL), to filter out nonlinearities induced by the instrument. The SL ultrasonic filter is designed with the bandgap of the SL, thus preventing wave propagation for a specific frequency range, i.e., the second harmonic. SL is made of periodic solid-solid, alternating copper and Sn-Pb solder layers, which is advantageous in portability and size. The metamaterial in this study has the pass and stop band for a fundamental frequency of 5 MHz and a frequency of 10 MHz of secondary harmonics, respectively. We choose 5 MHz as the fundamental frequency because the second harmonic nonlinearity in this frequency can detect minimal micro-scale damage. With Rytov's equation, we determined the thickness of each layer. We then conducted a Finite Element Analysis for this model in the COMSOL program to calculate the band structure. To validate the feasibility of the SL ultrasonic filter, experiments using acoustic waves were conducted with the aluminum specimen, the sample of interest, and the SL filter, respectively. A function generator generates three pulse sine signals, ranging from 2.5 to 20 MHz. As a result, in the case of the SL, there is a band gap of around 10 MHz, which means the SL can filter out the second harmonic. Compared to the data of the aluminum experiment, it shows that the intensity of the SL's second harmonic is much smaller than the intensity of the aluminum's second harmonic.

Keywords: nonlinear ultrasonic testing, nondestructive evaluation, superlattice (SL)

IS15

New functions of a semiconductor photodetector with a high-resistivity layer

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Abstract: New functionalities have evolved in semiconductor structures with high-resistivity layers between counter-directed potential barriers under conditions of longitudinal illumination and barrier closure. Mutual compensation of photocurrents due to potential barriers and, consequently, short-wave and long-wave spectral maximum are observed. In this case, the long-wavelength maximum coincides with the intrinsic absorption band of the semiconductor. Some technological solutions lead to abnormally high photosensitivity at the peaks of the spectrum. It is most pronounced in the short-wavelength maximum and results from an internal enhancement of the photocurrent. As the base layer narrows, the short-wavelength maximum shifts to the short-wavelength region. It is noteworthy that the mutual compensation of oppositely directed photocurrents creates very small dark currents, on the order of 10 nA. This, in turn, provides a low signal-to-noise ratio and the ability to record weak light signals. The capacitance-voltage characteristic has a maximum, the voltage value of which coincides with the difference in the heights of opposite potential barriers and makes it possible to identify the role of this difference in changing the sign of the spectral photocurrent. Changing the contact point of potential barriers depending on the external voltage changes the doses of individual waves absorbed in the potential barriers, which in turn opens up the prospect of creating a device for recording individual waves from the integral radiation flux.

Keywords: photodetectors, counter-directed potential barriers, high photosensitivity, photocurrent enhancement, radiation flux

IS16

Lanthanum-Doped Lead Zirconate Titanate Films for UV Sensing Applications

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Abstract: Ferroelectric materials have been extensively researched for several decades due to their piezoelectric, pyroelectric, and pyrooptic properties, exploring diverse applications. Ferroelectric thin films, unlike traditional semiconductor solar cells, can generate a photovoltage without the need for a p-n junction. This unique characteristic has led to the investigation of these materials as potential alternatives for photovoltaic applications, known as ferroelectric photovoltaic (FEPV). Among these materials, lead zirconate titanate (PZT) with a perovskite structure, especially near the morphotropic phase boundary, has been widely studied. The optical properties of PZT can be enhanced by doping it with La. However, the application of PLZT films in solar cell technology is limited due to low photocurrent and power conversion efficiencies resulting from its wide band gap. Considering the increasing demand for reliable and efficient UV monitoring technologies, driven by the adverse effects of ultraviolet (UV) radiation on human health and the environment, PLZT films present a promising solution. This study will present the preparation methods and structural, optical, ferroelectric, and photovoltaic properties of $Pb_{0.95}La_{0.05}Zr_{0.54}Ti_{0.46}O_3$ films. Various approaches employed to enhance the photocurrent of these films will also be discussed. The potential use of these films as UV sensors to develop portable wearable devices for personal use, such as real-time UV index monitoring to mitigate the harmful effects of UV rays on the skin, will be explored.

Keywords: Ferroelectric Photovoltaic, UV sensor, PLZT, Photocurrent, UV index, wearable

IS17

3D Printed Microwave Absorber

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ABSTRACT A high-performance microwave absorber was created using Fused Deposition Modeling (FDM) 3D printing. The absorber was designed at 4.9 GHz mid-band in WR-187 waveguide. Two types of carbon-loaded polylactic acid (PLA) plastic and unloaded PLA were printed with variable percentages of air to create different values of dielectric constant and loss tangent. A stack of six rectangular pieces of plastic each with different characteristics was optimized through computer simulation in HFSS and analytic modeling in MATLAB to maximize attenuation. The final load had simulated return loss of – 291dB at 4.9 GHz with an analytic solution in MATLAB and a corresponding result of -119 dB in HFSS. The measured return loss of the 3D-printed attenuator was -73.254 dB at 4.929 GHz. The total length of the absorber is 2.44 inches. A commercial absorber for WR-187 with a return loss of -40 dB has a length of 13 inches. The experiment proves that an effective microwave absorber can be created using 3D printing.

Index Terms microwave load, matched load, waveguide, attenuation, 3D printing.

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IS18

Zeolite-modified electrodes for electrochemical sensing: Surface and Interfacial Phenomena

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Abstract: This study presents the successful synthesis of Na-P1 zeolite by innovatively combining coal fly ash and fumed silica by-products. The zeolitization rate of started materials reached 84% and Na-P1 zeolite was the main neoformed phase with high crystallinity (104 %). The synthesized zeolite was strategically utilized as a modifier in graphite electrodes to enhance the electrochemical detection of heavy metals in fertilizer samples, addressing crucial environmental challenges. The electrochemical performance of the zeolite-modified electrode, specifically focusing on the detection of cadmium (II), was meticulously assessed through cyclic voltammetry (CV), square wave voltammetry (SWV) responses, and electrochemical impedance spectroscopy (EIS). Optimization parameters, including paste composition, solution pH, scan rate, and analyte concentration, were fine-tuned to enhance sensitivity and selectivity. Real-world applicability was demonstrated using fertilizer samples. The findings highlight the potential of Na-P1 zeolite in the development of handheld analytic devices, offering promising applications in environmental monitoring. This research aims to delve into the Surface and Interfacial Phenomena underlying the success of the zeolite-modified graphite sensing approach.

Keywords: zeolite-graphite electrode; Na-P1 zeolite; square wave voltammetry; heavy metals detection.

IS19

Two-Step Magnetron Sputtering And Annealing Process For The Synthesis Of High Crystalline And Single Phase CZTS And Cztse Absorber Layers

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Abstract: In this study, we introduce a novel two-step magnetron sputtering approach for synthesizing thin films of Cu_2ZnSnS_4 (CZTS) and $Cu_2ZnSnSe_4$ (CZTSe). The method entails depositing Cu_2SnS_3\ZnS and Cu_2SnSe_3\ZnSe stacks, followed by high-temperature sulfurization or selenization processes to produce the final CZTS and CZTSe films. Initially, Cu_2SnS_3 (CTS) and Cu_2SnSe_3 (CTSe) films were fabricated on soda lime glass (SLG) substrates through thermal treatment of different stacks. Subsequently, a ZnS or ZnSe layer was added to the CTS or CTSe films. The resulting CZTS and CZTSe films exhibited optimal stoichiometry and single-phase, kesterite-type crystalline structures. XRD and Raman spectroscopy confirmed the absence of secondary phases, while SEM analysis revealed homogeneous, dense, and well-adhered films. The optical bandgap values for CZTS and CZTSe films were approximately 1.5 eV and 1.0 eV, respectively, aligning with desired values for high-efficiency thin-film solar cells. EDS analysis validated the elemental composition and uniformity across the films. This method provides the advantage of producing high-quality CZTS and CZTSe films with precise stoichiometry control, no secondary phases, and favorable optical properties. Additionally, the two-step process enables enhanced control over film morphology and grain size, crucial for achieving high photovoltaic efficiency. Consequently, it emerges as a promising technique for the fabrication of efficient and cost-effective thin-film solar cells.

Keywords: Absorber layers, Kesterite, Thin films solar cells.

IS20

Electrocatalytic materials for anion exchange membrane fuel cells

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Abstract: Under the carbon neutrality scenarios, the demand for fuel cell electric vehicles (FCEVs) is rapidly growing. According to the IEA report, the transportation sector will demand more than 15,000 thousands of FCEVs by 2030. Besides continuing to improve the fuel cell performances, the fuel cells cost and FCEVs running cost come into attention. Anion exchange membrane fuel cells (AEMFCs) offer opportunities for using non-precious metal-based electrocatalysts for both anodic and cathodic reactions to reduce the fuel cell cost and relieve the concerns about Pt scarcity. This presentation will be focused on our recent efforts in the development of non-precious metal-based electrocatalysts for alkaline oxygen reduction reaction (ORR) and CO-tolerant electrocatalysts for hydrogen oxidation reaction (HOR). A couple of new strategies will be introduced to develop efficient electrocatalysts, including a molecular-based cascade anchoring strategy for general mass production of high-density metal-nitrogen single-atomic catalysts, metastable rocksalt oxide-mediated synthesis of high-density well-armored transition metal nanoparticle electrocatalysts, and interface assembly strategy for achieving high-density binary single-atomic catalysts with much improved active site utilization. Moreover, the binary active sites electrocatalysts will be introduced to synergistically boost the elementary reactions of the alkaline HOR. These results may provide new insights for the rational design and bottom-up synthesis of cost-effective and high-performance electrocatalysts for AEMFCs.

Keywords: Hydrogen energy, Fuel cells, Electrocatalysts, Nanomaterials

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IS21

3D and 4D Printed Nanocomposite Contact Lenses for Ocular Health Management

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Abstract: In this study, we presented the fabrication of tinted contact lenses for color blindness, and several issues related to their mechanical properties and toxicity were reported. Gold nanoparticles were integrated into the soft hydrogel material-based contact lenses, thus forming nanocomposite contact lenses targeted for red-green CVD application. The integration of nanomaterials into hydrogels is a prominent research challenge for a myriad of healthcare applications, such as bio-sensing, cancer therapy, and bone tissue engineering. In particular practical contact lenses, functionalized with metallic nanoparticles are of interest for therapeutics and targeted therapy. Several types of nanoparticles were synthesized, characterized, and incorporated within the pHEMA hydrogel material. The materials were utilized along with a Vat Photopolymerization 3D printer for printing soft contact lenses, and their resulting optical, mechanical, hydration and material properties were assessed. The optical transmission properties of the 3D printed nanocomposite lenses were found to be analogous to those of the commercial CVD glasses, and their water content and wettability properties were better in comparison to some of the commercially available contact lenses used for cosmetic/vision correction purposes. Hence, this work demonstrates the potential of 3D printing multi-functional and nanocomposite contact lenses for ocular health management and, more generally, color filtering applications.

Keywords: Contact lenses, 3D printing, nanocomposites, biomedical application

IS22

Experimental investigations on electrical properties of Al_2O_3 and Cyclic Olefin Copolymer composites

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Abstract: Understanding the performance of polymer dielectrics at different temperatures is becoming increasingly important due to the rapid development of electric cars, electromagnetic devices, and new energy production solutions. An attractive material due to its low water absorption, good electrical insulation, long-term stability of surface treatments, and resistance to a wide range of acids and solvents is the cyclic olefin copolymers (COC). This work focused on the dielectric and electrical properties of Cyclic Olefin Copolymer (COC)/Al_2O_3 composites over a wide range of temperature and frequency domains, from room temperature to cryogenic temperatures (around 125K). Permittivity, electrical conductivity, and electrical modulus are given consideration. The composite of Al_2O_3 with up to 50% mixed with COC was prepared via a conventional melt blending method. The final samples were formed in sheets and processed using injection and extrusion moldings. It was found that formulations with Al_2O_3 concentrations ranging from 10 to 50% resulted in higher electrical conductivity while maintaining the viscosity of the composite at a level acceptable for polymer processing machinery. By altering the filling concentration, it was possible to control the ϵ_R of the composites. Our data shows that the use of composites has a substantial potential to develop materials for high-frequency applications starting at cryogenic temperatures.

Keywords: Cyclic Olefin Copolymer, dielectrics, cryogenic temperature,

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IS23

Effects of change of chirality of green dielectric gold nanoparticles on the antimicrobial activity

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Abstract: Gold nanoparticles (AuNPS) are widely used metallic nanoparticles with unique surface plasmon characteristics. They have applications in biomedical and therapeutic fields. The principal method to synthesize particles is chemical, with the principal disadvantage of toxicity in living organisms, an alternative is the use of plant or fruit extracts, with a high content of phenolic compounds. AuNPs present a dielectric constant and electrical conductivity that may be used as important risk factors for bioaccumulation and toxicity of the smaller GNPs. The present study aims to study the effect of AuNPS chirality surface on the dielectric constant, electrical conductivity, and antimicrobial activity. AuNPs were prepared by green synthesis with an aqueous extract of Pirul. The modification of chirality is carried out by adding L or D-cysteine to the surface and corroborating it through a chirality analysis. The AuNPs were characterized by TEM to determine their size and morphology, and the particle size dispersion was evaluated by DLS, Z potential, and electrical parameters were obtained with a precision component analyzer. The microbiological activity was evaluated by the disk technique and the MIC and MBC against microorganisms with medical importance. AuNPs with different morphologies were obtained (spherical, triangular, and hexagonal) and diameters between 10 and 20 nm. The diameter increased after surface functionalization by 3 to 4 nm more, while the morphologies remained similar. The functionalization of the surface was verified through a chirality study, observing that the cysteine adhered to the surface, giving them L or D chirality. It was also confirmed that the functional groups of the cysteine and the extract are present on the surface with the help of an IR analysis. AuNPs present strong dielectric dispersion corresponding to the alpha relaxation region, and the conductivity values are dependent on the size of the particles; this parameter can be related to a major accumulation and better activity in cells. It was found that the change in chirality affects the antimicrobial properties of the particles, since when modifying to a chirality D, the activity decreases, while with L, it increases by up to 30% and allows antifungal activity against *C. albicans*. The functionalization of green gold nanoparticles was achieved by changing their chirality with the addition of the cysteine in its L or D conformation; these changes impact the electrical properties and antimicrobial activity, increasing or decreasing it according to the chirality obtained.

Keywords: Dielectric materials, Gold nanoparticles, Biomedical application, Antimicrobial activity

IS24

Vibrational Study of Hybrid Systems Based on Carbon Nanotubes For Organic Solar Cells

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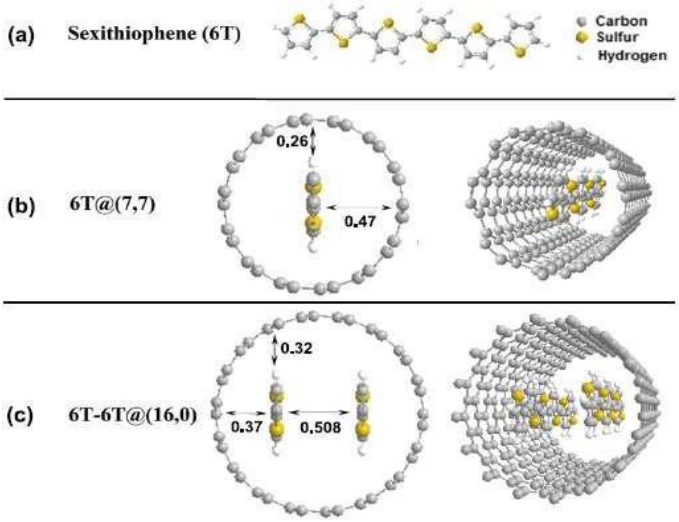
Abstract: Since the discovery of carbon nanotubes, much attention has been devoted to the investigation of their vibrational properties, experimentally as well as theoretically. Optical spectral methods have proven very useful in providing experimental information that can help characterize real carbon nanotube samples. In particular, Raman spectroscopy has been the method of choice in the investigation of the vibrational properties of carbon nanotubes. Nevertheless, the use of Infrared spectroscopy to study the chemistry of carbon nanotubes implies the knowledge of the Infrared intrinsic vibrational modes. In this work, we report the calculation results of Raman and infrared active modes in different systems studied in our laboratory like SWCNTs, DWCNTs, MWCNTs, and hybrid systems. Raman and Infrared spectra calculations are performed using the spectral moments method. We present the evolution of the Raman and Infrared spectra as a function of the diameter, chirality, and length of the nanotubes composing the system studied. The results are useful for the interpretation of future experimental work. In this theoretical work, we study the Raman spectra of hybrid nanostructures obtained by confinement of oligothiophene derivatives in SWCNTs. Minimum energy calculations are performed using a convenient Lennard-Jones expression of the van der Waals intermolecular potential, to derive the optimum configurations of oligothiophene with SWCNTs. Raman spectroscopy showed evidence of a significant positive charge transfer on the inserted oligothiophene. Both the G-band intensity and the low-frequency modes vanishing suggest a significant charge transfer between the bithiophene and the SWCNTs, which makes these hybrid systems potential candidates for possible organic solar cells.



IS25

Thermally Controllable Dual-Scale Roughness for Superhydrophobic, Transparent, and Durable Coatings to Optimize the Cleaning Process of Solar Panels

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Abstract: It is widely recognized that the accumulation of dirt on the surface of photovoltaic (PV) panels significantly diminishes electricity production due to obstructed light-to-panel contact caused by dust. Despite various cleaning methods, including robots and hoses, they are hindered by issues of inefficiency, cost, and feasibility. Recently, self-cleaning transparent coatings have emerged as a promising solution, reducing dust adhesion through the utilization of low surface energy micro/nanostructures. The application of superhydrophobic coatings necessitates striking a balance between self-cleaning, transparency, and durability, three conflicting attributes. This study's innovation lies in the development of a self-cleaning, robust, and ultra-transparent coating with thermo-controllable roughness, whether at one or two scales, achieved using the sol-gel technique by combining a layer of SiO2 nanoparticles mixed with an inorganic resin, followed by a random polymerization of methyl trichlorosilane on the surface of the nanoparticles, to create additional rods and increase the surface roughness while maintaining the glass transparency. The results demonstrated a contact angle >160° with a sliding angle close to 0° and a transmittance of 85 %. Tests for self-cleaning and anti-icing were applied to the surface and demonstrated excellent performance. Furthermore, the coating exhibited excellent chemical, mechanical, and thermal stability, with better resistance to UV rays. This method opens new perspectives for the design of highly performing-surfaces for various industrial applications. Rigorous durability tests were conducted on the coating to assess its stability. Notably, the coating demonstrated remarkable resistance against abrasion for up to 35 cycles and displayed excellent tolerance to high temperatures, maintaining its superhydrophobic properties even at temperatures higher than 280°C. The coating also exhibited substantial resistance to UV radiation for 50 hours and retained its stability under intense sandblasting pressures. Self-cleaning tests were conducted on both the coated and uncoated surfaces, revealing that the coating offers several advantages in terms of surface cleaning.

IS26

Green synthesis under microwave of the Knoevenagel-phosphate-Michael Addition Reaction by Doped Natural Phosphate

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Abstract: This research delves into the catalytic mechanism of the Knoevenagel-phospha-Michael addition reaction, specifically focusing on its application in the synthesis of β-phosphonomalonates. These compounds are renowned for their captivating biological properties, serving diverse roles as enzyme inhibitors, metabolic probes, and intermediates in organic synthesis. The spectrum of their biological activities encompasses anticancer, anti-inflammatory, antimalarial, and antimicrobial properties. The catalyst employed in this study is derived from naturally occurring phosphate, doped with zinc chloride. The preparation and characterization of this catalyst were conducted through a comprehensive array of analytical methods, ensuring a thorough understanding of its composition and properties. The experimental setup involved the use of various aldehydes, malononitrile, and diethyl phosphite to systematically evaluate the catalytic efficiency of the prepared phosphate-zinc chloride catalyst. In the pursuit of identifying optimal catalysts and refining operational parameters, comparative assessments were conducted with alternative catalysts such as natural phosphate, fluorapatite, and hydroxyapatite. The outcomes of these experiments indicated a marginal but noteworthy advantage for the zinc chloride-doped natural phosphate under microwave irradiation conditions. This preference suggests the existence of a synergistic effect between zinc chloride and natural phosphate, unveiling a potential avenue for enhancing catalytic performance in the studied reaction. The findings contribute valuable insights to the field of catalysis and may pave the way for the development of more efficient processes in the synthesis of biologically active β-phosphonomalonates.

Keywords: Heterogeneous catalysis, Natural phosphate, β-phosphonomalonate and Knoevenagel-phospha Addition of Michael.

IS27

Green Synthesis and Doping Strategies for Enhanced ZnO Photocatalysts: Sustainable Approaches for Solar-Driven Dye Remediation

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Abstract: This research endeavors to develop sustainable and efficient ZnO photocatalysts through a green synthesis approach and advanced doping strategies for the solar-driven remediation of dyes. The study integrates environmentally friendly methods for synthesizing ZnO nanoparticles and explores the synergistic effects of dopants to enhance visible light absorption and improve charge carrier dynamics. The research combines principles of green chemistry, materials science, and environmental engineering to contribute towards the development of eco-friendly and effecve photocatalytic technologies for dye degradation. The synthesized materials were characterized by various analytical techniques such as XRD, FTIR, Raman UV–vis, SEM, EDX, and TEM. The objective of the study includes implementing green synthesis methods for ZnO nanoparticles using biocompatible and eco-friendly precursors and investigating the impact of various green synthesis parameters on the size, morphology, and crystalline structure of ZnO nanoparticles. This study also explores green dopants (e.g., plant extracts, bio-derived molecules) for modifying the electronic and optical properties of ZnO and assesses the influence on the photocatalytic performance of ZnO for the remediation of organic dyes. We evaluate the stability and reusability of green-synthesized and doped ZnO photocatalysts for practical applicaons. Additionally, we have investigated the antibacterial efficacy against Escherichia coli and Staphylococcus aureus bacteria.

IS28

Next-Generation Sensors Using Artificial Intelligence as Enabling Technologies for Biomedical and Healthcare Applications

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Abstract: Infectious diseases, especially the ones that are antibiotic-resistant, pose the biggest threat to global health. Currently, bacterial contamination is detected using conventional culturing techniques, which are limited by the processing time and on-site availability. Thus, real-time and continuous monitoring of pathogen levels is necessary to analyze information that could assist prevention and containment of outbreaks. Nanotechnology-based smart sensors present new avenues for rapid detection of such pathogens at the patient's point of care. Hence, nanomaterials play a vital role in bacterial sensing due to their unique characteristics. Carbon nanoparticles, metallic nanoparticles, metal oxide nanoparticles, and various types of nanocomposites are examples of smart nanomaterials that have drawn intense attention in the field of microbial detection. Such characteristics in conjunction with the fourth industrial revolution, viz. artificial intelligence (AI), have led to the development and application of health monitoring sensors by digitalization and intelligence and predictably will help identify the location and source of the next. novel coronavirus variant or Disease X outbreak. Furthermore, adding piezoelectric materials to nanosensors provides an additional energy-harvesting capability for their use in standalone applications. These sensors have applications in medical care, personal health management, elderly care, sports, and other fields, providing convenient and real-time healthcare services. However, these sensors face limitations such as noise, drift, difficulty in data extraction, and lack of feedback or control signals. AI provides powerful tools and algorithms for data processing and analysis, enabling intelligent health monitoring, and achieving high-precision predictions and decisions. By integrating the Internet of Things (IoT), artificial intelligence, and health monitoring sensors, it becomes possible to realize a closed-loop system with the functions of real-time monitoring, data collection, online analysis, diagnosis, and treatment recommendations. We provide an overview of the development of healthcare artificial sensors enhanced by intelligent technologies from the aspects of materials, device structure, system integration, and application scenarios. Specifically, this review first introduces the great advances in wearable sensors for monitoring respiration rate, heart rate, pulse, sweat, and tears; implantable sensors for cardiovascular care, nerve signal acquisition, and neurotransmitter monitoring; and soft wearable electronics for precise therapy. We further refer to human-machine interfaces, AI-enhanced multimode sensors, and AI-enhanced self-sustainable systems. In summary, a fusion of AI, IoTs, and next-gen sensors will provide more intelligent, convenient, and secure services for healthcare and biomedical applications.

Keywords Healthcare, Artificial, Wearable sensors, Implantable sensors, Human-machine interfaces, Artificial intelligence of things

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Contributed

SP1

Advancements in Carbon Fiber 3D Printing for Energy Research

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Abstract: This study explores the applications of 3D printing technology in energy research, focusing on the utilization of the Onyx Pro 3D printer in the Physics department at Tuskegee University, for the fabrication of advanced energy storage and harvesting devices. Carbon fiber-reinforced composites offer superior mechanical and thermal properties, making them ideal for applications in energy devices. The study investigates the influence of carbon fiber orientation, volume fraction, and distribution on the mechanical and electrical properties of the printed components. The printer's capability to combine various materials, including polymers and conductive additives, allows for the creation of complex structures with tailored properties for energy applications. Additionally, the study explores the use of 3D printing in the fabrication of piezoelectric sensors. The ability to create custom geometries and integrate functional materials enables the development of efficient energy conversion systems. Overall, this research demonstrates the potential of 3D printing technology in advancing energy research by enabling the fabrication of complex energy devices with enhanced performance and functionality.

Keywords: 3D printing, Onyx Pro, advanced composite materials, piezoelectric sensors, batteries & energy harvesting.

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SP2

Synthesis and development of a new $Mn_{1-x}Cu_xMoO_4$ inorganic chromophores by using the sol-gel method and exploring their properties

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Abstract: The synthesis of nanomaterials and especially nanoparticles has been of increasing interest in the last decades[1-2]. This work aims to synthesize and characterize a novel series of environmentally friendly nanomaterial pigments based on copper-doped manganese molybdate, described by the general formula $Mn_{(1-x)}Cu_xMoO_4$ ($0 \leq x \leq 0.075$). The synthesized pigments manifested various shades of beige-yellow (Mn, Cu). Powders obtained through the sol-gel route were subjected to comprehensive characterization using thermal analysis (TGA- DTA), X-ray diffraction (XRD), infrared (IR), and UV-visible spectroscopies. Scanning electron microscopy (SEM) analysis was employed to examine the morphology of the resulting powders. Colorimetric parameters (CIE L*a*b*) were measured to investigate the color evolution with the substitution rate (x). All compounds exhibited crystallization in the monoclinic system with the C2/m space group, belonging to the β-$MnMoO_4$ phase. The SEM micrographs of $Mn_{(1-x)}Cu_xMoO_4$ show heterogeneous microstructures with the presence of small grains juxtaposed to large platelets. This result is similar to that observed in previous studies. The specific surface area (BET) of the powders increased proportionally ~~to~~ when Mn^{2+} ions were replaced by Cu^{2+} ions in the $MnMoO_4$ phase, to reach the highest value for the $Mn_{0.925}Cu_{0.075}MoO_4$ powder at approximately $8.09 m^2/g$. The successful alteration of pigment color from beige to yellow by introducing copper into ~~the~~ $MnMoO_4$ matrix highlights the control exerted by doping on pigment color. Optical properties results suggest that $Mn_{(1-x)}Cu_xMoO_4$ solid solutions can be classified as semiconducting materials.

Keywords: Citrate pathway; Characterization; Morphology; $Mn_{(1-x)}Cu_xMoO_4$; Semiconducting materials; CIE Lab*; Pigment.

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SP3

Hygrometric Investigation of the Influence of Cadmium, Magnesium, and Ferric Ions on the Thermodynamic Activities of Phosphoric Acid Solutions at T=333.15 K

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Abstract: The existence of metal ions in phosphoric acid can affect its purity, quality, and suitability for various applications. These ions can promote undesirable reactions, and disrupt industrial processes. Cadmium impurities may be present in phosphoric acid as a result of various sources, including raw materials, or contamination during the production process. Cadmium is a dangerous heavy metal that presents health and environmental risks [1]. Phosphoric acid may contain also magnesium impurities originating from phosphate ores. The presence of magnesium in phosphoric acid production can affect product quality by disrupting the desired chemical reactions in industrial processes. It can also lead to an increase in viscosity, thus altering the color of the final product [2]. Phosphates contain iron contents between 0.1 and 2.0%. The dissolved ferric ion also contributes to the formation of very stable metal complexes with the species present in the concentrated phosphoric acid [3]. In this context, the investigation of thermodynamic properties becomes crucial for understanding the reactions involved and assessing the impact of those ions in the solution. Using the hygrometric method, the water activities were carried out at a temperature of 333.15 K [4]. By analyzing these thermodynamic parameters, we can compare the synergy of cadmium, magnesium, and ferric ions in the phosphoric acid solutions for different concentrations. This approach provides an overview of the behavior of cadmium, magnesium, and iron ions in phosphoric medium. It also helps to develop appropriate solutions based on thermodynamic considerations.

Keywords: Phosphoric acid, metallic ions, hygrometric method, water activity.

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SP4

Synthesis And Characterization Of Novel (1-X) $Ba_{0.85}Sr_{0.15}tio_3$ - X $Cofe_2o_4$ [BST-CFO] Multiferroic Nanocomposites: Investigation On Dielectric Properties And Energy Storage Behavior.

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Abstract: This work presents studies on the dielectric and ferroelectric behavior of composite multiferroics, materials that are strong candidates for next-generation multifunctional devices. These investigations have been carried out on matrix-based composite magnetoelectric multiferroic consisting of magnetostrictive cobalt ferrite ($CoFe_2O_4$: CFO) and ferroelectric Barium Strontium Titanate ($Ba_{0.85}Sr_{0.15}TiO_3$: BST) with the magnetostrictive phase embedded in a matrix of the ferroelectric phase. New lead-free multiferroic (1-x) Ba0.85Sr0.15TiO3 - x $CoFe_2O_4$ (x = 0, 0.15, 0.30, 0.45) nanocomposite were prepared by the conventional solid-state reaction method. The phase composition and surface morphology of the elaborated BST-CFO composites were characterized by X-ray diffraction (XRD) and scanning electron microscope (SEM). The dielectric and ferroelectric properties of the composites were systematically investigated in the frequency range from 100 Hz to 1 MHz and temperature from 25 to 500 °C. The X-ray diffraction and scanning electron microscopy examinations confirm the presence of two phases in the composite: spinel cubic CoFe2O4 and tetragonal $Ba_{0.85}Sr_{0.15}TiO_3$ and show that the CFO nanoparticles were well distributed in the BST matrix. The dielectric responses show that the BST-CFO composites have colossal dielectric permittivity and are significantly modified by the incorporation of CFO nanoparticles in the matrix of BST. The values of remanent polarization P_r and coercive field E_c were decreased with increasing the percentage of CFO. Energy storage properties of composites have been examined via P-E (electrical field–polarization) loops analysis and confirmed that the energy storage efficiency increases with the incorporation rate of CFO.

Keywords: Ferroelectric $BaSrTiO_3$, Co-ferrite (CFO) , microstructure, Dielectric properties, energy storage,

SP5

Eco-Friendly Chalcogenides Semiconductors Cu_2XSnS_4 (X: Zn, Ni, Fe, Co): Elaboration, Characterization and Solar Cells Application

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Abstract: The Eco-Friendly quaternary chalcogenides semiconductors with chemical formula Cu_2XSnS_4 where X is the zinc or nickel or cobalt (X= Zn, Ni, Co) were successfully synthesized by facile sol-gel route, using the spin coating technique and without sulfurization step. Their structures, surface morphologies, composition, and optical, and thermoelectric properties were determined by X-ray diffraction, Raman spectroscopy, scanning electron microscopy, energy dispersive x-ray spectroscopy, and UV-visible-NIR double beam spectrophotometer. Also, to test the possibility of using the elaborated materials for photovoltaic applications, the solar cells with the Cu_2XSnS_4 (X = Zn, Ni, Fe, Co) as absorbing materials were prepared. Current density-voltage (J-V), and AC impedance spectroscopy measurements were used to characterize the cell devices under dark and standard AM 1.5 sunlight conditions.

Keywords: chalcogenides Cu_2XSnS_4, sol-gel, spectroscopy, characterization, solar cells.

SP6

Dielectric behavior and AC electrical conductivity of poly(methyl methacrylate)/Polypyrrole-doped composites

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Abstract: This work presents the electrical and dielectric properties of poly(methylmethacrylate) (PMMA) composites filled with conductive polypyrrole (PPy) particles in the frequency range from 600 Hz to 1 MHz and in the temperature range from 290 K to 380 K. The temperature dependence of the dielectric response has been analyzed below and at near the glass transition temperature of PMMA polymer for the concentrations above the percolation threshold. The shape of experimental spectra of these composite materials gives evidence of a typical dielectric relaxation process which could be attributed to the freezing process of dipoles and Maxwell-Wagner-Sillars (MWS) interfacial polarization. In addition, the investigation of AC conductivity indicated a thermally activated conduction mechanism, explained by a correlated barrier hopping (CBH) model. Notable, the decrease of activation energy with increasing frequency observed was also discussed from the CBH model.

Keywords: Conducting particles, Dielectric analysis, Impedance spectroscopy, Electrical conductivity, interfacial polarization.

SP7

Multi-Faceted Approach: QSAR, Molecular Docking, Molecular Dynamics Simulations, and ADMET Evaluation for Enhanced Binding of SARS-CoV 3CLpro Derivatives as Potent Peptidomimetic Inhibitors

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Abstract: The research centered on constructing a quantitative structure-activity relationship (QSAR) model to forecast the effectiveness of molecules against the SARS-CoV 3-chymotrypsin-like protease (3CLpro). Thirty molecules underwent selection for analysis. Validation of the QSAR model occurred both internally and externally, with assessments of statistical significance and predictive capability conducted through various tests. The model exhibited remarkable predictive accuracy, pinpointing five descriptors (NHA, NRB, ELUMO, μ, and TE) as pivotal factors influencing inhibitory activity. Utilizing the model, novel compounds can be designed based on the structure of SARS-CoV 3CLpro derivatives, enabling prediction of their anti-coronavirus potential. Moreover, thirty-five fresh molecules targeting SARS-CoV 3CLpro were generated by modifying an active molecule (molecule 24), adhering to drug-likeness principles. Molecular docking analysis explored ligand-receptor interactions, revealing enhanced affinity of the designed compounds over the reference inhibitor. Pharmacokinetic and toxicity evaluations, including ADMET analysis, indicated that the compounds met descriptive criteria at acceptable levels, demonstrating favorable intestinal permeability and water solubility while achieving therapeutic goals. Molecular dynamics simulations provided insights into the stability of the newly devised compounds, singling out compound X35 as a prospective candidate for further development as a novel SARS-CoV 3CLpro inhibitor for coronavirus treatment.

Keywords: QSAR, 3CLpro, ADMET, Molecular Docking, Molecular dynamics simulation

SP8

Substitution Effects in Oxide Semiconductors ($BIMeVO_X$) on Chemical, Physical, Electrical, Optical, and Microstructural Properties. Photocatalytic Applications on Pharmaceutical Products

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Abstract: In the BiMeVOx lattice $Bi_4V_2O_{11}$, copper (Cu^{2+}) and antimony (Sb^{5+}) cations are utilized as substitutes for vanadium (V^{5+}), resulting in the formation of polycrystalline samples with compositions in the range of $0.00 \leq x \leq 0.45$, denoted as $Bi_4V_{2-x}Cu_{x/2}Sb_{x/2}O_{11-3x/4}$. The solid-state reaction method was employed to synthesize these samples. To confirm the formation of the solid solution and comprehend the local structural modifications in each composition, various techniques including X-ray diffraction, thermal analysis, IR, and Raman spectroscopy were employed. The compound with x = 0.1 exhibits crystallization in the monoclinic α-$Bi_4V_2O_{11}$ form, while the compounds with $0.20 \leq x \leq 0.45$ correspond to the γ and γ' tetragonal forms. The microstructure of the different samples was examined using scanning electron microscopy (SEM) to investigate the influence of composition. The evolution of electrical conductivity about the ratio of copper and antimony was assessed through electrochemical impedance spectroscopy, and its correlation with structural transformations was established. The double substitution of copper and antimony resulted in an enhancement of ionic conductivity. Notably, the sample with x = 0.2 ($Bi_4V_{1.8}Cu_{0.1}Sb_{0.1}O_{10.85}$) exhibited the highest ionic conductivity value ($\sigma_{600°C} = 4.5\times10^{-2}$ S.cm^{-1}). The band gap of the materials was determined via diffuse reflectance spectroscopy (DRS), indicating that the BiCuSbVOx materials possessed a lower band gap (1.94 eV for the sample with x = 0.15) compared to the parent phase $Bi_4V_2O_{11}$.

Keywords: BiCuSbVOx, solid-state synthesis, band gap, ceramics, ionic conductivity.

SP9

Green synthesis of magnesium oxide nanoparticles from leaf extract and modeling of Adsorption for the Removal of Bemacid Red using BBD-RSM and ANN approach

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Abstract: Green synthesis is a simple, ecologically friendly, and innovative approach to synthesizing nanoparticles (NPs) that is now receiving scientific interest from all around the globe[1]. The current work sought to synthesize green magnesium oxide (MgO) NPs and assess their effectiveness for the adsorption of the Bemacid Red dye in an aqueous solution. MgO NPs were synthesized utilizing leaf extracts of plants to examine their treatability for wastewater. The green synthesized MgO NPs were also characterized using a UV-visible spectrophotometer, Scanning Electron Microscopy coupling with Energy-dispersive X-ray spectroscopy (SEM-EDX), Fourier Transform Infrared (FT-IR) spectroscopy, X-ray Diffraction (XRD), X-ray fluorescence (XRF), and differential thermal analysis and thermogravimetric (TGA-DTA). The current research used a response surface methodology (RSM)-artificial neural network (ANN) technology to optimize and predict model dispersion dye removal via Br dye adsorption. Furthermore, the green synthesised MgOs NPs removed 99.08% of the BR dye. Overall, green synthesized MgO NPs demonstrated the incredible potential of in situ industrial dye manufacturing as a clean-green treatment alternative.

Keywords: *Green synthesis, adsorption process, magnesium oxide, be acid red*

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SP10

Dielectric relaxation of polyester-based composites reinforced with Argan Nut Shell Powders

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Abstract: Dielectric measurements were performed on Argan nut shell powder (ANS) reinforced unsaturated polyester matrix (PS) by means of an Alpha Dielectric/impedance Analyser (Novocontrol) in the temperature and the frequency range from 303 K to 453 K, and 0.1 Hz to 1 MHz, respectively. Different ANS weight fractions (2 wt%, 4 wt% and 6 wt%) were taken into account in this study. Three main dielectric relaxation processes were identified. At low temperatures, dielectric relaxations were associated with water dipole polarization originating from ANS fillers due to their hydrophilic character. At higher temperatures and intermediary frequency ranges dielectric relaxations were attributed to the α relaxation process originating from the glass rubbery transition of the matrix. Whereas, at higher temperatures above the glass transition temperature and low frequencies, dielectric relaxations were identified as the interfacial polarization effect due to charge accumulation at filler/matrix interfaces. Filler/matrix interactions were probed according to the interfacial polarization effect taking into account the ANS weight fraction increase.

Keywords: Argan nut shell, Unsaturated polyester matrix, Biocomposites, Dielectric relaxations, Interfacial polarization effect.

SP11

Recent advancements in the electrolytic water-splitting process for hydrogen production

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Abstract:

Hydrogen, as an environmentally friendly element and a source of sustainable energy, is garnering increasing interest as an energy substitute. At the core of this energy transition, water electrolysis emerges as one of the predominant techniques for hydrogen production. This in-depth study delves into the essential foundations underlying the water electrolysis process, explores the various categories of electrolytic cells employed, and analyzes recent advances in catalyst development, and key elements for enhancing the overall efficiency of the process. By examining the fundamental principles, the study details the mechanism by which water electrolysis splits water molecules into hydrogen and oxygen using an electricity source. It also explores different categories of electrolytic cells, including alkaline, acidic, and proton-exchange membrane cells, highlighting their specific applications and respective advantages. The analysis also focuses on recent breakthroughs in the field of catalysts, emphasizing their crucial role in improving the efficiency of the electrolysis process. Innovative developments aiming to make catalysts more durable, affordable, and efficient are examined, laying the groundwork for significant progress in hydrogen production. Furthermore, the study addresses essential considerations related to energy efficiency, environmental sustainability, and economic viability of water electrolysis technology. The evaluation of the process's energy performance, its environmental impact, and its positioning relative to other hydrogen production methods contribute to a holistic understanding of its potential as an energy solution.

Keywords: Hydrogen; Water Electrolysis; Electrochemistry; Renewable Energy.

SP12

Effect of Annealing Time on the Properties of the CNTS Thin Films

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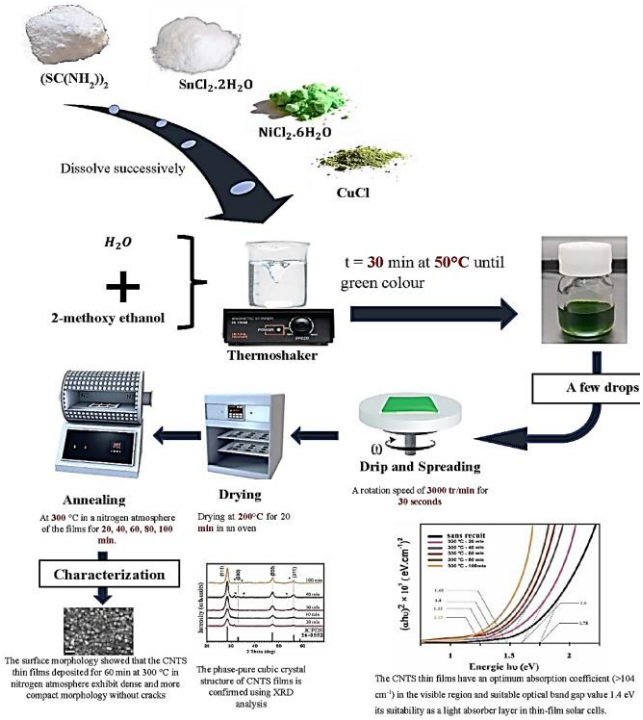
Abstract: Cu_2NiSnS_4 (CNTS) thin films were deposited using a spin-coating technique without sulfurization. The Effect of annealing time on the structural, morphological, compositional, optical, and electrical properties was reported. X-ray diffraction, Raman spectroscopy, scanning electron microscopy, energy dispersive analysis, UV-Vis-NIR spectrometry, and Hall-effect measurements were used to investigate the physical and chemical properties of the deposited CNTS thin films. After annealing for 60 min at 300°C in a nitrogen atmosphere, the prepared thin films exhibit a pure cubic structure, good morphology without any cracks, and are almost stoichiometric. The obtained absorption coefficient, optical bandgap, resistivity, and mobility of the annealed thin films for 60 min at 300 °C are found to be 10^4 cm^{-1},1.4 eV, 0.4 Ωcm, 3.4 cm^2/Vs, respectively. Their characteristics indicate that CNTS are potential absorber materials for solar cell application.



SP13

Water Treatment and Recovery of Sludge in Vitrification

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Abstract: Traditional chemical coagulants used for water treatment often pose potential risks to human health and the ecosystem due to their toxic nature and high operational costs. This study investigates the potential of caper (CAP) as an alternative to chemical coagulants for the removal of Cu and Zn from wastewater, employing response surface methodology (RSM) to optimize the coagulation process. The values obtained for the removal of Cu, and Zn using caper are 99.85%, and 89.58%. The study encompasses a comprehensive characterization of the CAP-based treatment process through various techniques, including Fourier Transform Infrared Spectroscopy (FTIR), X-ray Diffraction (DRX), and Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy (SEM-EDX). Moreover, the study explores the sustainable management of generated sludge from the wastewater treatment process. The focus is on the valorization of sludge through vitrification, aiming at environmental protection and resource recovery. Vitrification serves as an environmentally friendly approach, minimizing the environmental impact of sludge disposal while recovering valuable materials. This research contributes to the field by presenting an integrated approach that combines effective wastewater treatment using caper as a biocoagulant-flocculant, thorough characterization of the treatment process, and the environmentally responsible valorization of sludge.

Keywords: *Characterization, Metals, Caper, Optimization, Vitrification, Water treatment*

SP14

Harvesting Energy from Garden Compost Leachate through Microbial Fuel Cells for Tomorrow's Sustainable Power Generation

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Abstract: Microbial Fuel Cells (MFCs) offer a sustainable solution by simultaneously generating bioelectricity and treating wastewater. This study investigates the potential of electricity production from garden compost leachate using an MFC equipped with an air cathode. The compost leachate, with a chemical oxygen demand (COD) of 1623 mg/L, served as a substrate for electricity generation. On day 15, the MFC achieved a maximum voltage of 428 mV and a maximum power density of 148.95 mW/m², demonstrating its efficiency in harnessing energy from compost leachate. Furthermore, an impressive 81.45% reduction in total COD was observed, highlighting the MFC's effectiveness in wastewater treatment. Energy-dispersive X-ray spectroscopy (EDX) confirmed the decomposition of organic compounds in the leachate. Surface morphology and electrode composition changes were revealed through EDX and scanning electron microscopy (SEM). Additionally, the MFC demonstrated the removal of heavy metals, including Zn, Cu, Cr, Cd, As, and Ni, from the leachate. These findings underscore the MFC's potential not only for electricity production from organic waste but also for the concurrent treatment of effluents. In conclusion, MFCs emerge as a promising and sustainable approach for addressing both energy generation and wastewater treatment challenges.

Keywords: Microbial fuel cell, electro-active biofilm, chronoamperometry, microorganism, Harvesting Energy.

SP15

Elaboration, Characterization, and Thermodynamic Study of Superphosphate in Aqueous Solutions At 313.15 K

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Abstract: Inorganic phosphates are a large and diverse class of materials with many important industrial uses, for example, as catalysts, ion exchange materials, solid electrolytes for batteries, phosphors detergents, and fertilizers. Recently, much effort has been devoted to the investigation of $M_xH_y(AO4)_z$ type (where M = Cs, Rb, K, Na, Li, NH_4; A = S, Se, As, P), as a new family known by their transport properties in a wide class of proton conductors. The knowledge of the thermodynamic properties of aqueous superphosphate salts is of great interest to understanding the physicochemical processes and equilibrium in these aqueous solutions. The main objective is to develop and study the structural characterization of a superphosphate salt. Their thermodynamic properties in aqueous solutions were studied from dilute to saturated solution at 313.15 K. The experimental water activities were performed using the hygrometric method. The relevant properties such as osmotic and activity coefficients and solubility were evaluated by the developed ion interaction models.

Keywords: superphosphates, water activity, osmotic coefficient, activity coefficient, hygrometric method, thermodynamic modeling

Online

OL1

Broad Band Dielectric Spectroscopy - Challenges and Results

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Abstract: The dielectric response of materials provides information about the orientational adjustment of dipoles and the translational adjustment of mobile charges present in a dielectric medium in response to an applied electric field. Microwave and terahertz dielectric spectroscopy of ferroelectrics and related materials enables the independent determination of the dielectric permittivity and loss in the dispersion region, as well as the parameters of the soft modes related to phase transitions. Besides scientific purposes, microwave dielectric measurements are of increasing importance in telecommunications-related applications and the design of microwave circuit components. These applications include imaging radars, guidance systems, surveillance, and secure communications. The magnetic properties are also of crucial importance. Dielectric and magnetic parameters fully characterize how electromagnetic waves propagate within the medium. The difficulties of making measurements on a wide range of materials over a wide frequency (and temperature) range have led to the development of various direct and indirect methods. At microwave frequencies, the direct single-frequency methods were enriched in recent years with more convenient broadband frequency domain dielectric spectroscopy (FDDS), time-domain spectroscopy (TDS), and Fourier transform spectroscopy (FTS). Computer-controlled spectrometers are now the norm in dielectric spectroscopy. Computers allow the computation of electromagnetic fields in entirely new measurement geometries and the use of numerical analysis in the direct measurement process. The use of such spectrometers is now one of the most fruitful factors in new approaches to microwave dielectric spectroscopy. Each investigator employs a method adequate for the size and shape of a sample. The most important problem now is the rigorous mathematical solution of the microwave interaction with the samples in various geometries. Although there is now complete overlap and coverage of the radio frequency to the infrared band, the different experimental methods based on coaxial, waveguide, and resonator and free–space techniques are still divided and will be presented. Examples of various ferroelectric, relaxor, and other materials dielectric spectroscopy results will be presented."

Keywords: microwave spectroscopy, ferroelectrics, relaxors

OL2

Synthesis and Characterization of Metal-based Materials for Optoelectronic Applications

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Abstract: Conjugated polymers constitute an interesting class of materials for basic as well as applied research. Among the variety of conjugated polymers, poly(arylene ethynylene)s (PAEs) are of particular interest because of extended π-electron conjugation along the polymer backbone. However, the luminescence of these organic polymeric materials is restricted to fluorescent emissions. One way of accessing the emission from triplet states also is to introduce heavy metal atoms into the polymer chains. The inclusion of Pt(II) along the polymer backbone imparted large spin-orbit coupling to the poly(metallayne) materials to allow light emission from the triplet excited state. The triplet emission is extremely efficient, approaching 100% efficiency at low temperatures, making the Pt(II) polyynes good model systems to study the triplet excited state. The insight gained from the study has been successfully extended to PAEs. The PAEs and Pt(II) polyyne materials are soluble in common organic solvents, can be readily cast into thin films, possess high thermal stability, and exhibit interesting O-E properties, suitable for applications in modern semiconductor devices such as light emitting diodes (LEDs) and photocells as well as in non-linear optics (NLO) and liquid crystal displays (LCDs). Herein, I report the design, synthesis, and characterization of new conjugated organic polyyne and poly(metalla-yne) materials.

Keywords: Pt(II) polyyne, conjugated, metallayne, O-E properties, spin-orbit coupling.

OL3

The Effect of Pollution on High Voltage Power Line Insulators

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Abstract: This work relates to the study of the effect of pollution on the insulators of high-voltage overhead power lines. The study will be carried out on a new laboratory model for flashover studies. This model looks like a real outdoor insulator while respecting its shape and pollution. We carried out a series of experiments to measure the resistance of pollution between the electrode of mass and a static discharge in various positions of the discharge on the surface of the electrolyte as well as the current and critical voltage. The experimental results of this model and their analysis were performed in two groups: The first is the measure of pollution resistance between the ground electrode and a static discharge for many discharge positions. The second is the measure of critical current and critical voltage according to the position of the discharge starting point. A comparison with the case of a point-to-point gap reveals that the electric field in the air in the vicinity of the electrolyte surface is responsible for the discharge elongation, and the critical conditions of flashover are the weakest initial electric conditions necessary to create this field distribution. The results obtained verify and agree with those of other research works referring to devices considered as prototypes of work and allowing to validation of this model
.

Keywords: Discharge, Flashover, High voltage, Insulator

OL4

m-GGA Calculations of the Optical and Electronic Properties of Pristine and N-doped pentagraphene

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Abstract: We investigated the effects of nitrogen doping on the optical and electronic properties of penta-graphene using first-principles calculations under the meta-generalized gradient approximation. Results showed that with 4%-8% doping concentration of nitrogen with location variation, midgap states were added to the electronic state leading to a shift of the Fermi energy towards the valence band as shown in the band structure calculation. The peaks for Pentagraphene's quantum capacitance and surface charge are generally higher compared to graphene. The dielectric function, absorption spectrum, and energy loss function have been calculated for light polarization parallel and perpendicular to the plane of the pentagraphene sheets and compared with the properties of a single-layer graphene. The calculated dielectric functions and energy-loss spectra are in good agreement with the previous literature for pure graphene. Peaks in the dielectric function of graphene can be found among the peaks of pentagraphene systems which have more peaks than graphene. It has been found that N doping does not significantly affect the peaks of the imaginary component of the dielectric function of pentagraphene systems. However, there is an increase in the absorption spectrum for the terahertz range of the pentagraphene systems when nitrogen is introduced. The results can be used to tailor the quantum capacitance of supercapacitors, and the optical properties of penta-graphene in the visible region.

Keywords: optical properties, quantum capacitance, DFT, energy, dielectric

OL5

Modeling Of Time, Temperature, And Composition Effect Variation Upon the Thermic Treatment of Aluminum-Silicon Alloys

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Abstract: The extraordinary expansion of the aluminum industry is owing to the numerous beneficial typical design features of this valuable metal; hence the unceasing demands for products made of aluminum or integration of aluminum into their composition. To master and improve the quality and properties of the final products, the major industrial challenge lies in the possibility of controlling the morphology, and size of microstructures that reside within the molded pieces, as well as their defects; this is the fundamental reason according to which we are more and more interested in mastering the growth and germination of aluminum alloys, as well as the developing structures, at the time of solidification process. The modeling reveals a valuable aid in the mastery of the formation of such heterogeneousness: segregation cells that are incompatible with industrial requirements. The purpose of this work consists basically of studying the influence of homogenization, while systematically varying the three parameters: time, temperature, and composition of aluminum silicone alloys. Usually, the microstructure and mechanical behavior of such alloys are directly influenced by some parameters such as composition, cooling velocity, and homogenization process. One can then imagine the whole stake in understanding and mastering the morphology and evolution of the solidification interface.

Keywords: Solidification, Homogenization, Aluminum silicone alloys, Modeling.

OL6

Development and implementation of a blind source separation algorithm to extract the fetal electrocardiographic (ECG) signal in real-time

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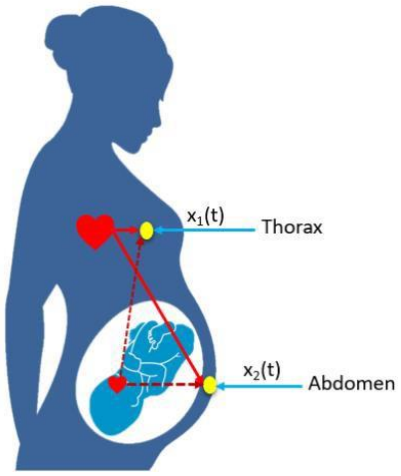
Abstract: The electrocardiogram (ECG) is a method used to record the heart's electrical activity. By analyzing the ECG, clinicians can evaluate the patient's heart condition and conduct additional analysis or diagnosis. The ECG signal is typically obtained through electrodes placed on the skin. However, for pregnant women, acquiring the fetal ECG poses challenges due to the risks involved in making direct contact with the fetus. In addition, abdominal ECG measurements obtained from the surface of a maternal abdomen contain several bioelectric potentials such as maternal cardiac activity, fetal cardiac activity, maternal muscular activity, fetal activity, and noise These different signals increase the difficulty of reconstructing the fetal ECG. To achieve this, our approach focuses on the analysis and extraction of ECG signals from the abdomen and thorax of the pregnant woman, to isolate the fECG and mECG (maternal ECG) signals. This separation is particularly difficult due to the very low amplitude of the ECG, the presence of various noises during signal acquisition, and the superposition of R waves. To solve this problem, we have developed an ECG signal extraction method based on blind source separation. Our model is based on a combination of separation algorithms using independent component analysis, which allows accurate detection and extraction of fECG and mECG signals from abdominal and thorax data. To evaluate our method, we used the FECGSYNDB database, which is a reliable reference for testing fECG extraction algorithms. Then, to validate our results in real-time, we implemented this method in an embedded card.

Keywords*: ECG, Blind Separation source, FPGA, fetal ECG, Real Time implementation.*

Graphics Abstract :



OL7

Study of Spintronics and Spinquant 2D Structures Prepared by Laser Plasma Method

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Abstract: The transformation of digital information devices from large installations to portable systems has been enabled by advanced processing technologies that allow ultrahigh integration of devices with atomic-scale dimensions that increasingly possess properties that are dominated by quantum physics. The quantum particles - Leptons are the good candidates to be quantum information carriers (qubits). After all, they also have an associated anti-particle, which has the same mass but opposite charge. The paper aims to elaborate on the concept of usage of leptons based spintronic and spinqubit systems obtained by Laser Plasma technology of 2D materials preparation. The convergence between quantum materials properties and prototype quantum devices is especially apparent in the field of 2D materials, which offer a broad range of material properties, high flexibility in fabrication pathways, and the ability to form artificial states of quantum matter. Along with the quantum properties and potential of 2D materials as solid-state platforms for quantum dot qubits, single photon emitters, superconducting qubits, and topological quantum computing elements, it is necessary to select the best method of preparation of spinqubit nanosystems. Based on the difference from conventional electronics which uses the electron's charge degree of freedom for information processing, spintronics is devoted to incorporating the electron's spin degree of freedom. In an ideal situation, there will be purely spin current and no charge current in the spintronic circuit, thus practically no heat will be created and wasted. Meanwhile, information will be transmitted at a high speed owing to the spin coherence effect. Even though a photon is a boson with spin "one", which is a typical boson spin, it is also a good candidate to be a quantum information particle (qubit). If we consider qubit itself as a symmetrical quantum system it could be represented by two optical modes, mainly spatial or polarization ones. Using the single photon with two optical modes of internal polarization degree of freedom we are coming to the term "polarization qubit" which together with so-called "dual-rail" qubits is the main engine for the organization of nonlinear quantum computing. In linear optical quantum computing the basic building blocks are beam splitters, half- and quarter-wave plates, phase shifters, etc. The main characteristic of the photonic computing process is the effect of nonlinearity of computation. The design of photonic computing devices which was inspired by the theoretical Ising model is based on lasers, mirrors, and other optical components commonly found on an optical table. Perfection and ultra-purity are not the only parameters that characterize material usefulness for quantum devices. Modification of material properties by different structural nonperfections (structural defects: impurities, isotopes, etc.) is the smart instrument for the regulation of their characteristics. Along with the quantum properties and potential of 2D materials as solid-state platforms for quantum-dot qubits, single-photon emitters, superconducting qubits and topological quantum computing elements it is necessary to select the best method of their preparation(Fig.).

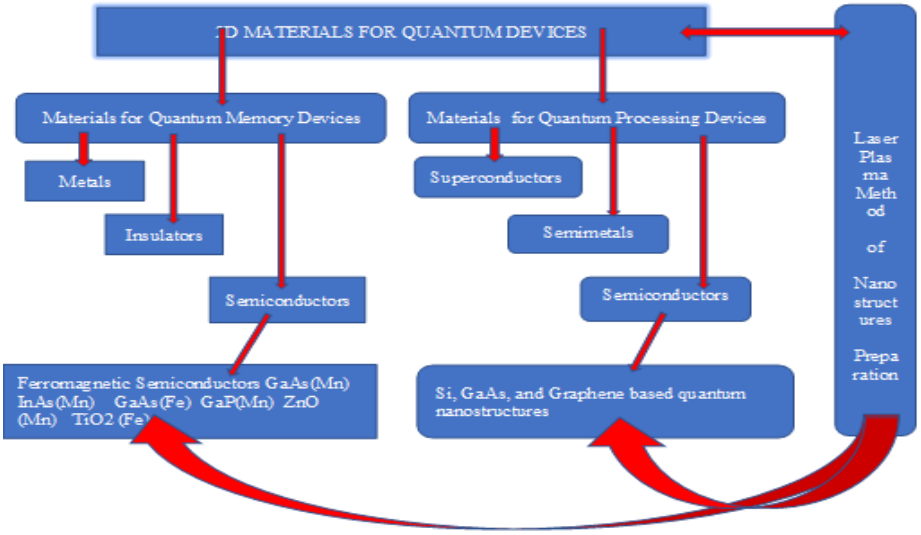

Figure: Roadmap of works related to obtaining spin electronic nanostructures for quantum devices

The potential of the laser plasma process for 2D materials preparation, particularly its usefulness for the organization of nanostructures applicable in spintronic and quantum computing devices nowadays is actively developing. Laser plasma formed under the ionizing effect of powerful laser radiation on the thing. The usage of resonance light heat creates the opportunity to energize the selected atoms as well as their groups (assemble) and to produce plasma with the necessary properties relevant to structures that must be prepared. We are looking for further development of LP processes aimed at preparing the next (higher) level of spintronic structures based on diluted semiconductors. Our works have shown that the LP method and technology are very useful for the preparation of new highly effective multiqubit elements. Finally, when we are choosing the particles for quantum computing we should consider that the candidate for a qubit generally needs to have the quantum properties of superposition and entanglement. There are also the main technical requirements of quantum computation which are: scalable physical systems with well-characterized qubits (Zeeman Splitting); long decoherence time higher than gate operation one; existence of qubits at the ground state; set of quantum gates; measurement capabilities, etc. Leptons – fermions (electrons, protons, neutrons, muons, tauon, and even neutrinos) as we know have those kind of properties. Concerning the photons – bosons particles with frequency-dependent energy collecting into the same energy state (Bose-Einstein condensation), they also could act as a qubits because of the polarization effects they characterized. The usefulness of the other boson particles as quantum information carriers is a very interesting task for current and future research works.

OL8

Optical and Structural characterizations of the base schiff complexes for solar cells

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Abstract: The development of new organometallic complexes, was validated with the synthesis, characterization, and testing in dye cells. The DSSCs were fabricated using Platinum as a photocathode, TiO_2 as a photo anode, I_2/KI as an electrolyte, and the sensitizers were varied. The sensitizers used were cobalt, vanadium, and copper. Photovoltaic parameters such as short circuit current (Jsc) fill factor (FF) and efficiency were calculated from the J-V curve and it was found that the copper-based cell is the highest (6.01%).

Keywords*: solar cell, complex, organometallic, Curve I-V.*

OL9

Energy harvesting efficiency analysis using artificial intelligence

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Abstract: Recent significant advancements in computational methodologies, especially within the realms of artificial intelligence (AI) and machine learning (ML), have amplified the need for intelligent self-sustaining devices. However, the global concern over energy consumption necessitates urgent solutions. It is imperative that cutting-edge technology curbs energy usage while preserving the efficiency of intelligent applications. A solution lies in energy harvesting technology, which harnesses ambient mechanical vibrations to generate electrical energy. The emergence of AI technologies tailored to real-world challenges has created a fascinating avenue for specific energy harvesting methods, notably piezoelectric nanogenerators (PENG) and triboelectric nanogenerators (TENG). This discourse delves into the progress of AI applications in processing data from PENG and TENG. Furthermore, a concise exploration is undertaken on the amalgamation of nanogenerator outputs with machine learning algorithms across diverse applications, including robotics, advanced security systems, medical devices, sports equipment, acoustic sensors, and object recognition. The associated principal obstacles and potential.

Keywords: Energy harvesting, Sustainable energy, Self-powering systems, Solar power, Piezotransducers

OL10

Enhancing Piezoelectric Properties of PLA/GO Nanocomposite for Energy Harvesting Application

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Abstract: Using flexible piezoelectric nanocomposite films in autonomous nano-systems, sensors, and portable electronics has garnered significant attention within the scientific community. This paper investigates the impact of graphene oxide (GO) nanoparticles on the crystal structure of polylactic acid (PLA), its distinctive crystallization behavior, mechanical properties, and the ensuing enhancement in piezoelectricity. In this study, polylactic acid/graphene oxide (PLA/GO) nanocomposite films were fabricated utilizing the solvent casting technique, incorporating varying concentrations of graphene oxide. Subsequent characterization of the films involved comprehensive analyses employing polarized optical microscopy (POM), Fourier-transform infrared spectroscopy (FTIR), and X-ray diffraction (XRD). POM observations revealed a homogeneous dispersion of graphene oxide nanofillers within the PLA matrix. FTIR and XRD analyses confirmed the presence of the β-phase in the nanocomposites, signifying improvements in their piezoelectric properties. The substantial augmentation in piezoelectricity witnessed emphasizes the potential of electroactive nanocomposites for energy harvesting applications. This research contributes to advancing sustainable energy technologies by elucidating the efficacy of graphene oxide-enhanced PLA nanocomposites as proficient materials for piezoelectric energy conversion.

Keywords: Piezoelectric films, Energy harvesting, Dielectric polymers, Nanocomposite

Posters

PO1

Structural, Optical, and Electrical Characteristics Of Kesterite (CZTS) for Solar Cells Applications

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Abstract: Due to its unique electrical, optical, chemical, and favorable capacitive properties, Kesterite (CZTS) thus making it a promising candidate for application, including fuel cells, supercapacitors, sensor technologies, catalysis, and selective absorbers for photothermal conversion. CZTS (Cu_2ZnSnS_4) thin films were deposited by reactive cathodic radio-frequency (RF) sputtering, using a pure CZTS target in the ALCATEL SCM 451 deposition system equipped with an ALCATEL ARF 601 RF generator operating at 13.56 MHz. The deposition was performed in an Ar atmosphere using an RF power of 200 W. The properties of the as-deposited and a series of samples annealed for 1 hour under nitrogen with sulfurization at 350,400,450 and 500°C were studied. X-ray diffraction (XRD) revealed the tetragonal phase of CZTS. The optical properties (especially the refractive index, absorption coefficient, and optical band gap) were investigated by optical transmission measurements in the ultraviolet-visible-near Infrared wavelength range. The band gap of the prepared CZTS was found to vary between 1.4 and 1.51 eV. The effect of the RF power and annealing on optical and electrical properties was investigated. The optimal annealing temperature was found to be T=500°C.

Keywords: Cu_2ZnSnS_4 (CZTS); Kesterite; RF sputtering; Thin film, Solar Cell.

PO2

Effects Of La Dopant On Diffused Ferroelectric Phase Transition And Electrical Properties of Lead Free $SrBi_2Ta_2O_9$ Ceramics

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Abstract: The Aurivillius compounds are typically described as being formed by the intergrowth of (Bi2O2)2+ fluorine types and blocks of perovskite structures. The use of lead-based compounds became more problematic due to the high toxicity, so bismuth-based layered Aurivillius oxides were developed to replace them. The most well-known compound in the wide family of bismuth-based Aurivillius phases is Bi4Ti3O12 oxide. Due to their important FRAM (ferroelectric random access memories) applications, the double layer-structured ferroelectrics have received much press. The citric acid-assisted method was used to get pure polycrystalline La-doped SrBi2Ta2O9 samples. La doping in the lattice of SrBi2Ta2O9 resulted in a smaller crystallite size and the unit cell volume of the sample. The shortening of these Ta-O bond lengths is a result of the La doping. Low dielectric loss was achieved by tailoring the sintering process at 1100 °C. When ceramics were sintered at 1100 °C for 6 hours, not only was the dielectric constant increased through lanthanum, but a flat trend was also produced in the wild-frequency region. The diffused ferroelectric phase transition (DPT) behavior was brought on by the positional static disorder of Sr-sites (Sr, Bi, and La cations) in the Bi2O2 layers and perovskite blocks. The appearance of peaks in the modulus spectrum provides a clear indication of ionic conductivity relaxation indicating that charge carriers can move over extended distances since their mobility is not constrained by the restoring force. The impedance spectra were analyzed by using the Rs(CPE-Rp) equivalent circuit, where R is a resistance and CPE is a constant-phase element. Meanwhile, CPE consists of two parameters: capacity (CPE-T) and an exponent (CPE-P). The first and second arc diameters, which are related to the grain and grain border, respectively, get smaller as the temperature rises. Considering that grain resistance is lower than grain boundary resistance, charges on either side of the grain boundary are blocked, forming a potential barrier and obstructing the passage of charge carriers. Therefore, the localized charges may be what causes the grain conductivity.

PO3

Study Of The Efficiency Of Layered Double Hydroxide-Based Corrosion Inhibitors On Mild Steel In Chemical Pickling In Hcl Medium

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Abstract: The materials used as corrosion inhibitors are [Zn-Al-Cl], [Mg-Al-Cl], [Ni-Fe-Cl], and [Co-Fe-Cl] layered double hydroxides (LDHs). They were synthesized by coprecipitation and characterized by X-ray diffraction (XRD), Fourier transforms infrared spectroscopy (FTIR), and thermal analyses. The efficiency of these corrosion inhibitors on mild steel in concentrated hydrochloric acid (18.5%) at 60°C (chemical pickling conditions of steel) was studied using electrochemical and gravimetric methods for different concentrations. The surface morphology and composition were examined by scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS), respectively. The inhibitory efficiency in the case of 1.2 g.L-1 LDH was found to be 83.33%, 83.65%, 68.38%, and 74.73% for [Ni- Fe-Cl], [Zn-Al-Cl], [Co-Fe-Cl], and [Mg-Al-Cl], respectively.

Keywords: layered double hydroxides; corrosion inhibitor; hydrochloric acid; chemical pickling; mild steel.

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PO4

Experimental and Computational Studies of Crystal Violet Removal From Aqueous Solution Using Sulfonated Graphene Oxide

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ABSTRACT: Positively charged contaminants can be strongly attracted by sulfanilic acid-functionalized graphene oxide. Here, sulfonated graphene oxide (GO-SO_3H) was synthesized and characterized for cationic crystal violet (CV) adsorption. We further studied the effect of pH, initial concentration, and temperature on CV uptake. The highest CV uptake occurred at pH 8. A kinetic study was also carried out by applying the pseudo-first-order and pseudo-second-order models. The pseudo-second-order's adsorption capacity (qe) value was much closer to the experimental qe (qe_{exp}:0.13, qe_{cal}:0.12) than the pseudo-first-order model (qe_{exp}:0.13, qe_{cal}:0.05). The adsorption performance was accomplished rapidly since the adsorption equilibrium was closely obtained within 30 minutes. Furthermore, the adsorption capacity was significantly increased from 42.85 to 79.23%. The maximum adsorption capacities of GO-SO_3H, were 97.65, 202.5, and 196.2 $mg \cdot g^{-1}$ for CV removal at 298, 308, and 328 K, respectively. The Langmuir and Freundlich adsorption isotherms were applied to the experimental data. The data fit well into Langmuir and Freundlich except at 298 K, where only Langmuir isotherm was most suitable. Thermodynamic studies established that the adsorption was spontaneous and endothermic. The adsorption mechanism was revealed by combining experimental and computational methods. These findings suggest that GO-SO_3H is a highly adsorbent for removing harmful cationic dye from aqueous media.

PO5

Dielectric Spectroscopy of melt-extruded polypropylene carbon nanofiber composites

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ABSTRACT: The influence of carbon nanofibers (CNFs) weight contents, from 0 to 3 wt. %, on the structural, morphological, and dielectric properties of melt-extruded polypropylene carbon nanofiber composites is discussed in this study. The morphologic analysis reveals that the CNFs exhibited randomly distributed agglomerates in the polypropylene (PP), whereas the structural analysis demonstrates that the CNF degree of disorder was not altered in the PP/CNF composites. The AC conductivity and dielectric permittivity behavior of the PP/CNF composites are discussed and associated with the inter-cluster polarization effects between the CNF agglomerates from the analysis of percolation power laws at a certain weight content of CNFs. Finally, the complex impedance and Nyquist plots of the PP/CNF composites are analyzed by using equivalent circuit models, consisting of a constant phase element. The analysis gathered here intends to contribute to the dielectric properties understanding of polypropylene composites filled with carbon nanofibers.

Keywords: carbon nanofibers; polypropylene; electrical conductivity; dielectric permittivity; electrical modulus; electrical impedance

PO6

Structural, electrical, optical, and microstructural properties of $Bi_4V_{2-x}Cu_{x/2}Sb_{x/2}O_{11-3x/4}$

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Abstract: In the BiMeVOx lattice $Bi_4V_2O_{11}$, copper (Cu^{2+}) and antimony (Sb^{5+}) cations are utilized as substitutes for vanadium (V^{5+}), resulting in the formation of polycrystalline samples with compositions in the range of $0.00 \leq x \leq 0.45$, denoted as $Bi_4V_{2-x}Cu_{x/2}Sb_{x/2}O_{11-3x/4}$. The solid-state reaction method was employed to synthesize these samples. To confirm the formation of the solid solution and comprehend the local structural modifications in each composition, various techniques including X-ray diffraction, thermal analysis, FTIR, and Raman spectroscopy were employed. The compound with $x = 0.1$ exhibits crystallization in the monoclinic α-$Bi_4V_2O_{11}$ form, while the compounds with $0.20 \leq x \leq 0.45$ correspond to the γ and γ' tetragonal forms. The microstructure of the different samples was examined using scanning electron microscopy (SEM) to investigate the influence of composition. The evolution of electrical conductivity about the ratio of copper and antimony was assessed through electrochemical impedance spectroscopy, and its correlation with structural transformations was established. The double substitution of copper and antimony resulted in an enhancement of ionic conductivity. Notably, the sample with $x = 0.2$ ($Bi_4V_{1.8}Cu_{0.1}Sb_{0.1}O_{10.85}$) exhibited the highest ionic conductivity value ($\sigma_{600°C} = 4.5\times10^{-2}$ $S.cm^{-1}$). The band gap of the materials was determined via diffuse reflectance spectroscopy (DRS), indicating that the BiCuSbVOx materials possessed a lower band gap (1.94 eV for the sample with $x = 0.15$) compared to the parent phase $Bi_4V_2O_{11}$.

keywords: BiCuSbVOx, solid-state synthesis, band gap, ceramics, ionic conductivity.

PO7

Psychoemotional State Sensors and Measurements for Risk Factors Identification

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Abstract: Most decision-makers are permanently under the high pressure of psychoemotional stress. One of the reasons is that professionals must keep up with advances in materials sciences for sensor development, fusion of data, and the required degree of accuracy due to multiple reasons. This persistent stress triggers psychoemotional stress, burnout, anxiety, depression, and lack of concentration. All these states are critical for individuals who are entrusted with decisions that affect millions of lives. To address this, we propose a method that can be easily applied in a short timeframe, as part of regular health check-ups for such individuals. This is a fine-tuning protocol that allows the recognition of the states mentioned above at the very initial stages of their development. This method has as a basis the heart rate variability measurement, but with extension to the physiologic method of the suprasegmental level of the central nervous system state analysis. The measurement itself to obtain the biosignal for evaluation is very simple to realize. This is very similar to a three-lead ECG recording device in a rest state, preferably in the supine orientation for 5 minutes. The bioanalytics of the signal should be performed by non-linear methods of mathematical analysis, this is the major difference to a common ECG, but it is important, because it delivers information about the state of the nervous system, especially because it allows the visualization of such states, like psychoemotional stress, burn out, anxiety, depression, lack of concentration and trigger-states of heart arrhythmia, even at the very initial stages. Thus, it could recognize these states of people working in a high-stress environment to prevent further progression and to send them for short treatment before they make life-threatening mistakes. We also discuss our results in the context of commercial off-the-shelf (COTS) devices such as KardiaMobile, Omron EKG, Eko DUO ECG, and laboratory devices with high-k dielectric to improve signal-to-noise ratio.

Keywords: Stress, Bioanalytics, ECG, high-k

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PO8

Dynamic Simulations Of Thermal Performance of A Building Based On Earth Bricks In Six Climatic Zones of Morocco

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Abstract. As we become more aware of the environmental impacts associated with traditional building materials like cement and concrete, considering their significant release of greenhouse gases and substantial energy requirements for heating and cooling, there is a growing interest in adopting alternative, eco-friendly, and sustainable materials. The present study focuses on assessing the energy efficiency of using clay, a locally abundant and recyclable natural resource, for construction in Morocco's diverse climatic zones. The approach of this study is based on a simulation methodology using EnergyPlus software, allowing a rigorous evaluation of the energy performance of a building based on clay bricks. The research process involves the manufacture of earth brick samples using clay extracted from the semi-arid zone of the country. Then, thermo-physical tests were conducted to analyze and characterize these brick samples. The results of these tests were integrated into energy simulations covering all six Moroccan climate zones. These simulations allowed for a comprehensive assessment of the energy demands associated with a building model based on these clay brick specimens. The results highlight the remarkable energy efficiency of these earth brick samples, resulting in a significant reduction in heating and cooling requirements. Furthermore, a significant conclusion of this work emphasizes that the adoption of clay as a building material has led to a significant reduction in greenhouse gas emissions from buildings in the different Moroccan climatic zones. This study highlights the energy efficiency and environmental benefits of using earth bricks in the six climate zones of Morocco. It offers a solution that is both energy efficient and environmentally friendly for construction in the various climatic conditions in the country. In addition, It also encourages the use of clay as an abundant, sustainable, and natural building material, and considers it as a key element in the transition to a more sustainable construction method, making an active contribution to preserving the environment.

Keywords: Natural building material, dynamic simulations, energy demands

PO9

Smart Nanocomposites for Energy Harvesting and Biomedical Sensing Applications

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Abstract: Demand for thin films of various functional materials is increasing due to the miniaturization of electronic devices to nanometer scales. Nano-sized thin films can be defined as material in reduced dimensions, having at least one dimension ~100 nm or less. Due to reduced dimensions, the materials exhibit unique characteristics, and the characteristics are completely different from bulk dimensions, thus categorized as SMART materials. Conjoining these characteristics, the present study involved the use of partially fluorinated polymers, such as PVDF, for their piezoelectric characteristics. The study reported in this presentation is to assess the optimum concentration of PVDF that is required to exhibit a high degree of polarity and consequently improved piezoelectric properties. Under the current investigation, PVDF thin films are fabricated with various concentrations of PVDF and characterized for their electrical, mechanical, and optical properties for their potential use as smart materials for energy harvesting and biomedical applications.

Keywords: PVDF, smart materials, sensors, optical, mechanical

References:

1. DOI: 10.1007/s10854-023-11066-6
2. DOI: 10.3390/polym15214253
3. DOI: 10.33425/2639-9466.1032

PO10

Recycling of Office Wastepaper in Eco-Friendly Clay Bricks for Sustainable Manufacturing to Enhance the Thermal Properties of the Clay-Paper Composite Material

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Abstract: The environmental problems caused by the use of conventional building materials, such as cement, and their rapid depletion, make it necessary to develop environmentally friendly building materials made from renewable resources. Inadequate management of waste office paper in landfill sites leads to air and groundwater pollution. In this context, the exploitation of wastepaper as a renewable resource, with its use as a reinforcement in the manufacture of unfired adobe bricks, appears to be a solution likely to resolve these environmental problems in a more environmentally friendly way. In this study, waste office paper was used as an additive in adobe clay bricks, with weight proportions of 0%, 2%, 4%, and 10%, to enhance their thermal performance. Several samples were prepared, and their thermophysical properties were experimentally characterized using a heat flow meter. The results revealed significant interest in the future use of this composite material in building construction, aiming to ensure thermal comfort and reduce greenhouse gas emissions. Furthermore, a standard building model was simulated using the clay-waste paper envelope in the semi-arid climate of Morocco to analyze its thermal behaviors and determine its ability to provide optimal comfort by minimizing excessive summer heat and preserving warmth during winter without artificial heating and cooling systems.

Keywords: Composite material, Adobe bricks, Waste office paper, thermophysical properties, Building construction, Thermal comfort

PO11

Oxygen Reduction Reaction Characterization of Platinum-functionalized CVD Growth Graphene Foam

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Abstract: The development of catalysts with high activity for the ORR is essential to proton exchange membrane fuel cells (PEMFCs), since most activation losses occur at the cathode, and it turns into an interesting research area. The present study, it is investigated the hydrothermal platinum functionalization of the CVD-grown three-dimensional graphene foam (3D-GrFoam) using three concentrations of dihydrogen hexachloroplatinate (IV) hydrate. The platinum functionalized graphene foam determined from XPS was 0.2 at %, 0.3 at %, and 0.4 at %, respectively. The catalytic activity towards ORR was analyzed from linear sweep voltammetry (LSV) plots recorded with a scan rate of 5 mV s^{-1} in oxygen-saturated 0.5 M H_2SO_4. In Figures 1 and the inset are presented the LSV curves and the Koutecky-Levich (K-L) plots for 0.4PtGrFoam as current density (mA^{-1} cm^2_{geo}) vs. $\omega^{-1/2}$ (rad $s^{-1})^{-1/2}$), for various rotation speeds (among 250–1500 rpm) and different potentials (0.1 V-0.8 V). From the fitted K-L plots it is noticed a fair linear relationship at all potentials, which confirms the electroreduction of platinum. The number of transferred electrons is between 3.22 to 3.59 indicating the preponderance of the four-electron transfer mechanism in the ORR corresponding to the direct reduction of O_2 to H_2O.

Keywords: Graphene; fuel cells; ORR; platinum; CVD

PO12

A Comparative Study On The Chemical, Structural, Thermal And Mechanical Properties Of Polyester And Epoxy Resin Reinforced By Sisal Fiber

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Abstract: This research encompassed an investigation into the chemical, structural, thermal, and mechanical characteristics of composites composed of polyester and epoxy matrices reinforced with natural fibers. The study involved creating sisal composites using two distinct thermoset polymer resins: polyester and epoxy. Fourier-transform infrared spectroscopy (FTIR) was utilized to identify the chemical composition of the resins and sisal fiber composites. Tensile and flexural tests were conducted to evaluate and compare the mechanical properties of the composites, considering both matrix types and sisal fiber reinforcement. Additionally, thermogravimetric analysis (TGA) was employed to supplement the comparative assessment of thermal properties. The findings indicated that the reinforcement process resulted in improved mechanical properties in sisal fiber-based composites for both matrices. The choice of resin as the matrix played a crucial role in influencing the mechanical properties of the composites. Specifically, epoxy matrix-based composites exhibited superior tensile strength, while polyester-based composites demonstrated higher tensile and flexural strengths compared to epoxy composites. TGA analysis revealed that the thermal stability of epoxy-based composites surpassed that of polyester-based composites.

Keywords: composites, epoxy resin, polyester resin, chemical mechanical and thermal properties, sisal fiber.

PO13

Mechanical Performance Evaluation of Adobe Bricks Manufactured Using Different Clay Soils Extracted from Northcentral Morocco

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Abstract: The use of earth materials in construction has been a sustainable practice since ancient times, embodying both historical significance and modern relevance. This paper focuses on the comprehensive evaluation of the mechanical performance of adobe bricks fabricated from two distinct clay soils sourced from the Beni Mellal region. The study aims to compare the mechanical strengths of adobes crafted from these clay soils, shedding light on their structural suitability for construction practices. The research employs a dual-pronged approach. First, physical testing of adobe bricks is carried out to ascertain their compression and flexural strengths. The findings reveal that the highest recorded values for compression and flexural strengths are 14.57 MPa and 0.5 MPa, respectively. This empirical data serves as a basis for evaluating the load-bearing capabilities of adobe bricks, an essential aspect of their feasibility as building components. By investigating these mechanical behaviors, the study provides insights into the structural response and durability of the adobe bricks, allowing for a comprehensive understanding of their performance under different conditions. In conclusion, this research paper offers a thorough examination of the mechanical properties of adobe bricks fabricated from clay soils in the Beni Mellal region. By comparing their mechanical strengths and interpreting the factors influencing their performance, the study contributes to a deeper understanding of the suitability of earth materials in construction. As sustainability takes center stage in the modern construction landscape, the findings obtained from this research have practical significance for architects, engineers, and policymakers in equal measure.

Keywords: earth materials, mechanical performances, Structural suitability

PO14

Hybrid Simulation Method For Dynamic Energy Harvesting Systems

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Abstract: This paper introduces a hybrid simulation method for dynamic systems, incorporating a bond graph approach with numerical-experimental real-time substructuring. The utilization of bond graph principles, such as virtual junctions and virtual actuators, traditionally applied in control based on physical models, facilitates substructuring in an intuitively appealing manner. The methodology is exemplified through the revision of a previously published case. However, by fusing diverse simulation techniques, researchers and practitioners can gain insights into the temporal and spatial dynamics of harvesting systems. Experimental validation of the method involves a bench-top system with multiple masses and springs serving as the physical substructure, and it employs automatically generated real-time code for the numerical substructure.

Keywords: Generating power, Energy harvesting, Powertrain, The rear wheel.

PO15

AC Electrical Conductivity Modeling of Polypropylene-Based Composites Melt-Processed With Carbon Nanofibers

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Abstract: This work presents a study on the interphase effects of melt-processed polypropylene (PP) composites filled with carbon nanofibers (CNFs) using a three-phase predictive model based on the modified Voigt and Reuss equation, widely used for describing the electrical conductivity of polymer composites [1]. In particular, the results presented here are based on the AC electrical conductivity analysis at room temperature and in the frequency range from 2 Hz to 2 MHz of two PP/CNF composite series, differing from the CNFs type utilized during the melt-mixing. Through fitting the experimental data, the Voigt and Reuss-modified model above mentioned is used to provide values of the volume, concentration, and intrinsic electrical conductivityover that range of frequency, corresponding to the interphase of the two PP/CNF composite series.

Keywords: polypropylene, carbon nanofibers, AC electrical conductivity, interphase, electrical modeling.

References:

[1]. A. J. Paleo, N. Aribou, Y. Nioua, Z. Samir, L. Fernandes, J A. Moreira and M. E. Achour. *Electrical properties of melt-mixed polypropylene and as-grown carbon nanofiber composites: Analysis of their interphase via the AC conductivity modeling*. J. Compos. Mater.,**2022**, Vol. 56(12) 1879–1889

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39	Mohcin Mekhioui
40	Mustapha Jouiad

41	Mustapha Mabrouki
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64	Vid Bobnar
65	Vladimir M. Fomin
66	Wafaa Mhaira
67	Yasuo Cho
68	Zdravko Kutnjak

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	Abdelmounaim Alioui
1	Al Rey Villagracia
2	Daniela Ion-Ebrasu
3	Juras Banys
4	Ludmila Sidorenko
5	Meryam Sami
6	Messaoud Hamouda
7	Mohammed Benfars
8	Mustapha Buyukharman
9	Najoia Aribou
14	Paata Kervalishvili
1	Rayya Al Balushi
2	Salma Hnawi

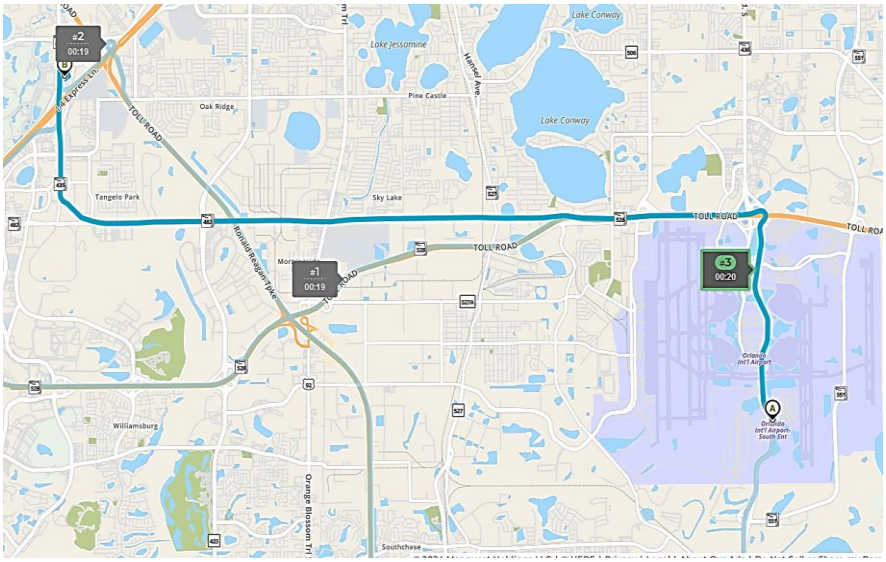
15 Sara El Hamzi
10 Souad Touairi
11 Youness Azalam
12 Zineb Samir

Useful Information

Driving direction:

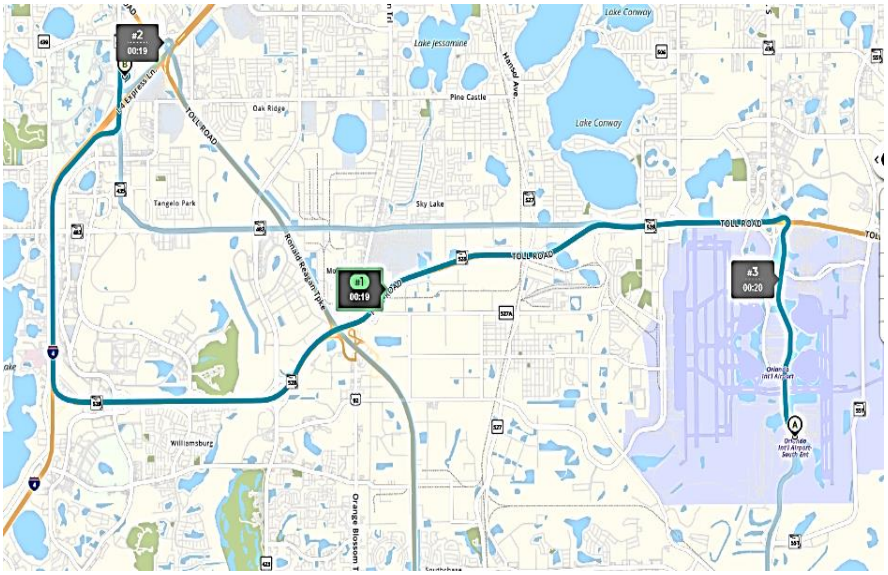
Toll-free option (20 - 25 minutes)

Head north on Jeff Fuqua Blvd. 0.3 mi. Keep right onto Jeff Fuqua Blvd toward Terminal B/ A/N. Exit/SR-436/SR-528-TOLL. 0.4 mi. Keep right onto Jeff Fuqua Blvd toward Ter. A/Eco. Parking-North Park Place/SR-528-TOLL N/Parking A/Cell Lot. 0.8 mi. Keep left onto Jeff Fuqua Blvd toward SR-436 N/SR-528-TOLL N. 1.2 mi. Continue on S Semoran Blvd (SR-436 N). 0.6 mi. Turn left onto N Frontage Rd. 0.8 mi. Continue on McCoy Rd. 1.0 mi. Turn left onto S Conway Dr toward SR-528-TOLL. 0.2 mi. Turn right onto McCoy Rd. Go for 7.2 mi.Take ramp onto S Kirkman Rd toward I-4 E. Go for 1.2 mi. Keep left onto S Kirkman Rd (SR-435 N). Go for 0.6 mi. Keep right onto S Kirkman Rd (SR-435 N). 0.3 mi. Turn right onto Major Blvd. Go for 394 ft.0.07 miles. Turn right onto Caravan Ct. Go for 509 ft.

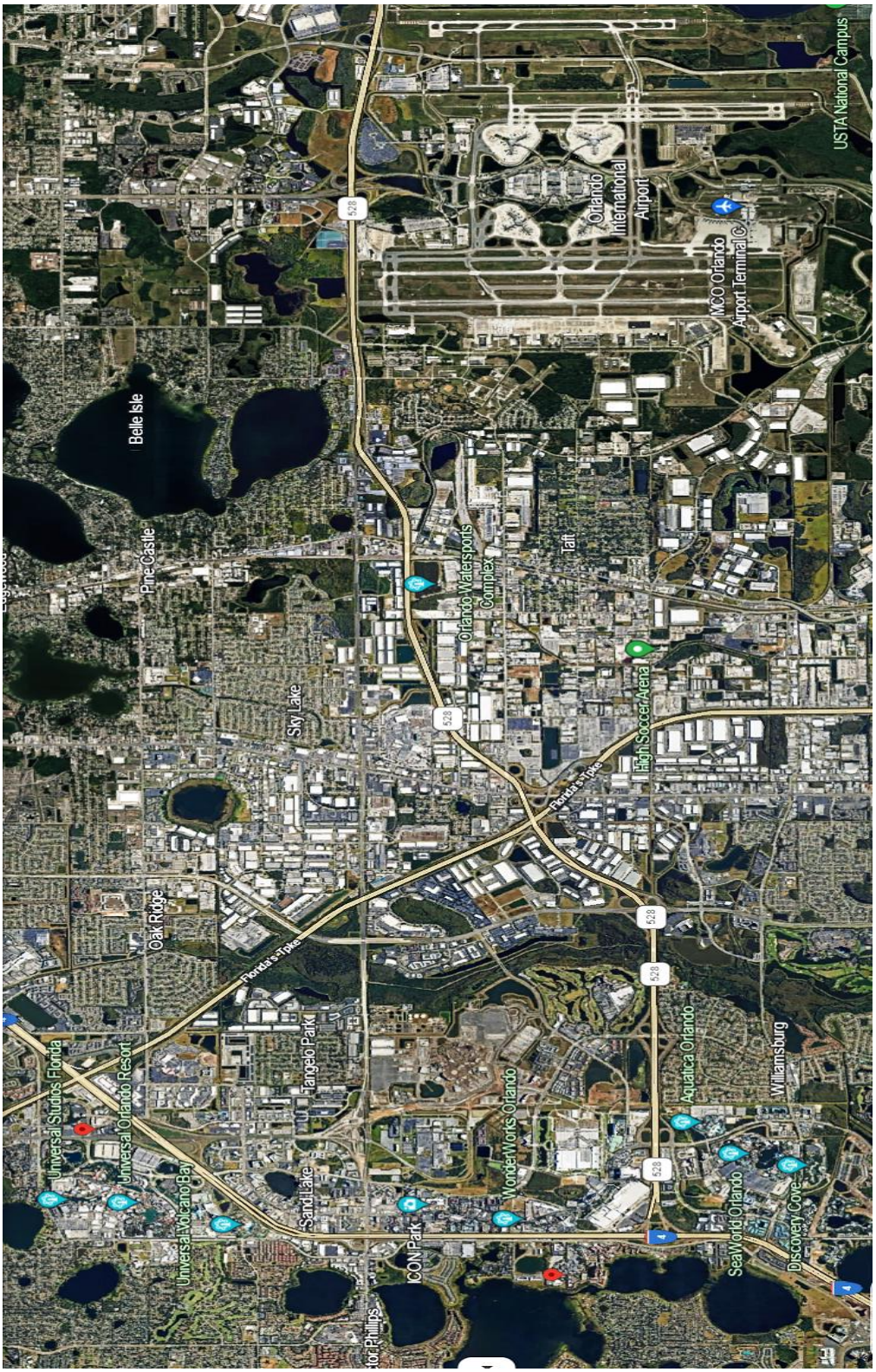


Toll Road option (19 – 24 minutes)

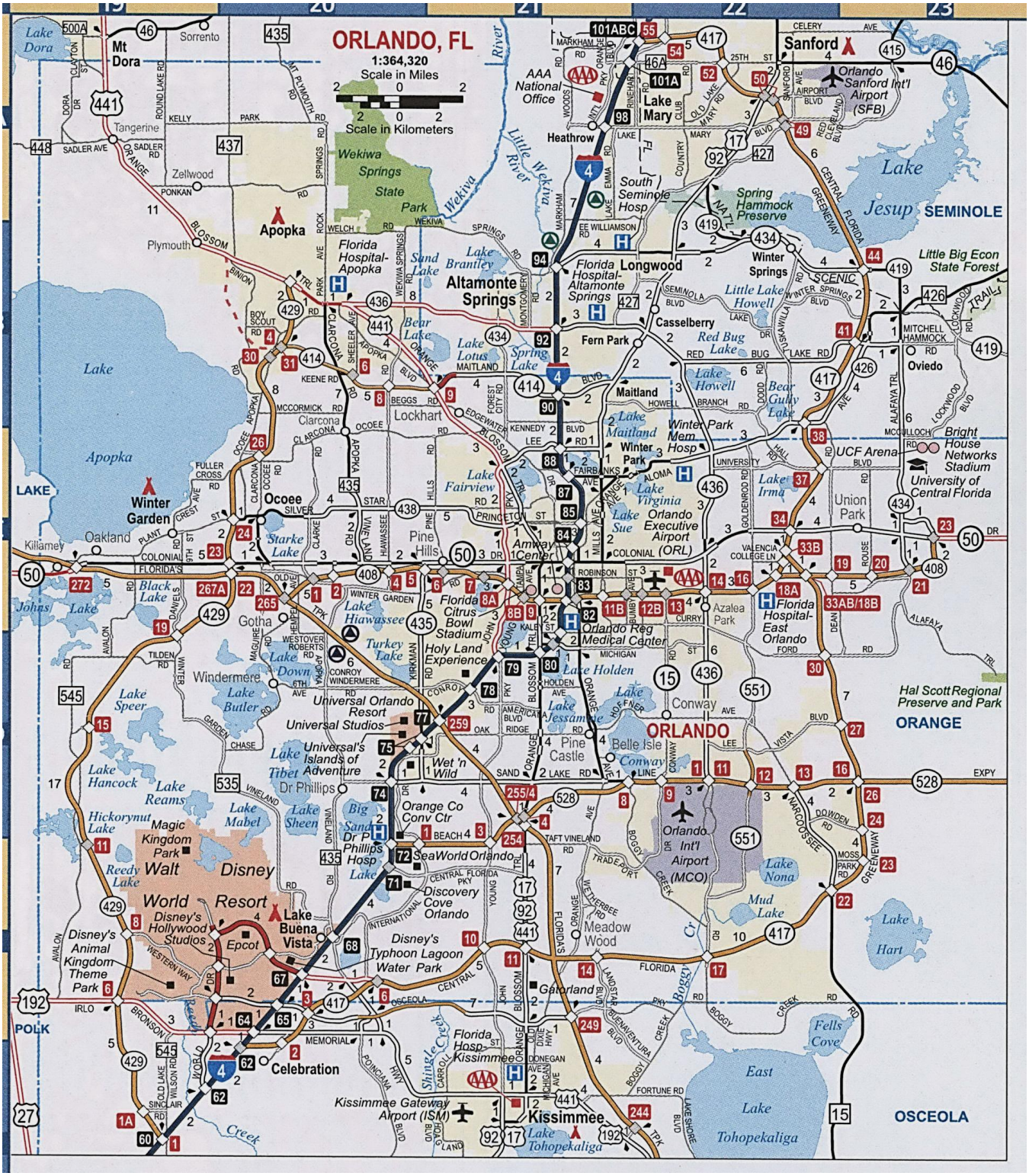
Continue onto Jeff Fuqua Blvd toward Terminal A, Parking C, 1.5 mi
Keep right to merge onto SR-528 W, 0.2 mi
Keep left to merge onto SR-528 W, 11 mi
Keep right on I-4 East toward Downtown Orlando, 3.4 mi
Take exit 75B onto SR-435, Kirkman Road, 0.2 mi
Keep left onto SR-435 North, 0.9 mi
Turn right onto Major Blvd, 400 ft
Turn right onto Caravan Ct, 167 ft



Google Earth Map



Map of Orlando

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