Book of Abstracts
International Conference on Advances in Physics
(ICAP-2025)

17-18 December, 2025

Published by

Department of Physics
Shahjalal University of Science and Technology, Sylhet-3114, Bangladesh

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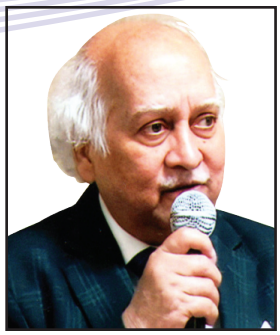
Printed by

Udayan Offset Press
Corner Plaza, Lamabazar Point, Sylhet



Message from Chairman

University Grants Commission Of Bangladesh

বাংলাদেশ
বিশ্ববিদ্যালয় মঞ্জুরী কমিশন

It gives me great pleasure to extend my warm greetings to all participants of the International Conference on Advances in Physics (ICAP-2025), organized by the Department of Physics, Shahjalal University of Science and Technology (SUST). This distinguished gathering brings together renowned scholars, researchers, and innovators to share cutting-edge knowledge, present recent breakthroughs, and deepen collaborative research across diverse branches of physics.
In an era defined by rapid scientific and technological transformation, research in the physical sciences plays a foundational role in driving national development, strengthening global competitiveness, and expanding the frontiers of human understanding. Conferences such as ICAP-2025 are essential platforms for advancing contemporary physics by facilitating the exchange of new theories, experimental methodologies, and emerging applications that contribute to innovation in industries, sustainable technologies, and high-end scientific instrumentation.

I am confident that ICAP-2025 will generate several meaningful outcomes, including new collaborative research initiatives, high-quality publications, strengthened academic partnerships, and innovative ideas that will inspire young researchers to pursue excellence in physics. By bringing together experts from home and abroad, this conference will support Bangladesh's broader goal of fostering a vibrant research culture and positioning our universities as key contributors to global scientific progress.

I commend the organizers for their dedication, vision, and meticulous planning in bringing this academic event to fruition. I also extend my appreciation to the distinguished speakers, authors, reviewers, and participants whose valuable contributions enhance the scientific merit and international relevance of this conference.

I wish the conference a resounding success and trust that ICAP-2025 will pave the way for transformative discoveries, productive collaborations, and impactful scientific outcomes in the years ahead.

Professor Dr. S. M. A. Faiz
Chairman
University Grants Commission Of Bangladesh

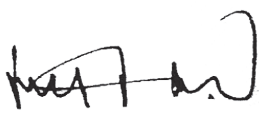
Message from Vice-Chancellor

It is a matter of great pride to witness the Department of Physics at Shahjalal University of Science and Technology (SUST) hosting the International Conference on Advances in Physics (ICAP-2025). This global event reflects our university's enduring commitment to academic excellence, frontier research, and meaningful international engagement.

The disciplines encompassed within the physical sciences continue to shape modern civilization, from energy and materials to space science, quantum technologies, and environmental sustainability. ICAP-2025 provides a timely platform for distinguished scholars, emerging researchers, and students to exchange transformative ideas and explore new avenues of discovery. I am confident that the interactions and deliberations during these two days will contribute significantly to advancing knowledge and strengthening research collaborations.

I congratulate the Organizing Committee for their tireless efforts, professionalism, and steadfast dedication in arranging this important academic gathering. Their collective initiative represents the spirit of scholarship and institutional progress for which SUST is known.

My sincere appreciation goes to all invited speakers, contributors, reviewers, sponsors, and participants for enriching this conference with their expertise and enthusiasm. I extend my best wishes for the highly productive and intellectually stimulating event.



Professor Dr. A. M. Sarwaruddin Chowdhury
Vice-Chancellor
Shahjalal University of Science and Technology (SUST)
Sylhet-3114, Bangladesh

Message from Pro Vice-Chancellor

It is a great pleasure to note that the Department of Physics is hosting the International Conference on Advances in Physics (ICAP-2025) on 17–18 December 2025 at Shahjalal University of Science and Technology. This conference brings together a diverse community of researchers, scholars, and students to engage in meaningful scientific exchange across the rapidly evolving frontiers of modern physics. I am confident that ICAP-2025 will serve as a vibrant platform for strengthening collaborations, fostering new research directions, and inspiring the younger generation to pursue excellence in scientific inquiry.

I commend the organizers for their dedication and commitment in assembling an impressive collection of invited and contributed works from both home and abroad. Their efforts have enabled the creation of a rich scientific program that reflects intellectual depth and disciplinary diversity.

I extend my sincere appreciation to all invited speakers, authors, reviewers, sponsors, and participants for their valuable contributions. I wish everyone a fruitful and stimulating conference experience.

Professor Dr. Md Shajedul Karim
Pro Vice-Chancellor
Shahjalal University of Science and Technology (SUST)
Sylhet-3114, Bangladesh

Message from Treasurer

It is my immense pleasure to welcome all participants to the International Conference on Advances in Physics (ICAP-2025). In an era where scientific challenges increasingly transcend disciplinary boundaries, the advancement of physics, whether theoretical, computational, or experimental, relies fundamentally on sustained collaboration, intellectual exchange, and shared vision. ICAP-2025 serves as a vital platform that brings together leading experts, emerging researchers, and students to engage in rigorous discourse, present frontier developments, and explore transformative ideas spanning the full breadth of contemporary physics.

The research contributions featured in this Book of Abstracts reflect the remarkable diversity and depth of modern scientific inquiry. From quantum materials, high-energy and nuclear physics, and photonics, to plasma science, astrophysics, environmental physics, and emerging quantum technologies, the works assembled here highlight both foundational investigations and application-driven innovations. These contributions embody the collective aspiration of our scientific community to address complex questions, develop advanced methodologies, and push the boundaries of knowledge.The successful preparation of this volume stands as a testament to the meticulous planning, scholarly dedication, and tireless efforts of the Organizing Committee and the faculty members of the Department of Physics. Their commitment to ensuring academic excellence and fostering an environment that enables meaningful scientific engagement is truly commendable.

I extend my sincere appreciation to all invited speakers, authors, reviewers, sponsors, and participants. I am confident that the discussions, collaborations, and new partnerships formed during this conference will contribute significantly to future scientific breakthroughs and strengthen the global network of physics research.

I wish the conference every success and hope that all participants find the experience enriching, inspiring, and conducive to continued scholarly growth.

Professor Dr. Md. Ismail Hossain
Treasurer
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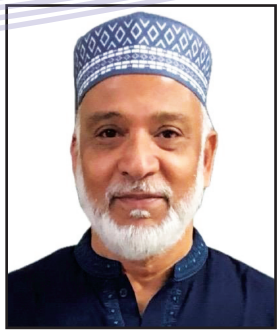

Message from Dean

It is my great pleasure to welcome all distinguished speakers, participants, and young scholars to the International Conference on Advances in Physics (ICAP-2025), organized by the Department of Physics under the School of Physical Sciences, Shahjalal University of Science and Technology (SUST). This conference brings together leading researchers from diverse disciplines, including condensed matter physics, photonics, high-energy and nuclear physics, materials science, astrophysics, nanoscience, and environmental physics, to share their most recent findings and to foster meaningful scientific exchange.

The School of Physical Sciences has long been committed to advancing frontier research and academic excellence across its constituent departments. ICAP-2025 exemplifies this mission by offering a platform where theoretical insights, experimental innovations, and computational approaches converge to address emerging questions in modern physics. The broad range of contributed talks and invited lectures reflects the vibrancy and depth of research being pursued both nationally and internationally.

I extend my sincere appreciation to all authors for their valuable submissions, and to the organizers for their meticulous planning and unwavering commitment.I wish all participants a stimulating and fruitful experience at ICAP-2025, with new collaborations, novel ideas, and continued scientific growth.

Professor Md. Ahmed Kabir Chowdhury
Dean, School of Physical Sciences
Shahjalal University of Science and Technology
Sylhet-3114, Bangladesh

Message from Convener

It is my privilege to welcome all distinguished scientists, academicians, early-career researchers, industry professionals, and students from around the world to the International Conference on Advances in Physics (ICAP-2025) at Shahjalal University of Science and Technology.

The central aim of ICAP-2025 is to bring together diverse expertise from across the physical sciences under a single platform, enabling deep scientific interaction and catalyzing future collaborations. The scientific program, encompassing plenary lectures, invited talks, parallel sessions, and posters, has been carefully designed to highlight contemporary advances and emerging challenges in theoretical, experimental, and computational physics.

I express my heartfelt gratitude to the Chief Patron and Patron of the conference for their continuous support and guidance. I also thank our sponsors, invited speakers, authors, reviewers, and volunteers whose contributions have made this conference possible. The dedication and relentless work of the organizing and technical committees deserve special recognition.

I warmly welcome all participants to ICAP-2025 and wish them an inspiring and enriching experience.

Professor Dr. Md. Shah Alam
Convener, Organizing Committee
International Conference on Advances in Physics-2025

Message from Member Secretary

On behalf of the Organizing Committee, I am delighted to welcome all participants to the International Conference on Advances in Physics (ICAP-2025). This conference has been envisioned as a platform for researchers from academia, national laboratories, and industry to share recent advancements, exchange scientific ideas, and explore opportunities for collaboration across multiple domains of physics.

The strong response from the scientific community and the high-quality submissions reflect the vibrancy of current research activities. We are pleased to have assembled a diverse set of abstracts representing theoretical, computational, experimental, and interdisciplinary studies across the physical sciences.

I extend my sincere appreciation to all authors, reviewers, session chairs, volunteers, and committee members for their commitment and countless hours of effort. Their contributions have been instrumental in shaping this conference. I also hope that visitors will enjoy the natural beauty of our campus and the welcoming environment of Sylhet during their stay.

Wishing everyone an intellectually rewarding and memorable experience at ICAP-2025.

JASEER AHMED

Dr. Jaseer Ahmed
Member Secretary, Organizing Committee
International Conference on Advances in Physics-2025

Editorial Note

It is my great pleasure to welcome you to the International Conference on Advances in Physics 2025 (ICAP-2025) and to present this Abstract Book, which compiles the scientific contributions submitted to this academic event. ICAP-2025 serves as a global platform for physicists, researchers, and innovators to exchange ideas, share discoveries, and explore the frontiers of modern physics.

This volume reflects the remarkable breadth and depth of current research—from theoretical and experimental physics to emerging interdisciplinary fields. Each abstract included here represents the dedication, curiosity, and rigorous scientific inquiry of our contributors. Together, they offer an inspiring snapshot of the progress and potential that continue to drive advancements in physics worldwide.

This Abstract Book comprises the work of 9 distinguished plenary and invited speakers, whose lectures highlight cutting-edge advances and emerging directions in modern physics. In addition, it features 89 oral presentations and 31 poster presentations, reflecting a wide range of topics and research areas—from fundamental physics to applied and interdisciplinary fields. Together, these contributions demonstrate the depth, creativity, and global collaboration that drive progress in our scientific community.

I extend my sincere appreciation to all authors for their valuable submissions, to our reviewers for their thoughtful and timely evaluations, and to the scientific and organizing committees for their tireless efforts in shaping a high-quality and impactful program. Their commitment has ensured that ICAP-2025 remains a dynamic forum for innovation, collaboration, and academic excellence.

On behalf of the editorial team, I hope this Abstract Book enriches your conference experience and serves as a lasting reference for your future research endeavors. We look forward to the insightful discussions, new collaborations, and scientific inspirations that will emerge throughout ICAP-2025.
Thank you for being part of this international gathering, and I wish you a productive and intellectually stimulating conference.

Professor Dr. Sharif Md Sharafuddin
Editor-in-Chief, Book of Abstracts
International Conference on Advances in Physics-2025

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*In fond memory of Professor Dr. M Shamsher Ali, whose guidance and contributions to ICAP-2025 will be remembered with deep gratitude. He passed away on 03 August 2025.

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Day 1 (17 December 2025, Wednesday)

Inaugural Session: 09:00 am - 10:00 am
Venue: Central Auditorium, Shahjalal University of Science and Technology

Time	Details
07:30 am to 09:00 am	Reporting and Reception
09:00 am to 09:05 am	Welcome Address by Dr. Jaseer Ahmed Member Secretary, Organizing Committee, ICAP-2025
09:05 am to 09:10 am	Speech from Special Guest Professor Md. Ahmed Kabir Chowdhury Dean, School of Physical Sciences, SUST, Sylhet, Bangladesh
09:10 am to 09:15 am	Speech from Special Guest Professor Dr. Md. Ismail Hossain Treasurer SUST, Sylhet, Bangladesh
09:15 am to 09:20 am	Speech from Special Guest Professor Dr. Md Shajedul Karim Pro Vice-Chancellor SUST, Sylhet, Bangladesh
09:20 am to 09:30 am	Speech from Chief Guest Professor Dr. A. M. Sarwaruddin Chowdhury Vice-Chancellor SUST, Sylhet, Bangladesh
09:30 am to 09:35 am	Address by Chair Professor Dr. Md. Shah Alam Convener, Organizing Committee, ICAP-2025
09:35 to 10:00 am	Photo Session
10:00 am to 10:30 am	Tea Break
10:30 am to 11:10 am	Speech from Plenary Speaker **Professor Dr. Masashi Ohashi** Kanazawa University, Japan **Title**: Correlation between magnetocaloric effect and crystal growth in manganese oxide ferromagnet $La_{1.4}Ca_{1.6}Mn_2O_7$

Technical Session-1

Condensed Matter Physics
11:10 am to 12:50 pm

Session Chair: Professor Dr. Shumsun Naher Begum
Department of Physics, SUST, Sylhet
Venue: Central Auditorium, SUST

Invited Speaker	**Professor Dr. Abul Klam Azad** Universiti Brunei Darussalam, Brunei
Title of the Invited Talk	Solid Oxide Fuel Cells (SOFCs): Technology, Challenges and Applications for Energy Sustainability
Time	11:10 pm to 11:35 pm

Contributory Talks

Abstract No	Abstract Title
119	Design and Realization of Plasmonic Solar Cell Platform
74	Tuning Charge Dynamics through La^{3+} Substitution in CoFe2O4: Insight for Energy Storage Efficiency
26	Unveiling Crystal Structure and Properties of an Organic-Inorganic Hybrid Material
33	Low-Temperature Fabrication of CIGS Layers Exhibiting Superior Optoelectronic and Semiconductor Properties
178	Investigation of the Insulator to Metallic Phase Transition of $LaCoO_3$
8	Structural and Flow Characteristics of Polycarbonate Microfiltration Membrane Synthesized Through the Phase Inversion Technique

1:00 pm to 2:00 pm
Prayer and Lunch Break

Technical Session-2

02:00 pm to 03:45 pm

Session Chair: Professor Dr. Masashi Ohashi, Kanazawa University, Japan
Co-chair: Professor Dr. Muhammad Omar Faruk, Department of Physics, SUST, Sylhet
Venue: Room 129, Academic Building-A, SUST

Invited Speaker	**Professor Md. Wahadoszamen** Department of Physics, University of Dhaka
Title of the Invited Talk	Engineering Light–Matter Interactions in Nanoscale Materials for Enhanced Raman and Nonlinear Optical Responses
Time	02:00 pm to 02:25 pm

Contributory Talks
02:25 pm to 03:45 pm

Room 129A	**Nonlinear Optics and Nanoscience**

Session Chair: Professor Dr. Masashi Ohashi, Kanazawa University, Japan

Co-chair: Professor Dr. Muhammad Omar Faruk, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
167	FFT-Based Noise Filtering in Low-Power Z-Scan Measurements
181	Concentration-Driven Higher-Order Nonlinear Optical Responses in Triarylmethane Chromophore
116	Semiconducting and Self-Regulating Characteristics of BaTi0.80Mo0.20O3 Ceramics for heat sink application on microprocessor
183	Thermally Induced Nonlinear Optical Effects in Ni (II), Co (II), and Cu (II) Complexes of L-Phenylalanine: A CW Z-Scan Analysis
32	Synergistic Interplay of Ce-Doped g-C_3N_4 and MXene for Enhanced Energy Storage
130	An Artificial Intelligence Approach Towards Noise Analysis In Electrical Circuits Using Neural Networks And Reinforcement Learning

Room 409 A	Experimental Condensed Matter Physics

Session Chair: Professor Dr. Abdul Hannan, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
5	Phase stability, electronic, mechanical and thermoelectric properties of Zintl phases: XIn2C2 (M= Mg, Sr and Ba)
19	Design of MoS_2/VS_2/PANI Hybrid Nanocomposites with Superior Electrochemical Capacitance
55	Synthesis and Study of Multifunctional Properties of a High-capacitance Supercapacitor Electrode Pr2CoCrO6 Nanoparticles.
154	Theoretical investigation and experimental val idation of ZnCr2O4 for structural, mechanical, electronic and thermal property
93	Structural, morphological, magnetic and dielectric properties of Nd3+doped zinc ferrites using conventional solid state reaction technique for high frequency applications
104	Structure based Electric Polarization in Mo and W Doped BaTiO3 Ceramics fo Energy storage applications

Room 307 A	Atomic, Molecular and Plasma Physics

Session Chair: Dr. Md. Khairul Islam, Bangladesh Atomic Energy Commission, Dhaka

Abstract No	Abstract Title
138	Photoelectric effect on dust acoustic mode in ionospheric dusty plasmas with dust charge fluctuation
61	Instability of plasma modes due to photoelectric effect in streaming and irradiated dusty plasmas
81	Comparative Study of Ion and Neutron Properties in Low-Energy Plasma Focus Devices
182	Excitation of Ion Acoustic Mode in Magnetized Dusty Plasma
82	Excitation of Electrostatic Dust Modes in Magnetized Dusty Plasma
77	Atomistic View of Molten Vanadium: Insights from Orbital-Free ab-initio Molecular Dynamics

03:45 pm to 04:00 pm
Tea Break

04:00 pm to 6:00 pm
Poster Session

06:30 pm to 9:00 pm
Online Session

Invited Speaker	Dr. Mohammad Belal Hossen Department of Physics, Chittagong University of Engineering and Technology, Chittagong, Bangladesh
Title of the Invited Talk	Nano-Manganites on a Sustainable Path: Enhancing Functional Properties While Preserving Intrinsic Structure for Sustainable Applications
Time	06:30 pm to 06:55 pm

Contributory Talks
06:55 pm to 09:00 pm

Room IICT Virtual Room	**Physics: Mixed**

Session Chair: Dr. Md Enamul Hoque, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
115	Neutronic Assessment of SiC- and ZrC-Reinforced E110 Cladding for VVER-1200 Fuel Assembly Using OpenMC
118	Thermal Performance Improvement of Zr-1%Nb (E110) Cladding Reinforced with 2-15% SiC Nanoparticles for VVER-1200 Fuel Rods Using ANSYS

145	Wigner-based Monte Carlo Simulation of Three-Flavor Neutrino Oscillation in Vacuum
45	Multi-Task Machine Learning for Accelerated Prediction of Band Gap and Formation Energy
51	Bionic Design and Finite Element Analysis of an Elliptical Pressure Hull for Deep-Sea Applications
124	An Investigation on the Efficiency of CIGS solar cell by applying ZnSe buffer layer and Zn-MgO Electron Transport Layer: A Simulation Approach by SCAPS-1D
12	A Comparative Study of Molecular Transport to Identify the Lamellarity of Vesicle Using COMSOL Simulation
99	Comprehensive Analysis of Vertical Wind Shear on Intensity and Rainfall of Tropical Cyclones over the Bay of Bengal
103	Modeling Built-up Area through Atmospheric Pollutants in Bangladesh using Random Forest Algorithm
141	Assessment of Natural and Artificial Radioactivity Levels in Surface Water and Sediment Samples from Bhairab and Rupsha River in Khulna, Bangladesh
21	Evolution of Core Structure from Helium Burning to Oxygen-Neon Stages in a 15 M Star
135	AI-Based Inverse Design of Metamaterials for Electromagnetic Cloaking

Day-2 (18 December 2025, Thursday)

Plenary Speech: 9:00 am to 9:40 am

Session Chair: Professor Dr. Md Shah Alam, Department of Physics, SUST, Sylhet

Plenary Speaker	Professor Emeritus Dr. A.K.M. Azharul Islam Department of Physics, University of Rajshahi, Rajshahi 6205, Bangladesh.
Title of the Invited Talk	Nanotech Wonders - Road from Fiction to Emerging Reality
Time	9:00 am to 9:40 am
Venue	Mini Auditorium, SUST, Sylhet

Technical Session-3
09:40 am to 11:20 am

Session Chair: Professor Dr. Md Shah Alam, Department of Physics, SUST, Sylhet
Venue: Mini Auditorium, SUST, Sylhet

Invited Speaker	**Professor Dr. Khondkar Siddique-e Rabbani** Honorary Professor and Founding Chairperson (2008–2015), Department of Biomedical Physics & Technology, University of Dhaka, Dhaka, Bangladesh
Title of the Invited Talk	Bioelectrical Frontiers in Medicine: Diagnostic and Therapeutic Potentials-Explored in Bangladesh
Time	09:40 am to 10:05 am

10:05 am to 10:20 am
Tea Break

Contributory Talks
10:20 am to 11:20 am

Room 129 A	**Medical, Health and Bio-Physics**

Session Chair: Professor Dr. Md Shah Alam, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
158	Towards an EMI-Free Hospital Communication System in Bangladesh: A VLC-Based Approach
108	Optimized D-Shaped PCF-SPR Biosensor Using HfO2 Adhesive Layer for MDA-MB-231 and MCF-7 Biomarker Detection
163	Z-Scan Profiling of Sunlight-Exposed Cholecalciferol in Pharmaceutical Formulations
143	Impact of GPS Sensor Tracking on Astronauts' Retina to Outbreak of Unexpected Eye Disease
98	A Machine-Learning Framework for Non-Invasive SpO_2 and Heart Rate Prediction from Photoplethysmography

Room 409A	Condensed Matter Physics: Experiment and Computation

Session Chair: Professor Dr. Sharif Md. Sharafuddin, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
148	Synthesis and Structural Characterization of Mn Doped $SrFeO_3$ as Perovskite
176	Optimizing Deposition of Platinum Nanoparticles on Functionalized Graphene Oxide
72	Exploring the Properties of Double Perovskite Pr2CoCrO6 through DFT: An Analysis of Electronicand Optical Properties
85	Generalization and Efficiency of Graph Neural Networks for Crystal Formation Energy Prediction
91	Optimization of the superparamagnetic properties of Fe2+ replacing by Al3+ of Zn-Mn ferries for biomedical applications

Room 307 A	Optoelectronics

Session Chair: Professor Dr. Nazia Chawdhury, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
34	Sustainable synthesis of Titania Nanoparticles with tunable crystallinity and optoelectronic properties
137	Structural, Optical, and Electrical Properties of FAPbI3 Perovskite Film and Simulation of the Perovskite Solar Cells
147	Investigation of Semiconducting and Optical Properties of Spray-Coated Ag–Sn Dual-Doped CdO Thin Films for Optoelectronic Applications
87	Band Gap Engineering and Lattice Distortion in Co and Cu-Doped BaTiO3 Ceramics for advanced optoelectronic applications
134	Optoelectronic and Kinetic Properties of Pt-Bipyridine Complexes as Triplet Emitters in OLEDs: A Computational Study

Technical Session-4
11:30 am to 01:00 pm

Session Chair: Professor Dr. Abdul Hannan, Department of Physics, SUST, Sylhet
Venue: Room 129, Academic Building A, SUST

Invited Speaker	**Professor Dr. Saleh Hasan Naqib** Department of Physics, University of Rajshahi, Rajshahi 6205, Bangladesh
Title of the Invited Talk	Ca-substituted YBCO: a playground to explore magnetism, hole doping, and T_c degradation
Time	11:30 am to 11:55 am

Contributory Talks
11:55 am to 01:00 pm

Room 129A	**Condensed Matter Physics: Theory and Computation**

Session Chair: Professor Dr. Abdul Hannan, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
72	Exploring the Properties of Double Perovskite Pr2CoCrO6 through DFT: An Analysis of Electronic and Optical Properties
80	Dynamic and Mechanical Stability of Ternary Semiconductor Na2CuP: A Theoretical Insight
105	Electronic and optical properties of the ferromagnetic A2CrWO6 (A = Sr, Ba) for spintronic devices: A DFT insights
161	A comprehensive first-principles analysis of X2AgIrBr6 (X = Rb, Cs) halide double perovskites for advanced optoelectronic and energy conversion applications
146	Electronic and Charge Transport Properties of Metal Bathocuproine complexes utilizing Quantum Chemical Calculation

Room 409A	Earth, Atmospheric, and Environmental Physics

Session Chair: Dr. Tanvir Ahmed, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
165	Investigating the relationship between Lightning Potential Index and Microphysical Volume of Hydrometeors using Weather Research and Forecasting Model over Bangladesh
113	Vertical Wind Shear Dominates Over Sea Surface Temperature in Controlling Tropical Cyclone Persistence: A WRF-Based Analysis of Cyclone Remal (2024)
30	Sensitivity of Weather Models to Initial Conditions in Long-Term Forecasts: A Comprehensive Analysis
58	Assessment of Groundwater Quality and its Suitability for Drinking and Irrigation Purposes in Sunamganj Sadar and Bishawamvarpur Upazila, Sunamganj, Bangladesh
22	Spatiotemporal Analysis of Poverty and Climatic Influences on Hospitalization Trends in Bangladesh (2019–2024): A Multivariate Public Health Perspective

Room 307A	Condensed Matter Physics: Experiment and Computation

Session Chair: Professor Dr. Muhammad Omar Faruk, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
94	Sintering temperature dependent electromagnetic properties of gold (Au3+) doped cobalt based ferrites for different potential applications
89	Sintering effect on electro-magnetic properties of Mn-Zn ferrites by green synthesis route
54	Coupled Influence of Surface Oxidation and Interlayer Structure on Proton Transport in Graphite Oxide
184	A Self-Consistent Computational Design of Fe-Doped CsGeCl3 for Flexible Perovskite Solar Cells
150	A Comparative DFT Study of Pb-Based and Pb-Free Ruddlesden-Popper $Cs_2BCl_2I_2$, (B = Pb, Ge) Perovskites for Next-Generation Optoelectronic and Solar Cell Applications

01:00 pm to 02:00 pm
Prayer and Lunch Break

Technical Session-5
02:00 – 03:30 pm

Session Chair: Professor Dr. Nazia Chawdhury, Department of Physics, SUST, Sylhet

Venue: Room 129, Academic Building A, SUST

Invited Speaker	**Professor Dr. Ismail Rahman** Institute of Environmental Radioactivity, Fukushima University, 1 Kanayagawa, Fukushima City, Fukushima 960-1296, Japan.
Title of the Invited Talk	The Fukushima Daiichi Water Challenge: Innovations in Radionuclide Separation and Containment
Time	02:00 pm to 02:25 pm

Contributory Talks
02:25 pm to 03:30 pm

Room 129A	**Nuclear, Reactor and Particle Physics**

Session Chair: Professor Dr. Nazia Chawdhury, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
7	191Ir(n, γ) cross section and its impact on astrophysical network calculations
107	Selective Separation Of Radiostrontium From Aqueous Waste Using Porous Macrocyclic Based Sorbent
47	An Integrated Remediation Framework for Radionuclide-Contaminated Lands: From Molecular Extraction to Landscape Stabilization
10	Natural radioactivity in sediments of the Jamuna River of Bangladesh: Concomitant radiological risk assessment with a statistical approach
71	Nuclear and Radioactive Waste Management in Bangladesh: Present Status and Future Challenges

Room 409A	Nanoscience and Material Physics

Session Chair: Dr. Sarwat Binte Rafiq, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
127	Controlled Deposition of Photothermally Active Ag@TiO2 Coreshell onto Nano-cellulose Hydrogels Matrix for the Application of Wound Healing
169	Structural, Electronic, and Optical Properties of Copper Oxide Nanomaterials: A Comparative Study of DFT Predictions and UV-Vis Experimental Analysis
46	Sol–Gel-Derived NiO/ZnO Thin Films with Single and Heterostructure Layers for Electrochemical Energy Storage
25	Crystallographic Characterization Of Sol-gel Produced H-bn And Its Amino Functionalization: Resolving Functionalization Limitations
160	Impact of high sintering temperature on frequency dependent magnetic & dielectric properties of (Mg 0.25 Ni 0.25 Co 0.25 Zn 0.25) 2 SiO 4 high-entropy ceramics

Room 307A	Condensed Matter Physics: Computation

Session Chair: Mr. Anock Somadder, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
171	A Quantum Espresso recipe for Z_2 invariant of 2D topological material 1T'WTe_2
65	A Comparative Study of Bilayer and Bulk Heterojunction Organic Photovoltaic Devices Employing Poly(3-hexylthiophene) and Polynaphthalene-bithiophene Polymers Through SCAPS Simulation
70	High-Pressure First-Principles Insights into BeCN2: A Promising Ultra-Wide Band Gap Semiconductor for Next-Generation Electronics
139	Synthesis and Characterization of Sm Doped Cu -Zn Ferrite for High Frequency devices
142	The Investigation of the Cancer Cell's Fate by Integrating Agent-Based Modeling and Predictive Machine Learning

03:30 pm to 03:45 pm
Tea Break

Technical Session-6
03:45 – 05:15 pm

Session Chair: Professor Dr. Mohammad Delawar Hossain, Department of Physics, SUST, Sylhet

Venue: Room 129, Academic Building A, SUST

Invited Speaker	Professor Dr. Syed Badiuzzaman Faruque Department of Physics, Shahjalal University of Science and Technology, Sylhet, Bangladesh
Title of the Invited Talk	Gravitomagnetism and Some of its Consequences
Time	03:45 pm to 04:10 pm

Contributory Talks
04:10 pm to 05:15 pm

Room 129A	**Theoretical Physics, Mathematical and Computational Physics**

Session Chair: Professor Dr. Mohammad Delawar Hossain, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
92	Doppler Lensing in Cosmic Voids: Relativistic-N Body Simulation Insights
125	Mathematical Modelling of Binary Stability: From Gravitational Binding to Evolutionary Disruption Show abstract
49	The VORTEX–MAJORANA Model: A Theoretical Framework for Neutrino Oscillations
129	Spectroscopy-Based Tracking and Timing Calorimetry for Enhanced Sensitivity in Muon–Electron Conversion Searches
28	Simulation-Based Investigation of Pulsed Electromagnetic Field (PEMF) Effects on Hemodynamics via Physics-Informed Modeling

Room 409A	Condensed Matter Physics: Computation

Session Chair: Professor Dr. Khurshida Begum, Department of Physics, SUST, Sylhet

Abstract No	Abstract Title
114	Strain Engineering and Hybrid Functional Insights into III-V Compounds and the 2D InSe Monolayer for Advanced Electronic Applications
105	Electronic and optical properties of the ferromagnetic A2CrWO6 (A = Sr, Ba) for spintronic devices: A DFT insights
168	Optical and Electrical Properties of Methylammonium Tin Iodide Perovskite for the Application in Solar Cells: A Density Functional Theory Approach
3	Comparative First-Principles Study of M2SnGeO6(M = Ca, Sr, Ba) Double Perovskites: Electronic, Optical, Mechanical, and Thermoelectric Perspectives
109	Assessment of Free Layer Volume Influence on switching energy, current, and stability of Spin-Transfer Torque Devices.

Concluding Session

06:30 pm - 07:30 pm

Venue: Mini Auditorium, Shahjalal University of Science and Technology, Sylhet

Time	Details
6:30 pm to 6:40 pm	Vote of Thanks by Professor Dr. Abdul Hannan Treasurer, ICAP-2025
06:40 pm to 06:45 pm	Speech from Special Guest Professor Md. Ahmed Kabir Chowdhury Dean, School of Physical Sciences, SUST, Sylhet, Bangladesh
06:45 pm to 06:50 pm	Speech from Special Guest Professor Dr. Md. Ismail Hossain Treasure, SUST, Sylhet, Bangladesh
06:50 pm to 06:55 pm	Speech from Special Guest Professor Dr. Md Shajedul Karim Pro-Vice Chancellor, SUST, Sylhet, Bangladesh
06:55 am to 07:05 pm	Speech from Chief Guest Professor Dr. A. M. Sarwaruddin Chowdhury Vice-Chancellor, SUST, Sylhet, Bangladesh
07:05 pm to 07:25 pm	Best Poster Award
07:25 pm to 7:30 pm	Concluding Remarks by Chair Professor Dr. Md. Shah Alam Convenor, ICAP-2025

Conference Dinner: 7:30 pm

Plenary Talk: 1

Correlation between magnetocaloric effect and crystal growth in manganese oxide ferromagnet $La_{1.4}Ca_{1.6}Mn_2O_7$

Masashi Ohashi[1,2], Yuki Nakajima[2], Yoshiki Maruyama[2], Zhou Dejun[2], Ovijit Chandrow[2,3], and Shumsun Naher Begum[3]

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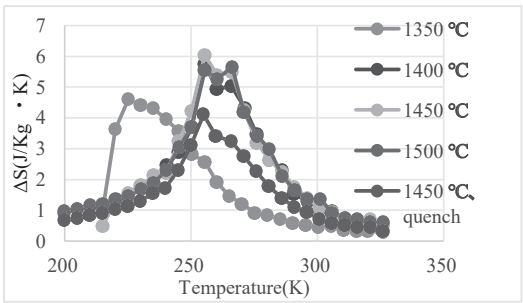
Abstract

We present systematic studies of calcium-doped lanthanum manganite La1.4Ca1.6Mn2O7 near a second-order phase transition from a ferromagnetic to a paramagnetic state. The polycrystalline samples of composition were prepared by a standard ceramic method. The crystal structure was shown to be in good agreement with previous reports1. Although the XRD pattern showed absence of other phases, the growth of XRD patterns tend to occur with heat treated temperature. The particle size estimated from the SEM results increased with heat treatment temperature, but the lattice constant was independent. The temperature dependence of La1.4Ca1.6Mn2O7 on the heat capacity shows the Curie temperature TC= 270 K is independent of heat treated temperature. On the other hand, the discontinuous of heat capacity at TC tends to be enhanced as increasing heat treated temperature. Similar behavior is also observed in the magnetization. Figure 1 shows the magnetic entropy change ΔS of La1.4Ca1.6Mn2O7 obtained from the magnetization measurements. In this work, the largest ΔS has been obtained to be 6 J/kg K at 255 K for the sample of the heat treated temperature at 1450 ℃. Although it is smaller than the results of previous report2, it was also found to change if the preparation method was changed. Such behaviors may come from the spin canting preferentially at a surface of particles of La3-x CaxMn2O7 (0<x<3) system.

Figure 1. Temperature dependence on the magnetic entropy changes ΔS of La1.4-Ca1.6Mn2O7 for various heat treated temperatures at a magnetic field ΔH = 5 T.



References

1. H. Zhu, S. Hao, Y. Zhang: Applied Physics Letters 81 (2002), 3416.
2. J. L. Zhu, R. C. Yu, C. Q. Jin, F. Y. Li, Z. Zhang. Materials Science and Engineering B, 95 (2002) 19.

Plenary Talk: 2

Nanotech Wonders - Road from Fiction to Emerging Reality

A.K.M. Azharul Islam

Department of Physics, University of Rajshahi, Rajshahi 6205, Bangladesh

Abstract

Once confined to the realm of speculative fiction, nanotechnology has rapidly evolved into one of the most transformative scientific revolutions of our time. At the heart of this revolution lies a class of extraordinary materials: 2D MXenes. These atomically thin structures- born from the selective etching of MAX phases- possess a rare combination of metallic conductivity, hydrophilicity, and surface tunability, making them true `wonder materials' of the nanoscale world.

This keynote explores the synthesis and evolution of MXenes, tracing their journey from 3D sheets to emerging 2D architectures. It highlights their diverse applications- from energy storage and biomedical devices to environmental remediation and electromagnetic shielding- demonstrating how these materials are reshaping industries and redefining possibilities.

As we stand at the threshold of a new era, the story of MXenes is not just about materials science- it is about imagination meeting innovation. This is the road from fiction to reality, from 2D to 3D, and from curiosity to capability. The future is being built one nanolayer at a time.

Invited Talk: 1

Solid Oxide Fuel Cells (SOFCs): Technology, Challenges and Applications for Energy Sustainability

Abul Kalam Azad

Chemical and Process Engineering, Universiti Brunei Darussalam, Jalan Tungku Link, Gadong, BE 1410, Brunei

Abstract

Fuel cells are increasingly recognised as a pivotal clean-energy technology capable of supporting global transitions toward decarbonisation and long-term energy sustainability. Operating through electrochemical conversion rather than combustion, they offer high efficiency, low emissions, fuel flexibility, and scalable designs suitable for stationary, portable, and transportation applications. This presentation is an integrated overview of two major fuel cell systems, i.e. Solid Oxide Fuel Cells (SOFCs) and Proton-Conducting Ceramic Fuel Cells (PCFCs) with emphasis on their operating principles, material requirements, and performance characteristics.

Key challenges hindering widespread deployment include electrode and electrolyte degradation, impurity poisoning, carbon deposition, thermal cycling instability, and interfacial reactions that limit durability. High manufacturing costs, complex water and thermal management, and the need for improved catalyst design and system integration remain significant barriers. Emerging opportunities such as green hydrogen, ammonia, and biomass-derived fuels introduce additional demands on catalyst tolerance and stack optimisation.

Fuel cell applications continue to expand across diverse sectors. SOFCs and MCFCs are increasingly used for highly efficient stationary power and combined heat and power (CHP) systems, while PEMFCs are enabling the decarbonisation of heavy-duty transport, maritime systems, and off-grid power solutions. Their integration with renewable energy, energy storage, and smart grids highlights their potential role in resilient, net-zero energy systems.

Overall, fuel cell technologies are progressing toward wider commercial maturity, driven by advancements in materials engineering, cost reduction, and fuel infrastructure development. Addressing remaining technical challenges through coordinated research, industrial partnerships, and supportive policy frameworks will position fuel cells as a central component of future sustainable energy landscapes.

Invited Talk: 2

Engineering Light–Matter Interactions in Nanoscale Materials for Enhanced Raman and Nonlinear Optical Responses

Md. Wahadoszamen

Department of Physics, University of Dhaka, Dhaka, Bangladesh

Abstract

Controlling and engineering light–matter interactions at the nanoscale is central to advancing modern photonic and optoelectronic technologies. In my research group, we focus on engineering such interactions through the controlled fabrication of diverse nanostructures and probing their optical responses using Raman spectroscopy, surface-enhanced Raman spectroscopy (SERS), and nonlinear optical techniques, particularly the Z-scan method. To this end, we synthesize a wide range of monometallic nanoparticles with systematically varied sizes, shapes, and morphologies using both bottom-up approaches (chemical, sonochemical, hydrothermal, and green synthesis) and top-down routes (laser ablation and sonochemical fragmentation). Using identical synthesis protocols, we further develop bimetallic core–shell nanostructures with tunable core dimensions, shell thicknesses, and shape anisotropies, alongside multiple classes of highly fluorescent carbon nanodots (CNDs) emitting across the UV, blue, green, yellow, and red spectral ranges.

These monometallic and bimetallic nanoparticles, together with the fluorescent CNDs, are subsequently integrated onto the elongated surfaces of two-dimensional semiconducting nanoflakes, such as ZnO and MoS_2, to construct a family of metallic–semiconducting heterostructure nanocomposites. The resulting hybrid systems exhibit dense distributions of plasmonic and excitonic super-hotspots embedded in the dielectric environment of the 2D hosts, which significantly amplify both Raman and nonlinear optical signals. Such enhanced architectures serve as highly efficient SERS platforms and sensitive Z-scan media, enabling detailed exploration of electromagnetic coupling, charge-transfer processes, and nanoscale field confinement.

In this presentation, I will highlight our recent findings on the SERS and Z-scan responses of these engineered nanostructures, with an emphasis on structure–property correlations and the underlying enhancement mechanisms. Additionally, I will present our fluorescence spectroscopic investigations of various batches of multicolor CNDs, shedding light on how their surface chemistry and defect landscapes dictate their emission behavior and optical nonlinearities. Together, these results underscore the potential of rationally designed hybrid nanostructures for next-generation sensing, imaging, and photonic applications.

Invited Talk: 3 (Online)

Nano-Manganites on a Sustainable Path: Enhancing Functional Properties While Preserving Intrinsic Structure for Sustainable Applications

Mohammad Belal Hossen

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Abstract

Nano-manganite's have emerged as a versatile class of functional materials with exceptional structural, magnetic, catalytic, and electronic properties, making them strong candidates for addressing global sustainability challenges. This work presents a comprehensive overview of the synthesis, characterization, and multifunctional behavior of nano-structured manganite systems, emphasizing their potential in environmentally sustainable technologies. Owing to their tunable crystal structure, mixed-valence states, and size-dependent phenomena, nano-manganites demonstrate enhanced performance in applications such as renewable energy generation, photocatalysis, supercapacitors, gas sensing, magnetic refrigeration, and wastewater treatment. Special attention is given to the correlation between nanoscale effects and functional properties, highlighting how particle size reduction, cation doping, and surface engineering can significantly improve catalytic activity, electrical conductivity, and environmental stability. Controlled doping can strategically tailor the functional performance of nano-manganites without altering their intrinsic crystal structure, thereby preserving the fundamental perovskite framework while enhancing targeted functionalities. Light doping at the A- or B-site introduces subtle modifications in carrier concentration, defect density, and Mn^{3+}/Mn^{4+} ratios, which lead to measurable improvements in conductivity, magnetization, catalytic activity, and environmental stability.The importance of low-cost and eco-friendly synthesis approaches, which further strengthen the role of nano-manganites in sustainable material solutions. The study concludes by outlining current challenges—including stability, scalability, and long-term environmental impact—while identifying emerging research directions aimed at optimizing nano-manganites for next-generation green technologies. Overall, this work underscores the transformative potential of functional nano-manganites in shaping innovative, efficient, and environmentally responsible applications.

Invited Talk: 4

Bioelectrical Frontiers in Medicine: Diagnostic and Therapeutic Potentials—Explored in Bangladesh

Khondkar Siddique-e Rabbani

Honorary Professor and Founding Chairperson (2008–2015)
Department of Biomedical Physics & Technology, University of Dhaka, Dhaka, Bangladesh

Abstract

Research on Pulsed Electromagnetic Field (PEMF) therapy for bone healing began in Bangladesh in 1978, led by a team that included the author. These early studies produced promising outcomes and established a foundation for later innovations. A significant academic collaboration with Sheffield University, UK (1983–1992), expanded this work through joint research carried out at the Department of Physics, University of Dhaka, and later at the new Department of Biomedical Physics & Technology, where the author served as founding Chairperson.

In 1988, the team developed Bangladesh's first computerised medical device—an EMG/EP machine—launching the country's first clinical service for nerve conduction studies. The group also pioneered the Distribution of F-Latency (DFL) technique, enabling early diagnosis of cervical and lumbosacral spondylotic neuropathy, and contributing to the discovery of a new mechanism of nerve conduction in myelinated nerves.

The Sheffield collaboration further catalyzed research in Electrical Impedance techniques. A major innovation from this phase was the Focused Impedance Method (FIM) developed by the author, enabling regional physiological assessment using simple, locally built instrumentation. Potential applications include monitoring lung ventilation, lung perfusion, gastric and bladder emptying, and more. FIM has earned international recognition, with multiple variants introduced by the author's group. Recently another innovation by the author, '6-electrode Tetrapolar Impedance Measurement' provides enhanced depth sensitivity using conventional simple instrumentation and has achieved considerable international attention.

Upholding a philosophy against patenting technologies that may exacerbate global inequities, the author declined patenting and commercial investment offers. Several Bangladeshi universities are now exploring FIM's diagnostic potential.

Additional successes include locally developed iontophoresis instrumentation for hyperhidrosis, achieving nearly 90% success rates. The author's team has also revived PEMF research for pain relief, achieving nearly 90% success across diverse pain conditions and in Benign Prostate Hyperplasia, enlargement of the prostate glands in men.

Bioelectricity has a major role to play in the assessment and therapy of health conditions and the author feels fortunate that he chose this area early in his career.

Invited Talk: 5

Ca-substituted YBCO: a playground to explore magnetism, hole doping, and Tc degradation

Saleh Hasan Naqib

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Abstract

Ca substitution in place of Y increases the hole content (p) in the CuO2 planes of Y1-xCaxBa2-Cu3O7-™ high-Tc superconductors. We have explored the charge transport and magnetic properties of high-quality sintered Y1-xCaxBa2Cu3O7-™ in this study with different levels of Ca substitution. Quite surprisingly, non-magnetic Ca was found to induce paramagnetic enhancement in the bulk magnetic susceptibility. The magnetic moment survives in the superconducting states. The increment in the magnetic susceptibility is nonlinear as a function of the Ca content (x). At the same time, the superconducting transition temperature, Tc, decreases weakly with increasing Ca content. We believe the unusual magnetic effect and degradation of the Tc are intimately linked and propose a model where Ca substitution not only donates holes to the CuO2 planes but also give rise to a narrow impurity band responsible for the magnetic effect and decrement of the superconducting transition temperature.

Keywords: Copper oxide superconductors; Ca substituted YBCO; Magnetic susceptibility; Superconducting transition temperature

Invited Talk: 6

The Fukushima Daiichi Water Challenge: Innovations in Radionuclide Separation and Containment

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Abstract

The 2011 Fukushima Daiichi Nuclear Power Plant (FDNPP) incident presented an unprecedented environmental challenge: managing vast volumes of water polluted with persistent radionuclides. This presentation will provide a comprehensive overview of the strategies developed and implemented over the past decade to address prolonged and multifaceted environmental challenges, with a particular focus on technological advancements in liquid waste treatment and the creation of novel materials for selective radionuclide containment. The early phase of the reaction at FDNPP was primarily focused on managing and treating contaminated water produced by cooling the damaged reactors, which had intermingled with groundwater and rain. This discussion will cover the progression of water treatment systems, beginning with the early use of zeolite-based and co-precipitation techniques, culminating in the adoption of the Advanced Liquid Processing System (ALPS). The ALPS has effectively eliminated 62 distinct radionuclides, thereby substantially mitigating radioactive hazards; yet issues with tritium and the reprocessing of a considerable quantity of stored water persist. The strategic decision to conduct a regulated discharge of ALPS-treated water into the ocean, in compliance with rigorous international safety regulations, will also be analyzed. Concurrently with these extensive initiatives, emphasis has been placed on advancing next-generation materials for improved radionuclide separation. Innovative solutions focused on supramolecular chemistry principles will be discussed, encompassing the manufacture and utilization of ion-selective solid-phase extractants. Integrating these specialized chemical breakthroughs with proven engineering solutions provides essential insights for optimizing existing treatment protocols and for the future of long-term radioactive water management.

Invited Talk: 7

Gravitomagnetism and Some of its Consequences

Syed Badiuzzaman Faruque

Department of Physics
Shahjalal University of Science and Technology, Sylhet 3114, Bangladesh

Abstract

Gravitoelectromagnetism (GEM) is a set of formal analogies between the equations for electromagnetism and relativistic gravitation. Gravitomagnetism is part of GEM and is the kinetic effects of gravity, in analogy to the magnetic effects of moving electric charge. There are many effects of gravitomagnetism such as gravitomagnetic clock effect (GCE), Lense-Thirring effect, gravitational time-delay etc. In many cases gravitational spin-orbit coupling is behind these effects. In this talk, I shall mainly delve on GCE. Although GCE is a classical effect, we have found quantum version of GCE. Moreover, spin-orbit coupling affects periastron precession. I shall briefly discuss that.

Primarily, orbiting bodies have been found, theoretically, to show GCE even if they were spinless. I have shown for the first time in 2004 that spin of orbiting bodies contributes to GCE. I shall finally present a probable new theory of gravity that contains four fields to convey gravitational force.

Abstract No: 03

Comparative First-Principles Study of M2SnGeO6 (M = Ca, Sr, Ba) Double Perovskites: Electronic, Optical, Mechanical, and Thermoelectric Perspectives

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Abstract

Lead-free double perovskites are gaining attention as sustainable alternatives for multifunctional energy applications. In this work, the electronic, optical, mechanical, and thermoelectric properties of Ca2SnGeO6, Sr2SnGeO6, and Ba2SnGeO6 are systematically investigated using first-principles density functional theory within the FP-LAPW method as implemented in WIEN2k. The electronic structures were examined with both PBE-GGA and TB-mBJ functionals, while transport coefficients were evaluated using the BoltzTraP code.

The calculations reveal that Sr2SnGeO6 and Ca2SnGeO6 are semiconductors, with band gaps of 0.49 eV (PBE-GGA) and 2.29 eV (TB-mBJ) for Sr2SnGeO6, and 0.998 eV (PBE-GGA) and 2.946 eV (TB-mBJ) for Ca2SnGeO6. Ba2SnGeO6, however, shows metallic character within PBE-GGA but transitions to a semiconducting phase with a 1.49 eV band gap under TB-mBJ, indicating strong functional dependence. Optical investigations demonstrate that all three compounds possess strong absorption in the UV-visible region, high optical conductivity, and low reflectivity, making them attractive for optoelectronic and photovoltaic devices. Mechanical stability is confirmed for all systems, with elastic constants indicating ductile behavior and robustness suitable for practical applications. Thermoelectric analysis highlights favorable Seebeck coefficients and competitive figures of merit (ZT), with performance improving at elevated temperatures. Among them, Sr2SnGeO6 and Ca2SnGeO6 display higher band gaps beneficial for UV optoelectronics, while Ba2SnGeO6 shows intermediate behavior with promising energy conversion efficiency.

Overall, the study establishes M2SnGeO6, (M = Ca, Sr, Ba) as promising lead-free double perovskites, combining electronic tunability with strong optical activity and reliable thermoelectric properties, offering potential for next-generation sustainable optoelectronic and thermoelectric devices.

Keywords: Lead-free double perovskite, Optoelectronic properties, Elastic properties, Thermoelectric performance, First-principles study

Abstract No: 04

Physics-Driven Pathways to Sustainable Technology

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Abstract

Heightened effects of climate change in combination with growing scarcity of resources require ever more efficient, durable and sustainable materials and systems. Environmental physics Environmental physics, by using principles derived from thermodynamics, fluid dynamics, and material science, supports the development of innovative energy saving technology in line with sustainable development.This work seeks to explore the role of environmental physics in the design of sustainable technologies. It includes renewable energy, advanced water system, and smart materials among others to develop physics inspired techniques that can improve the efficiency and reduce the cost and adoption of such technologies.

Theoretical and data analysis work was implemented using a review based analytical methodology. Physical theories were matched with practical implements. Efficiency records, cost reductions, material stability, and visitor numbers (in terms of adoption) were reviewed through time, providing a representation of sustainable technological advances up to this point.

The results show that the physics-based optimization can indeed enhance the performances of renewable energy systems including biomass, wind turbine, and PV, and achieve the higher conversion efficiencies and smaller carbon footprints. Fluid and phase-transition work provide insights into water management technologies that can contribute to cost-effective filtration and harvesting solutions. Material developments inspired by quantum and surface physics provide increased robustness, recyclability and reduced environmental footprints.

Comparison of performance and sustainable technology adoption the current analysis provides evidence of significantly improving performance as well as of sustainable technology adoption. As can be seen from Figure 1, performance doubled from ca. 22% in mid 1990s to close to 40% in the later years and installation rates skyrocketed from below 15 to more than 30%. This demonstrates how physics-informed optimization can lead both to better technology and faster societal acceptance. Improvements of material stability and price reduction also underline the role of environmental physics for providing durable and less expensive solutions.

Environmental physics appears as an enabling keyholder for sustainable technology. It does so through the integration of material, water and energy systems with physical principles that with the goal of accelerating the realization of performance gains and adoption, and thereby minimizing their environmental and resource impacts. These results highlight the importance of physics for global sustainability transitions.

Keywords: Environmental Physics, Sustainable Technology, Renewable Energy, Smart Materials.

Abstract No: 05

Phase stability, electronic, mechanical and thermoelectric properties of Zintl phases: XIn2C2 (M= Mg, Sr and Ba)

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[2]Advanced Computational Materials Research Laboratory, Department of Physics, Chittagong University of Engineering and Technology (CUET), Chattogram-4349, Bangladesh

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Abstract

Searching for a new thermoelectric material with a high figure of merit (ZT), at least 2.5, have a strong commercial motivation. Zintl phases are considered to be the most promising candidate for thermoelectric energy conversion through the recovery of waste heat. In the scope of the present research, we employed a combination of the first principles calculations with Boltzmann transport theory to study the transport properties of two predicted compounds, SrIn2C2 and BaIn2C2, and compared the results with those of the previously synthesized MgAl2C2. We carried out geometric optimization for stable phase development, and assessed their stability through various criteria, including formation enthalpies, reaction energy, decomposition energy, cohesive energy, and study of high temperature stability via ab initio molecular dynamics calculations. Additionally, we investigate their dynamic stability via phonon dispersion and phonon density of states indicating short phonon lifetimes, low phonon group velocities, and large scattering rates. The band gap values for MgAl2C2, SrIn2C2, and BaIn2C2 compounds are 2.46, 0.76, and 0.93 eV, respectively. It is noticeable that the total thermal conductivities (in the unit, Wm-1K-1) of MgAl2C2, SrIn2C2, and BaIn2C2 are 10.957, 1.538 and 0.383.The figures of merit of these three compounds at 300 K are 0.06, 0.19 and1.10, respectively. The ultra-low lattice thermal conductivity (0.24 Wm-1K-1) and high Seebeck coefficient (225 μVK-1) at 300 K are the prime contributors to achieving the high ZT value of BaIn2C2. The unprecedented ZT value is 2.86 for BaIn2C2 and 1.93 for SrIn2C2 at a high temperature of 1000 K. Furthermore, the ductile nature and high melting point of BaIn2C2, renders it highly suitable for practical applications.

Keywords: Zintl phases; Thermoelectricity; Electronic properties; Thermal conductivity; DFT

Abstract No: 07

191 Ir(n, γ) cross section and its impact on astrophysical network calculations

M.K.A. Patwary[1, 2], M. Segawa[2], M. Maeda[2], S. Endo[3], S. Nakamura[3], G. Rovira[3], N. Iwamoto[3], Y. Toh[2], O. Iwamoto[3], A. Kimura[3]

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Abstract

This study aims to measure the 191Ir(n, γ) cross section up to 1 MeV and evaluate its impact on stellar s-process nucleosynthesis network calculations. Neutron capture cross sections of 191Ir were measured at the ANNRI facility at J-PARC using the neutron TOF method. Capture yields were analyzed with the pulse-height weighting technique relative to the 197Au standard. MACSs were derived for = 5–100 keV. The measured MACSs overestimate evaluated libraries and KADoNiS up to 20 keV, with discrepancies ranging from 7 to 33, most significant at = 5 keV. At = 30 keV, the MACS of 191Ir is significantly lower than the KADoNiS v1.0 recommended value of 1350 43 mb. Above 30 keV, results remain systematically smaller than JENDL-5 by up to 23, while ENDF/B-VIII.0 and the theoretical TALYS-2.0 calculations overestimate the data by about 14. These findings directly influence astrophysical reaction rates. This study provides improved MACS values for 191Ir, highlighting significant deviations from evaluated libraries and databases, thereby refining input data for stellar s-process nucleosynthesis calculations.

Keywords: 191Ir(n, γ), nucleosynthesis, s-process, MACS, TALYS-2.0.

Abstract No: 10

Natural radioactivity in sediments of the Jamuna River of Bangladesh: Concomitant radiological risk assessment with a statistical approach

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Abstract

Membrane methods can be considered the most energy-saving separation techniques. From the standpoints of materials and preparation techniques for membranes, this research focuses on the development of porous polymeric membranes. In this work, different concentrations (ranging from 12 wt% to 16 wt%) of polycarbonate microfiltration membrane were fabricated through phase inversion via the immersion precipitation method. A number of morphological and performance characteristics had been studied, including SEM, pore size, pore size distribution, volumetric flux, liquid permeability, and porosity. The SEM images revealed the presence of irregular, non-uniform, and asymmetric pores throughout the entire membrane structure. The sizes of the smallest and largest pores and MFP existing in a membrane sample had been found out through the pore size distribution experiment. According to experimental data, permeability dropped for all produced membranes, but mass flux and volumetric flux rose as applied pressure increased. Permeability, volumetric flux, and mass flux displayed lower values in the decompression direction compared to the compression direction for all pressures. Overall, the membranes showed promising features for microfiltration, and these findings highlight how simply adjusting polymer content can be an effective way to tailor membrane properties for specific filtration needs, especially in industrial and environmental applications.

Keywords: Polycarbonate Membrane; Phase Inversion Method; Microfiltration membranes; Pore Size Distribution; Porosity; Permeability; Volumetric Water Flux

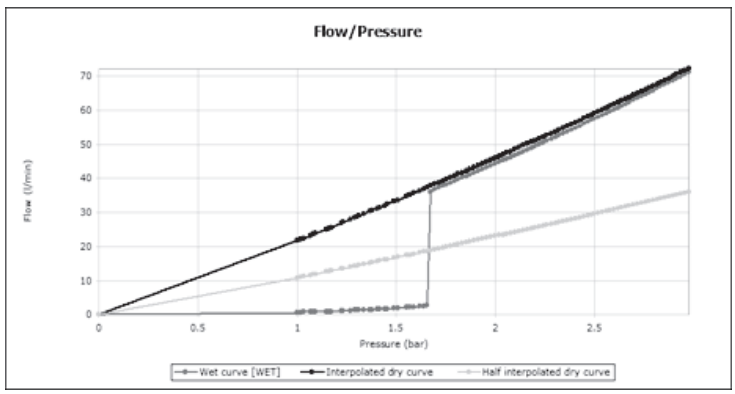

Figure 1: Air flow rate (both wet & dry curve) through membrane prepared from 12% of polycarbonate solution.

Abstract No: 12

A Comparative Study of Molecular Transport to Identify the Lamellarity of Vesicle Using COMSOL Simulation

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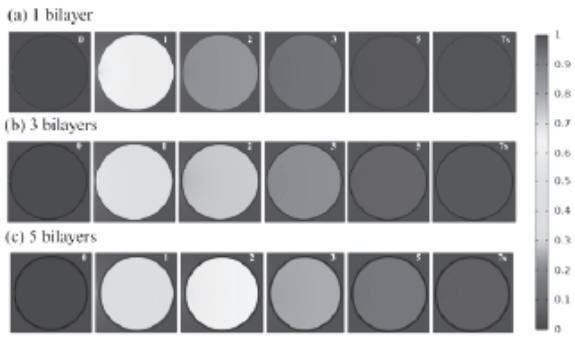
Abstract

Biomembranes, with their ability to form nanopores, regulate molecular transport, which is vital for cellular function and are essential for numerous biomedical applications, such as gene therapy and drug delivery. Multilamellar vesicles may have advantages over unilamellar vesicles in drug delivery because of greater capacity for carrying hydrophobic drugs. However, molecular transport through multilamellar vesicles has not been investigated in detail yet. In this work, we studied molecular transport through giant multilamellar vesicles by COMSOL Multiphysics simulation. Here, we modeled a cell with a diameter of 10 μm and 5 nm thick cell membrane using AutoCAD software. We designed 3 vesicles of varying degrees of lamellarity. Molecular transport, from the outside to the inside of vesicle through the nanopore for fluorescent probe (Calcein) was simulated. Transport of diluted species (tds) module was used as physics and after setting all the required parameters and boundary conditions, the COMSOL simulation was performed and the molecular concentration of the cell interior was calculated and plotted with the time. "Figure 1" indicates the results.

From the simulation results, it is concluded that as the degree of lamellarity increases, it takes more time to reach an equilibrium concentration in cell interior and exterior. Thus the rate constant of molecular transport decreased with an increase in the number of bilayers in multilamellar vesicles.

Figure 1. Molecular concentration variation inside a vesicle for various degree of lamellarity in COMSOL simulation. The time-dependent concentration variations of Calcein in the inside of vesicle for a 1 bilayer, b 3 bilayers and c 5 bilayers. The numbers at the corner of each image show the time in seconds after the simulation was started.



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Abstract No.: 19

Design of MoS_2/VS_2/PANI Hybrid Nanocomposites with Superior Electrochemical Capacitance

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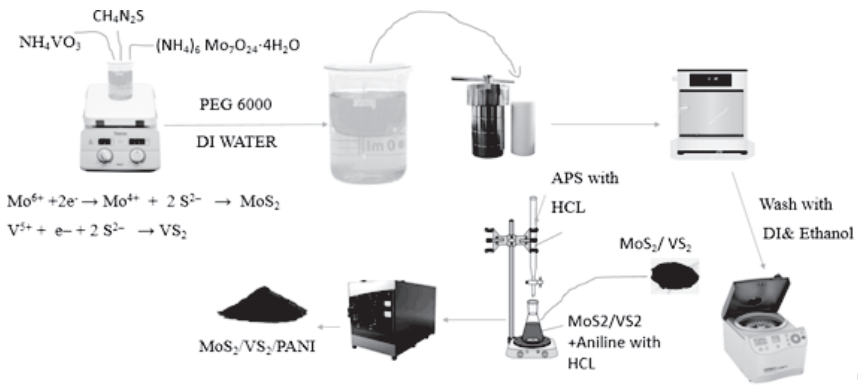
Abstract

Supercapacitors have attracted significant attention due to their superior properties, including long cycle life, high power density, and excellent charge storage capability. A wide range of electrode materials—such as MXenes, mixed metal oxides, perovskites, layered double hydroxides (LDHs), and transition metal dichalcogenides (TMDs)—have been investigated for advanced supercapacitor applications. Among them, TMD–polymer hybrids are particularly promising owing to their high thermal stability, fast doping–dedoping kinetics during charge–discharge, and large surface area.

In this work, a MoS_2/VS_2 hybrid was synthesized via a one-step hydrothermal method [1]. Firstly, ammonium metavanadate (NH4VO3) and ammonium molybdate tetrahydrate ((NH4)6 Mo7O24 4H2O) were dissolved in deionized water, then polyethylene glycol 6000 was added as surfactant, and thiourea powder was used as a source of sulfide. The mixture was subsequently stirred continuously for an additional hour, and was heated at 200 0C for 24 h in Teflonlined stainless steel autoclave, where MoS_2/VS_2 was formed. Subsequently polyaniline (PANI) was incorporated with t MoS_2/VS_2 through in-situ oxidative polymerization to form a MoS_2/VS_2/PANI ternary nanocomposite. The PANI nanowires anchored on the MoS_2/VS_2 surface created a highly conductive and porous network, offering abundant ion transport channels and lowering charge transfer resistance. Figure 1 presents a schematic of the MoS_2/VS_2/PANI nanocomposite synthesis process and their molecular interaction.

Electrochemical evaluation revealed that the MoS_2/VS_2/PANI composite demonstrated a specific capacitance of 560 F g^{-1}, outperforming pristine PANI (336 F g^{-1}) and MoS_2/VS_2. These findings highlight the synergistic effect of TMDs and conducting polymers in achieving enhanced energy storage performance. Therefore, the MoS_2/VS_2/PANI composite with good stable morphology and excellent galvanic properties emphasizes the significance of optimizing energy storage material design and contributes to the advancement of supercapacitor electrodes.

Figure 1. Schematic illustration of the synthesis of MoS_2/VS_2/PANI nanocomposite.



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Abstract No: 20

Synthesis and Crystal Structure of Two Novel Transition Metal Oxyfluoride Compounds

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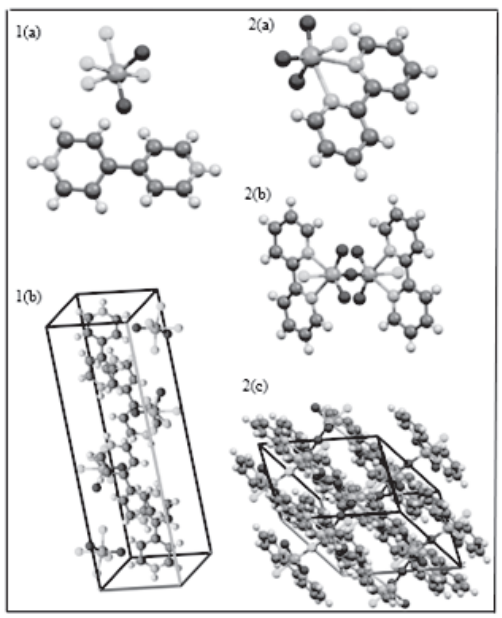
Abstract

Advances in modern technology have shown that crystalline materials possess many remarkable, structure-specific characteristics such as ferroelectricity, pyroelectricity, piezoelectricity, and nonlinear optical (NLO) properties. One of the emerging approaches to designing solid-state materials with interesting optical properties is the synthesis of transition metal oxyfluorides containing asymmetric basic building units (BBUs). In this study, single crystals of two novel oxyfluoride compounds, [WO2F4][4,4′-bpy] (1) and [W2O5F2(2,2′-bpy)2] (2) (bpy = bipyridine), have been synthesized using the hydrothermal method. Single crystal X-ray diffraction (SCXRD) data were used to determine the crystal structures. Analysis indicates that both compounds crystallize in the space group P21/c, with the oxyfluoride moieties of the W6+ cation and organic ligands forming the structural framework of the crystals. The structures of the synthesized compounds have been fully characterized through spectroscopic methods, thermogravimetric analysis, and bond valence sum calculations. The compounds exhibit band gaps of 3.59 and 3.60 eV, respectively.



Figures: Ball-and-stick or space-filling representations revealing 1(a) Asymmetric BBU and 1(b) crystal packing in a unit cell of compound 1; 2(a) Asymmetric BBU, 2(b) repeating unit, 2(c) crystal packing in a unit cell of compound 2.
[Color: blue = W, red = O, yellow = F, black = C, white = H and light blue = N]

Abstract No: 21

Evolution of Core Structure from Helium Burning to Oxygen-Neon Stages in a 15 M⊙Star

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Abstract

This research work aims to determine the effect of the masses and radii of helium, carbon-oxygen, and oxygen-neon cores change with the star's age in a fifteen solar mass star. First, we calculate the reaction rate of 83Kr (n,) for different neutron energies and evaluate our calculation with the help of data available in Reaclib database and other data found in literatures. Using these evaluated reaction rates we determine the variations of masses and radii of different core with respect to ages for 15 M star. During the calculation several models with varying metallicity (z) and helium mass fraction (y) were considered (z = 0.03, y = 0.3; z = 0.03, y = 0.24; z = 0.018, y = 0.276; z = 0.018, y = 0.3). We have drawn an H-R diagram, from which we can conclude that the evolution begins from ZAMS at a temperature of 3980 Kelvin and a luminosity of 7943 L for both models with z = 0.03. During helium burning process, the high metallicity stars show less luminosity and vice versa. For higher y values, the CO core's mass and radius start increasing earlier in the star's evolution than for lower y values. The oxygen-neon core mass and radius are smaller in high metallicity stars compared to low metallicity stars.

Abstract No: 25

Crystallographic Characterization Of Sol-gel Produced H-bn And Its Amino Functionalization: Resolving Functionalization Limitations

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Abstract

Functionalized boron nitride (f-BN) has enhanced characteristics then normal boron nitride like more dispersion stability, surface reactivity, and biocompatibility due to the introduction of active functional groups. But functionalization of BN is limited due to its high chemical stability and hydrophobicity within organic and aqueous systems. So, understanding how synthesis routes and surface modification influence the crystallographic behavior of boron nitride (BN) is essential for developing application-ready nanomaterials. This study aimed to overcome the functionalization challenges, synthesize, and characterize functionalized-BN. BN was first synthesized via sol gel method at 600oC using 4M precursor solution, then functionalized with amino groups using diazonium salt. The functionalized BN was characterized by FTIR and XRD. FTIR ensured the formation of BN and functionalized BN. XRD analysis ensured hexagonal structure with the crystal size 28.95 nm for BN and 31.33 nm for functionalized BN. Other structural properties such as dislocation density, number per unit area, degree of crystallinity, inter-planner spacing are also compared.

Abstract No: 26

Unveiling Crystal Structure and Properties of an Organic-Inorganic Hybrid Material

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Abstract

Crystal structure of a synthesized pyrazole–tin chloride hybrid [pz]2[SnCl6]•2H2O [1] (pz = pyrazole) has been determined using the single-crystal X-ray diffraction (SCXRD) data. The compound adopts a triclinic space group where the [SnCl6]2- octahedra is connected to pyrazolium cations through hydrogen bonding. Besides the primary Sn–Cl coordination, the lattice is stabilized by N–H•••Cl hydrogen bonds linking neighboring molecular chains, π–π stacking between adjacent pyrazole rings, and longer Sn-Cl contacts that reinforce the crystal packing. This hierarchy of interactions assembles the discrete [SnCl6]2- octahedra and pyrazolium cations into a zero-dimensional molecular hybrid, stabilized by hydrogen bonding, π–π stacking, and secondary Sn–Cl contacts. Powder X-ray diffraction (PXRD) confirmed phase purity of the bulk phase crystals. Birefringence studies revealed anisotropic optical behaviour consistent with the crystalline packing. Thermogravimetric and DSC profiles confirm subsequent stability up to 210 °C, while UV–Vis absorption & Diffuse Reflectance Spectroscopy identified the compound as a deep-UV material, with the optical band gap estimated by Kubelka–Munk analysis. Density functional theory (DFT) calculations, including band structure, density of states, electron localization function, and HOMO–LUMO studies, complemented the experimental findings and provided a theoretical framework for interpreting the electronic structure.

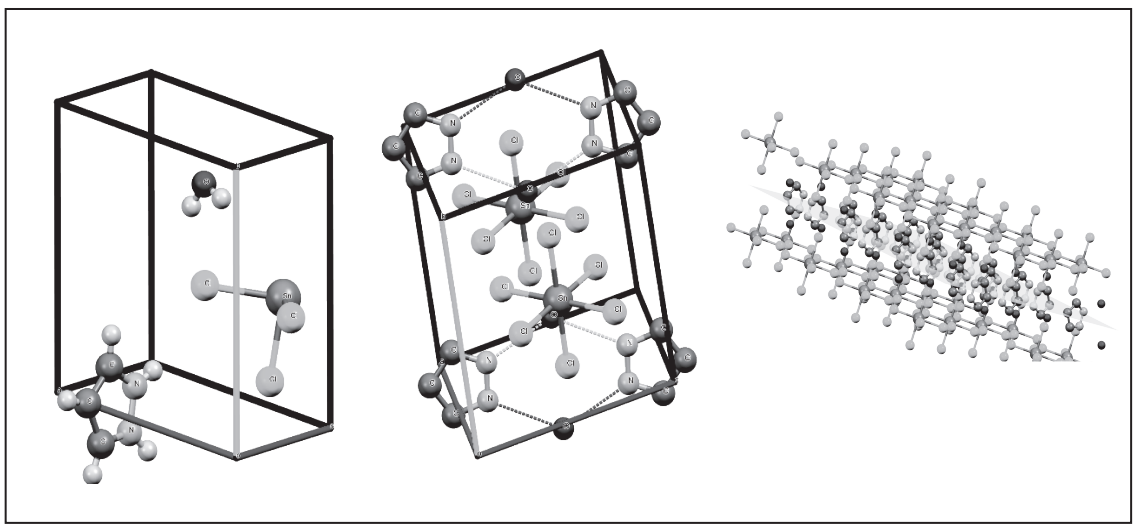

Figure 1. (a) Asymmetric Unit, (b) Unit Cell, (c) π–π stacking between pyrazole rings

Abstract No: 27

Facile Synthesis of Iron-Based Nanoparticles from Diospyros Malabarica Leaf Extract.

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Abstract

Iron nanoparticles (FeNPs) are becoming more popular due to their distinctive properties and multipurpose applications in medical, environmental, and industrial sectors. The study focuses on the green synthesis and magnetic behavior of iron (Fe) nanoparticles mediated through Diospyros malabarica leaf extract for superparamagnetic applications. Nanoparticle formation and stability were ensured through UV-Vis spectroscopy by the intense absorption peak in the range of 280–320 nm due to surface plasmon resonance. FTIR confirmed functional groups as O–H, C=O, and Fe–O, indicating the plant extract's dual role as a reducing and stabilizing agent. The XRD analysis showed a broad pattern with no peaks, suggesting amorphous or very minute nanoparticle size advantageous for high surface activity. The TGA-DTA analysis revealed the loss of moisture around 100°C, ensuring the involvement of phytochemicals in the synthesis process. Magnetic characterization was performed by VSM, which confirmed superparamagnetic nature with zero coercivity, no remanence, and low saturation magnetization of 0.73 emu/g. The results confirm successful green synthesis of Fe nanoparticles with encouraging magnetic and biosensing behavior for biomedical and environmental superparamagnetic applications.

Keywords: Iron nanoparticle, Green synthesis, UV–vis absorbance, FTIR analysis, TGA–DTA analysis.

Figure

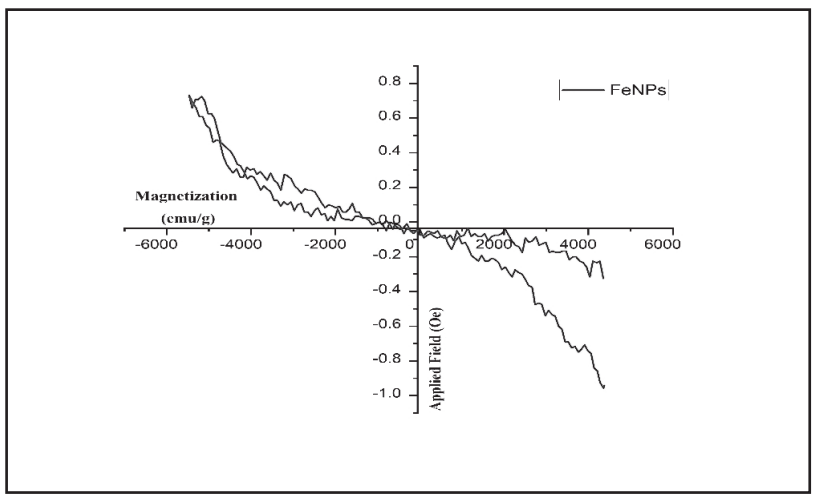

Figure 1. *Magnetic hysteresis curve confirming superparamagnetic behavior of Fe nanoparticles.*

Abstract No: 28

Simulation-Based Investigation of Pulsed Electromagnetic Field (PEMF) Effects on Hemodynamics via Physics-Informed Modeling

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Abstract

Pulsed Electromagnetic Fields (PEMF) have shown promise in influencing vascular dynamics. In this simulation-based study, we model how PEMF might theoretically influence blood flow via Lorentz force interactions. This study presents a physics-informed simulation framework for analyzing how PEMF affect charged particle dynamics in blood vessels.

The computational core of our framework relies on numerical integration techniques to compute particle displacement from velocity, and vector field calculations based on the Biot-Savart law for a line segment, summed over many segments to model the coil. The system simulates multiple coil orientations and calculates time-resolved traces of magnetic field |B|, induced electric |E|, force |F|, particle velocity, and displacement assuming overdamped motion in a viscous medium. Displacement magnitudes reached 1.2–9.8 μm with peak velocities of 60–80 μm/s, varying with coil angle and spatial probe location. At $\theta = 90°$, Lorentz force peaked due to orthogonality of B and v, while $\theta = 0°$ yielded higher |E| and resultant displacement. Field strength and force gradients are spatially evaluated along axial and radial lines. Physiological constraints—including vessel radius (2–4 mm), wall effects, and charged particle types (Na^+, Ca^{2+}, RBC clusters)—are incorporated for biological realism. A separate synthetic PPG signal generator has been implemented to simulate downstream pulse changes under different vascular modulation levels, providing a conceptual bridge to observed hemodynamic responses.

Our model reveals PEMF-induced microforces are directional, highlighting coil orientation as a key design parameter for non-invasive vascular therapy.

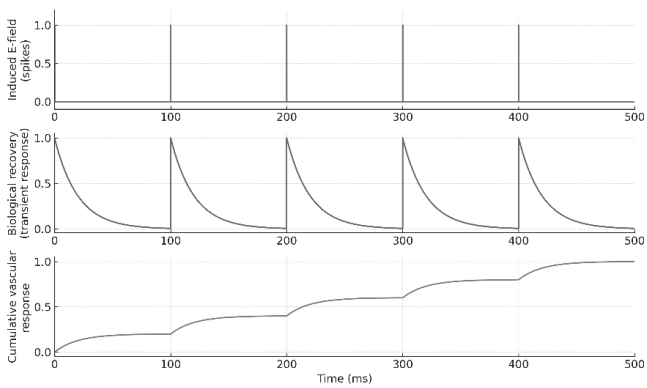

Figure 1: EM effects and cumulative response coil

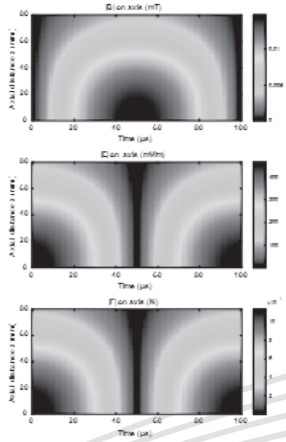

Figure 2: Simulated EM field maps due to PEMF

Abstract No: 30

Sensitivity of Weather Models to Initial Conditions in Long-Term Forecasts: A Comprehensive Analysis

Sajib Hossain[1], Dr. Mst. Jesmin Sultana[1]*, Abhi Saha[1]

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Abstract

This paper looks at how much weather forecasts change over long periods based on tiny differences at the start. Weather is super chaotic! Because weather models use tricky equations, even tiny changes at the beginning can cause big forecast errors after just a week and a half. I used math stuff like Lyapunov exponents, plus some ensemble forecasting and data trickery, to figure out how quickly these errors grow and how to make forecasts more reliable. I checked out old weather data from ECMWF and GFS. Turns out, a tiny 0.1◦C difference at the start can mess things up so badly that the forecast is off by more than 3◦C in just 10 days! New tricks with data and machine learning are making starting conditions better, but long-term forecasts still get messed up because things are so chaotic. This matters for everyday forecasting and even big climate models. I think it would be good to use AI to get even better starting data, and to get more observations.

Key Words: Weather, Forecasts, Error, Analysis.

Abstract No: 32

Synergistic Interplay of Ce-Doped g-C_3N_4 and MXene for Enhanced Energy Storage

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Abstract

The project reports the development of a Ce-doped graphitic carbon nitride/MXene (MCeCN) composite with outstanding multifunctional properties. The composites were synthesized through a self-assembly approach. The material's structural and optical properties were probed using UV-visible absorption, Fourier-transform infrared (FTIR), and photoluminescence (PL) spectroscopy, while its electrochemical behaviour was evaluated through cyclic voltammetry (CV) and galvanostatic charge-discharge (GCD) techniques. The composite exhibited excellent supercapacitor performance, showing a high specific capacitance of 109.1 F/g at a discharge time of 20 s, along with superior cycling stability. The specific capacitance values of the samples were calculated from the GCD curves, as shown in the figure below, and the corresponding values are presented in the table. The synergistic interplay between Ce doped g-C_3N_4 (CeCN), and MXene was instrumental in achieving these properties, enabling effective charge transport, enhanced conductivity, and highly porous. These results highlight the MCeCN composite as a versatile material for applications spanning energy storage, environmental remediation, and sustainable energy conversion.

Keywords: Photocatalytic anti-bacterial agent, Supercapacitor, Dye sensitized solar cell, Photo-current, Self-assembly.

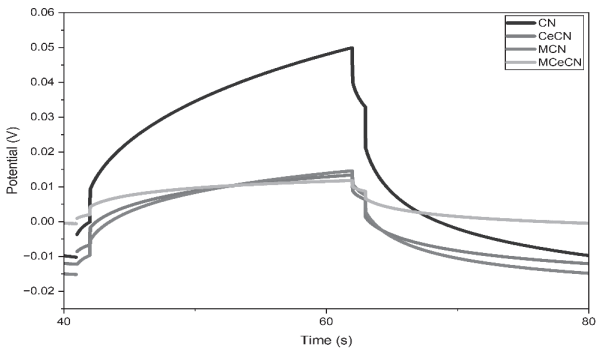

Figure: GCD data at 100 μA.

Table: Specific Capacitance data of the samples

Sample name	Specific Capacitance (F/g)
CN	24
CeCN	89.55
MCN	81.63
MCeCN	109.1

Abstract No: 33

Low-Temperature Fabrication of CIGS Layers Exhibiting Superior Opto-electronic and Semiconductor Properties

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Abstract

$Cu(In,Ga)Se_2$ (CIGS) thin layers were deposited by single-target radio-frequency sputtering at low substrate temperature and subsequently treated with a single-step rapid thermal anneal in various inert atmospheres. Comprehensive structural, optical, and electrical studies show that the annealing environment critically influences crystallinity, grain growth, and charge-transport properties. Argon-annealed films exhibit enhanced crystal order, larger grain size, and improved carrier mobility, along with a modestly widened band gap indicative of reduced defect density. These material improvements are directly relevant to a wide range of semiconductor and opto-electronic applications including photovoltaics, photodetectors, and thin-film electronic devices, where high optical absorption and controlled electronic properties are essential. The results demonstrate a scalable low-temperature process that unites RF sputtering with atmosphere-engineered annealing to produce high-quality CIGS absorbers suitable for next-generation semiconductor devices.

Keywords: CIGS thin layer, EDX, Total strain, Roughness, Polycrystalline.

Abstract No: 36

Evaluation of the 169Tm(p,n)169Yb Reaction up to 200 MeV for Medical Radionuclide Production

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Abstract

This study investigates the excitation function of the 169Tm(p,n)169Yb reaction up to proton energy of 200 MeV for producing 169Yb (T_(1/2)= 32 days), a therapeutic radionuclide, applied in IVBT to treat vascular blockages, utilizing its low-energy γ-rays to deliver targeted doses, and for portable industrial radiography. Using TALYS-2.0, a nuclear reaction calculation tool, we performed a continuous evaluation of the 169Tm(p,n)169Yb reaction to obtain a comprehensive cross-section profile. Calculations included cross-section, specific activity, physical yield, and production amount of 169Yb. For this purpose, various level density models (LDMs), optical model parameters, and mass models were considered for data evaluation. The proton beam current was held constant at 5 mA and the target, 169Tm (0.03353 mmt × 10 mm × 10 mm) was irradiated for 24 hours. Cross-section calculations indicated strong consistency across the evaluated energy range. The optimal excitation function occurred between 5-20 MeV. The highest cross section value of 170 mb was obtained at 10 MeV as shown in Fig.(a).

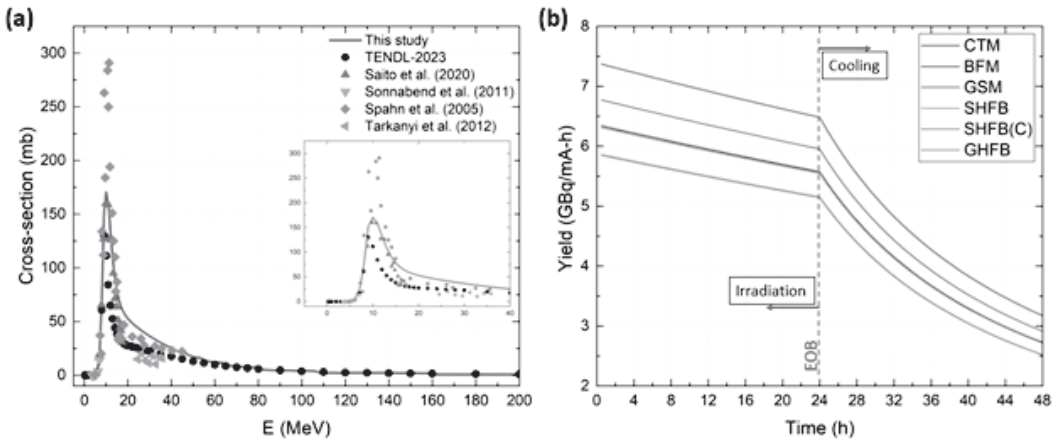

Fig. (a) Excitation function of 169Tm(p,n)169Yb reaction from different data evaluations, and (b) the physical yield of 169Yb radionuclide obtained with various LDMs.

During 24-hour irradiation, specific activity rose linearly, peaking at ~28.42 GBq/mg. Post-irradiation, the specific activity followed an exponential decay trend consistent with the decay scheme of 169Yb. The highest initial yield was detected at ~7.37 GBq/mA-h as shown in Fig. (b). The maximum production of 169Yb, amounting to 3.1 × 1018 atoms, can be achieved at the EOB. Upon further analysis, the 169Tm(p,n)169Yb reaction demonstrated a favorable excitation function between 5-20 MeV with strong consistency across six LDMs as well. Owing to its decay properties, this proton-induced, accelerator-based production of 169Yb offers a practical approach for localized production, supporting on-site radiopharmaceutical development. Detailed results and analysis will be presented during the conference.

Abstract No: 37

Investigation of Interference Effect in VVER-1200 Control Rod Efficiency

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Abstract

The efficiency of Control and Protection System Control Rod (CPS CR) plays an essential role for ensuring safe and reliable operation of VVER-1200 type reactors. However, their performance can be significantly influenced by the mutual influence of the effectiveness of one rod on the efficiency of others and been studied for EPR and small research reactors [1-2]. This research aims to investigate the effect of interference in determining the Control Rod worth for a VVER-1200 reactor. This goal was achieved by BIPR-7A program, a 3D coarse-mesh diffusion code used for neutronic calculations of VVER type reactors. The individual and group worth calculations are evaluated at Hot Zero Power (HZP) for both Beginning of Campaign (BOC) & End of Campaign (EOC) at first standard core loading. The investigation revealed that positioning of control rods, neutron flux distribution, presence of Gadolinium (Gd) in fuel, asymmetric distribution of in-core instrumentation system and relative location of ex-core sensors introduces a significant spatial dependence of interference effect in calculating the efficiency of control rods. The study's findings also indicate that the calculated results are in reasonably good agreement with the values provided in Preliminary Safety Analysis Report (PSAR) [3].

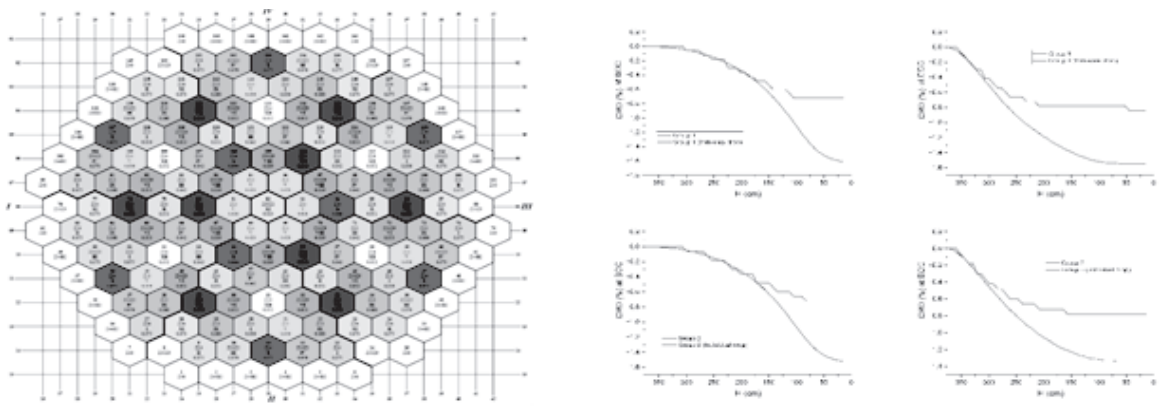

Fig. 1. (a) Cartogram of the reactor core with CPS CR group distribution and individual efficiency of CPS CR (b) change of efficiency of CPS CR groups for individual and simultaneous insertion into the core.

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Abstract No: 40

Physics-Informed Machine Learning for Air Quality Prediction in Dhaka City

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Abstract

Dhaka, as one of the most populous cities in the world, is facing severe air pollution caused by rapid urbanization, vehicle emissions, and industrial activities. Classical statistical methods fail to capture the complex behavior of pollutants, while purely data-driven machine learning methods are not interpretable and physically consistent. Physics-Informed Machine Learning (PIML) combines atmospheric physics and data-driven methods for better accuracy and reliability of air quality prediction.

This study aims to develop a PIML system to predict key pollutants (PM2.5, NO_2, O_3) in Dhaka by (i) combining atmospheric dispersion principles, (ii) improving short- and medium-term forecast accuracy, and (iii) producing explainable results to guide urban air quality governance and policymaking.

This research mainly depends on secondary data from 2000 to 2023. Microsoft Excel and Python were used for quantitative analysis. Physics-informed loss functions ensured predictions followed conservation and diffusion principles.

In Dhaka, PM2.5 and PM10 are closely linked, as are NO_2 and CO from vehicle emissions. O_3 rises with temperature but decreases with higher NO_2 and CO. Rainfall lowers particulate levels, and wind affects pollutant dispersion. These patterns reveal key pollutant interactions and environmental influences for air quality management.

The significance of these findings lies in improving air quality management and prediction in Dhaka. Understanding pollutant interactions and environmental influences helps policymakers target major emission sources, optimize monitoring, and design effective mitigation strategies, while also enhancing the accuracy of predictive models for public health protection.

Physics-informed machine learning offers accurate, reliable, and interpretable air quality predictions for Dhaka and can be extended to other South Asian megacities facing similar pollution challenges.

In Dhaka, PM2.5 and PM10, and NO_2 and CO share the same sources, whereas O_3 rises with temperature and falls with rising NO_2/CO. Pollutant concentrations are influenced by rain and wind and exhibit interactions and environmental effects useful for air quality management and modeling.

Keywords: Air pollution, Physics-Informed Machine Learning, PM2.5, Predictive modeling

Abstract No: 42

Wintertime Fine Particulate Matter (PM2.5) Pollution in Rural Bangladesh: An Integrated Health Risk and Exposure Assessment

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Abstract

This study addresses the critical yet under-recognized health crisis of fine particulate matter (PM2.5) pollution in rural Bangladesh, particularly in communities with limited monitoring infrastructure and public awareness. Guided by the theme "High Exposure, Low Awareness," this research investigated PM2.5 concentrations in Bharasar village of Cumilla during the winter season to establish a scientific evidence base for health-centric policy interventions. Analysis of weekly PM2.5 data from December to February revealed alarming exposure levels, with mean wintertime concentrations of 125.69 μg/m³ and peak events reaching 191.64 μg/m³. This average concentration is 8.4 times higher than the World Health Organization's 24-hour guideline (15 μg/m³), indicating severe air quality conditions. These extreme concentrations result from atmospheric stability (inversion) that traps pollutants near the ground, combined with intense localized emissions from unregulated brick kilns, biomass burning for household energy, and poorly managed road dust. This sustained exposure to microscopic PM2.5 presents a significant public health threat, elevating the risk of respiratory and cardiovascular diseases, particularly chronic obstructive pulmonary disease (COPD), and premature mortality among rural populations. We recommend immediate implementation of health-oriented air quality management policies, including targeted interventions against local emission sources and community-level awareness programs.

Keywords: PM2.5 pollution, rural air quality, biomass burning, brick kilns, winter atmospheric inversion, public health, respiratory diseases, environmental health policy

Abstract No: 44

Modeling and analysis of primary coolant specific activity resulting from damage to Z13-type fuel assemblies during the first fuel cycle of the VVER-1200 reactor, with consideration of fuel washout events

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Abstract

Coolant activity analysis is essential for understanding fuel cladding integrity and predicting primary circuit contamination level in operating plants due to fuel failure. Among the twelve fuel assembly types in the VVER-1200 reactor, the Z13 assembly has the lowest enrichment, yet occupies the largest number of core cells, and is sent to wet storage facility after first cycle. Its prevalence and short residence time make it a critical focus when evaluating the consequences of early fuel failures. This study investigates how leakage from one or more Z13 assemblies could influence primary coolant activity. Both short-lived and long-lived benchmark radionuclides were examined. A dedicated fuel failure modeling code was applied to simulate radionuclide release from defective rods, incorporating fission product diffusion in the fuel matrix, transport across the cladding gap, and release into the coolant. The results highlight three governing factors: defect size, its location, and timing. Larger openings produced markedly higher coolant activity, but it saturates after reaching certain defect size. Leaks located in the lower core generated stronger activity peaks than those higher up, reflecting impact of greater neutron flux and fission product generation in beginning of the campaign. The timing of failure also proved critical: early defects led to sharp, sustained increases in activity, while later ones produced smaller, delayed peaks. In contrast, burnup followed a steady trend independent of defect conditions. These findings strengthen the basis for nuclear and radiation safety assessments and provide practical guidance for monitoring and managing the first fuel cycle of VVER-1200 operation.

Abstract No: 45

Multi-Task Machine Learning for Accelerated Prediction of Band Gap and Formation Energy

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Abstract

The rapid discovery of new materials is essential for advancing energy, electronics, and sustainable technologies, yet traditional approaches such as experiments and density functional theory (DFT) simulations are often slow and computationally demanding. Machine learning (ML) offers a promising alternative by predicting material properties directly from data, thereby accelerating the screening of candidate compounds.In this work, we focus on predicting two fundamental properties: band gap and formation energy. The band gap determines electronic and optical behavior, making it critical for semiconductors, solar cells, and optoelectronic devices, while formation energy indicates thermodynamic stability and synthesizability. Using open-access databases such as the Materials Project and OQMD, we construct datasets containing compositional and structural descriptors of thousands of compounds.To strengthen prediction performance, we adopt a multi-task learning framework that predicts band gap and formation energy simultaneously, exploiting correlations between these properties. In addition, we integrate a classification step to distinguish metals from non-metals prior to band gap regression, improving model reliability for semiconductors. Several ML algorithms including Random Forest, Gradient Boosting, and Neural Networks are trained and evaluated using regression metrics (MAE, RMSE) and classification metrics (accuracy, F1-score), with cross-validation ensuring robustness.Our approach highlights the value of combining multi-task prediction, classification, and explainable ML in materials science, and lays the groundwork for future applications in designing efficient semiconductors, catalysts, and energy-storage materials.

Abstract No: 46

Sol–Gel-Derived NiO/ZnO Thin Films with Single and Heterostructure Layers for Electrochemical Energy Storage

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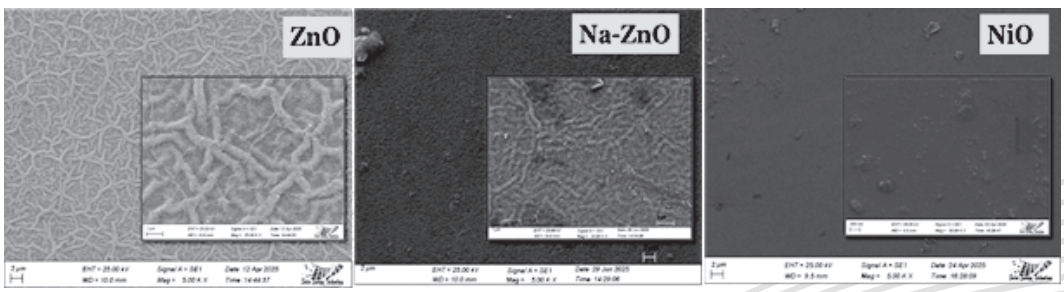
Abstract

NiO/ZnO-based thin films, including single-layer and heterostructure configurations, were synthesized to investigate the influence of stacking order on their electrochemical performance for supercapacitor applications. To improve the relatively low capacitive performance of ZnO compared to NiO, alkali Na (Sodium) was introduced as a dopant. All films were deposited using a non-vacuum spin-coating method on fluorine-doped tin oxide (FTO) substrates, chosen for their excellent electrical conductivity and stability as electrode materials. The surface morphology and structural parameters were examined using scanning electron microscopy (SEM) and X-ray diffraction (XRD), respectively. Optical properties were analyzed via UV–Vis spectroscopy, revealing direct band gaps in the range of 3.17–3.31 eV for ZnO and Na–ZnO, and wider gaps up to 3.81 eV for NiO. Electrochemical performance was evaluated using cyclic voltammetry (CV), galvanostatic charge–discharge (GCD), and electrochemical impedance spectroscopy (EIS) in a three-electrode configuration with 1 M KOH as the electrolyte. Among the electrodes, the single-layer NiO film exhibited the highest specific capacitance of 1.391 F g^{-1}. In contrast, the NiO/ZnO heterostructure demonstrated a synergistic effect, resulting in enhanced charge storage and achieving a maximum specific capacitance of 1.627 F g^{-1} at a current density of 2.0 mA cm^{-2}. Furthermore, Na doping significantly improved the capacitance of ZnO. Overall, the results highlight the potential of sol–gel-derived oxide heterostructures and doped thin films as cost-effective and scalable electrode materials for supercapacitors in portable electronics and energy storage systems.

Figure 1. Scanning electron microscopy images of Sol-gel synthesized ZnO, Na-ZnO and NiO film



Abstract No: 47

An Integrated Remediation Framework for Radionuclide-Contaminated Lands: From Molecular Extraction to Landscape Stabilization

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Abstract

The long-term management of land contaminated by radionuclides, such as those affected by the Fukushima Daiichi Nuclear Power Plant accident, requires a flexible range of clean-up technologies. In this research, an adaptable framework is presented for cleaning up radiocesium (Cs-137) accumulated in soil. To address the challenge posed by large volumes of contaminated soil, a physical separation technique was developed. Through the use of a dispersing agent, over 92% of the Cs-137 can be concentrated into the very fine clay and silt particles. It allows for the separation of a much larger volume of less-contaminated sand, potentially for reuse, which significantly reduces the amount of waste that requires long-term storage. Besides, for large, low-contaminated areas where excavation is not feasible, a plant-based solution known as phytostabilization is suggested. With this method, Cs-137 is effectively trapped in the extensive root system of the bioenergy crop Erianthus arundinaceus, with minimal transfer to its stems and leaves. The contaminant is thereby locked in the soil, and its spread by wind or water is prevented. Together, these methods form a tiered, versatile strategy, allowing the appropriate technique—from chemical washing to plant-based stabilization—to be selected based on the specific contaminant concentration and future land use plans.

Abstract No: 49

The Vortex–majorana Model: A Theoretical Framework For Neutrino Oscillations

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Abstract

Neutrinos play a pivotal role in uncovering physics beyond the Standard Model [1-3]. Their ability to oscillate between flavors implies that they possess nonzero masses—something the Standard Model failed to explain. Understanding the mechanism behind flavor oscillation is therefore essential for revealing the structure of fundamental interactions.

We propose a vortex–Majorana model of neutrino flavor oscillations that offers a self-consistent and physically intuitive alternative to the conventional Pontecorvo–Maki–Nakagawa–Sakata (PMNS) framework. In this model, the three neutrino flavors (νe, νμ, ντ) are treated as dynamically coupled components of an internal flavor-space rotor that continuously rotates through a three-dimensional complex space. The intrinsic rotational motion replaces the notion of propagation of distinct mass eigenstates and provides a natural mechanism for flavor transition and phase evolution. The dynamics of this system are governed by a Hamiltonian Rotational Matrix (Hrot), where diagonal terms δα represent Majorana self-coupling (diagonal energy term) and off-diagonal couplings kαβ represent Vortex mediated flavor changing coupling. When diagonalized, the Hamiltonian Rotational Matrix (Hrot) yields emergent energy eigenvalues whose differences correspond to effective mass-squared splitting Δmij2=2Eν(Ei−Ej). By tuning the rotor asymmetries δα and couplings kαβ, we can reproduce the observed mixing hierarchy: large atmospheric (θ23 45), moderate solar (θ12 33), as well as near-experimental mass-squared differences. Moreover, complex phases embedded in kαβ naturally produce intrinsic CP violation, without invoking a single global phase as required in the PMNS scheme. Our vortex–Majorana model shows that flavor mixing, and CP violation naturally arise from internal rotational dynamics, providing a consistent framework to understand neutrino mass and its implications for physics beyond the Standard Model.

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Abstract No: 51

Bionic Design and Finite Element Analysis of an Elliptical Pressure Hull for Deep-Sea Applications

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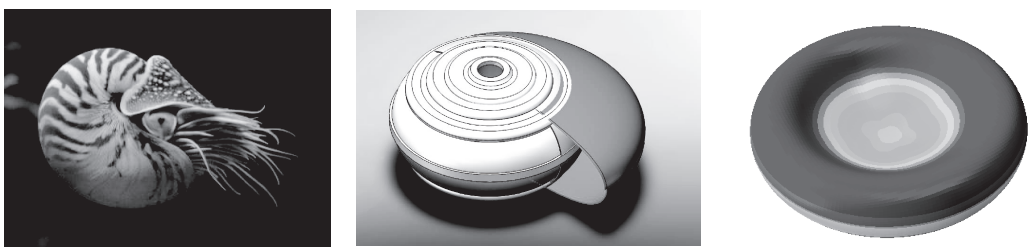
Abstract

The evolution of submarines, from basic submersibles to advanced nuclear-powered vessels, reflects humanity's drive for underwater exploration and military advantages. A key aspect of submarine engineering is the pressure hull, the primary load-bearing structure designed to withstand hydrostatic pressures at various depths. As submarines dive deeper, they face increased stress and potential structural failures. Modern pressure hulls are typically cylindrical or spherical to optimize performance, as studies have demonstrated their advantages in withstanding these extreme conditions. However, recent studies have proposed different types of geometry inspired by nature and have proved their efficiency against conventional geometries. Based on the progress of bionic thinking, this paper proposes and evaluates a bionic pressure hull inspired by the chambered nautilus (Nautilus pompilius) for deep-sea applications. The structure, modeled in CAD, is analyzed using finite element methods for linear static stress, eigenvalue buckling, and nonlinear buckling under hydrostatic pressure at 6000 m depth. The titanium alloy Ti–6Al–4V is selected for its high strength and corrosion resistance. Results confirm that the proposed design can withstand the target external pressure of 60.60 MPa with safety margins in strength and stability, while demonstrating potential efficiency advantages in internal space utilization. Limitations and directions for optimization and experimental validation are discussed.



(a) (b) (c)

Figure 1. (a) Nautilus Pompilius, (b) Bionic design proposed in the study, (c) Non-linear buckling revealed failure of the elliptical pressure hull

Abstract No: 54

Coupled Influence of Surface Oxidation and Interlayer Structure on Proton Transport in Graphite Oxide.

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Abstract

This study investigates how surface oxidation and interlayer structure collectively influence the proton-conductive behavior of graphite oxide (GO). Three types of GO—H-GO, S-GO, and B-GO—were synthesized using the traditional Hummers, Staudenmaier, and Brodie oxidation methods, and Proton conductivity in the bulk state was evaluated using pelletized samples of the synthesized GO. The samples were characterized through Raman, XPS, XRD, and SEM to analyze their oxidation degree, functional group distribution, interlayer distances, and surface morphology. Proton conductivity measurements revealed a descending trend of H-GO > S-GO > B-GO. According to XPS analysis, the total oxygen content followed the order H-GO > B-GO > S-GO, while XRD data indicated that the interlayer spacing decreased in the sequence H-GO > S-GO > B-GO. These observations suggest that, in addition to the oxidation degree and surface functionalities, the interlayer distance plays a crucial role in determining proton conduction efficiency. Temperature-dependent Arrhenius analysis yielded activation energies of 0.274, 0.291, and 0.296 eV for H-GO, S-GO, and B-GO, respectively. The relatively low activation barriers confirm a Grotthuss-type proton conduction mechanism. The high conductivity value and low activation energy of H-GO, with a maximum interlayer distance, indicate that the rotational movement of hydronium ions and the re-formation of hydrogen bonds by the Grotthuss mechanism are facilitated by a more flexible interlayer. These findings provide a valuable framework for enhancing proton conductivity by tuning interlayer distances, not only within carbon-based materials but also across a broader range of layered systems.

Abstract No: 55

Synthesis and Study of Multifunctional Properties of a High-capacitance Supercapacitor Electrode Pr2CoCrO6 Nanoparticles

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Abstract

In recent years, supercapacitors have garnered considerable interest because of their high capacitance, outstanding stability, prolonged cycle life, and exceptionally high-power density. In this investigation, we have synthesized Pr2CoCrO6 (PCCO), a double perovskite compound, for the first time using facile sol-gel method. Electrode capacitance (430 Fg−1) and device capacitance (240 Fg−1) are quite high in a symmetric two-electrode system, making the material highly competitive for supercapacitor applications. These results resemble the real capacitor device owing to multistage cationic ordering of cobalt and chromium cations confirmed by X-ray photoelectron spectroscopy (XPS). Compared to many reported double perovskites, it exhibits a high capacitance retention of 98.5% up to 10,000 charging-discharging cycles. Along with electrochemical properties, the structural, morphological, magnetic, and optical properties were also studied. Structural and morphological properties reveal the formation of nanoparticles with average size of 57 nm in a single phase. Figure 1 shows (a) M-T curves for ZFC and FC conditions, (b) monoclinic distorted unit cell of PCCO and (c) the mechanism for the formation of electrochemical capacitor using PCCO nanoparticles. Magnetic characterization determines promising magnetic features with a high transition temperature of TN1 = 218 K and an exhibition of magnetic reversal below Tcomp = 21 K, due to antisymmetric Dzyaloshinskii–Moriy (DM) interaction between Co and Cr ions and antiparallel polarization of the Pr3+ ion. Due to this feature, this PCCO compound is highly implementable in next-generation spintronic devices. Finally, the optical feature unveils its ultraviolet (UV) light harvesting potential, mostly having a bandgap of 2.9 eV. Band edge position obtained from bandgap calculation demonstrates its promising capabilities of photocatalytic H2 and O2 production from H2O. After all, PCCO is the most demanding material for supercapacitors, next-generation spintronics devices, and photocatalytic water splitting.

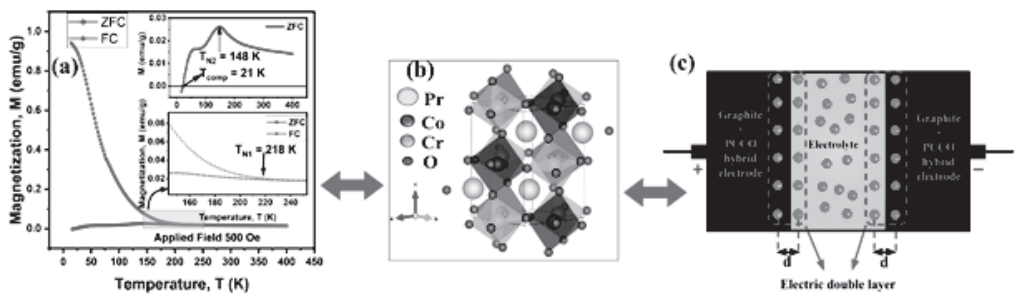

Figure 1: (a) Temperature-dependent magnetization curve for ZFC and FC conditions obtained under an applied magnetic field of 500 Oe. The upper inset of Figure (a) depicts detailed views of the ZFC curve, and the lower inset demonstrates the split between the ZFC and FC magnetization, (b) Monoclinic distorted unit cell of PCCO, and (c) Formation of electrochemical capacitor using PCCO nanoparticles.

Abstract No: 58

Assessment of Groundwater Quality and its Suitability for Drinking and Irrigation Purposes in Sunamganj Sadar and Bisawamvarpur upazila, Sunamganj, Bangladesh

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Abstract

Water is an essential component for life. In its pure state, it is a colorless, odorless, and tasteless chemical that is one of the most important and most readily available substances required for the existence and growth of all living organisms. In Bangladesh, 70% of rural population and 95% of urban residents depend on groundwater for drinking and domestic use [1]and as water demand escalates, groundwater extraction is increasing [2].In the majority of the developing countries including Bangladesh, there is no other single source of drinking water bigger than groundwater. A research was carried out to assess the quality of groundwater in Sunamganj district. A total of 36 water samples were collected between January and March 2025 at 36 locations in Sunamganj sadar upazila and Bisawamvarpur upazila. The physicochemical parameters of these samples were measured to assess their suitability for households and irrigation uses. The majority of the samples exhibited alkaline characteristics, with pH values ranging from 7.55 to 8.54. The main ions were Ca, Mg, Na, K and Cl with average concentrations of 0.120 0.110 0.134,11.97 and 18.03 respectively. All other ions, including As , Fe, NO3- and physicochemical parameters including (TDS, DBS,TSS,BOD,COD and EC) within the acceptable range for irrigation and drinking purposes. The classification of water suitability was determined using pH, total dissolved solids (TDS), sodium adsorption ratio (SAR), magnesium adsorption ratio (MAR)and soluble sodium percentage (SSP). Some water sources could be used for domestic, drinking, and irrigation purposes. Water contaminated with it should be cleansed prior to human consumption to safeguard public health . Assessing integrates various factors (SAR, KR, MAR, TDS) were used to categorize water for irrigation purposes. 18 samples (50 %), 15 samples (42%) and rest samples (8%) are suitable , permissible and marginal characteristics respectively. Consequently, the majority of groundwater in the study area is suitable for irrigation; however, consistent monitoring is essential to prevent long-term soil salinity issues.

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Abstract No: 61

Instability of plasma modes due to photoelectric effect in streaming and irradiated dusty plasmas

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Abstract

Photoelectric effect is introduced through the dust charge fluctuation dynamics to study its effect on plasma modes. The photoelectric effect is thus enhances the plasma electron temperature as well as makes the plasma modes unstable. It has been found that both the high-frequency plasma wave [1] and the low-frequency dust modes become unstable due to the presence of photoelectrons in irradiated dusty plasmas [2-3]. It is also observed that the plasma modes become unstable significantly due to the photoelectric effect compared to the Landau damping, streaming and collisional effects.

In this paper, our model of dust charge fluctuation including photoelectric effect is discussed. In this model, fluctuating electron densities ne1 are considered to be piled up on a dust grain due to plasma mode perturbation on electron–grain current. The fluctuating dust charge, Qd1, is then returned to its equilibrium value through the emission of ne1 electrons by the photoelectric effect.

Without photoelectric effect dust charge fluctuation usually gives damping of the mode due to the collision of the plasma particles with the dust grain. According to our model of dust charge fluctuation, the collected plasma particles by dust grains are returned to the plasma as photoelectrons. These energetic photoelectrons make the plasma modes unstable. Hence, our study clarifies the formation of radar echoes in the polar mesosphere and communication of information from satellite to the Earth in the presence of solar radiation. A brief review of our studies is given in this paper.

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Abstract No: 64

DFT investigation of mechanical, optical, electronic and thermodynamic properties of olivine materials Mg2XO4 (X = Si, and Ge)

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Abstract

The physical features of cubic-type olivine materials Mg2XO4 (X = Si, and Ge) were studied using an ab-initio method based on density functional theory (DFT). All of our calculated results and earlier theory and experimental results seem to agree with each other pretty well. The mechanical stability of the Mg2XO4 (X = Si, and Ge) compounds has been verified based on the observed elastic stiffness characteristics of both materials. The calculated elastic constants agree with the results from former theoretical studies. It has been discovered that both Mg2SiO4 and Mg2GeO4 compounds are brittle in nature by the analysis of Cauchy pressure, Pugh's ratio, and Poisson's ratio. Young's modulus and hardness values of Mg2SiO4 were the highest among the studied materials, suggesting potential industrial uses such as long-range stress resistance. Analysis of the electronic band structure and density of state of Mg2SiO4 and Mg2GeO4 has proven their insulator characteristics. Ultraviolet energy range (16–26 eV) exhibits high absorption and conductivity, suggesting that the material Mg2XO4 (X = Si, and Ge) may be used as an efficient UV absorber. The materials Mg2XO4 (X = Si, and Ge) that have been studied have a high reflectivity, which makes them acceptable as coating materials. For the first time, calculations and a detailed discussion of the thermodynamic characteristics of Mg2XO4 (X = Si, and Ge) have been performed. These phases have very low thermal conductivity, which means they can be used as thermal barrier coatings (TBC).

Keywords: Density functional theory, Perovskites, Mechanical properties; Electronic properties; Thermal properties.

Abstract No: 65

A Comparative Study of Bilayer and Bulk Heterojunction Organic Photovoltaic Devices Employing Poly(3-hexylthiophene) and Polynaphthalene-bithiophene Polymers Through SCAPS Simulation

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Abstract

Organic photovoltaic devices have attracted considerable attention due to low fabrication cost, mechanical flexibility, and potential for large area applications. In this research work, a detailed numerical study of bilayer and bulk heterojunction (BHJ) organic photovoltaic devices was carried out using the Solar Capacitance Simulator (SCAPS) tool in order to compare their photovoltaic performance. For SCAPS simulation, we employed the device architectures of ITO/PEDOT:PSS/P3HT/N2200/BCP/Al and ITO/PEDOT:PSS/P3HT:N2200/BCP/Al in bilayer and bulk heterojunction structures, respectively where PEDOT:PSS was used as a hole transport layer (HTL) and BCP as an electron transport layer (ETL). The simulated BHJ device exhibited a JSC of 15.029 mA/cm2, VOC of 0.699 V, FF of 74.684% and PCE of 7.845% whereas the bilayer structure device shows PCE of 1.79% only with a 5.952 mA/cm2 short circuit current density. The impact of the thicknesses of P3HT, N2200 and P3HT:N2200 active layers on the photovoltaic performance has been investigated both for bilayer and BHJ structure devices. In addition, the impact of working point temperature has also been studied. Furthermore, a systematic investigation has been done to examine how the thicknesses of P3HT, N2200 and P3HT:N2200 active layers influence the quantum efficiency (QE) of the devices. Simulation results reveal that in the case of bilayer device, an optimum thin layer of P3HT (~20 nm) shows higher device PCE, whereas the PCE increases with the thickness of N2200 and becomes stable when the layer is 200 nm or more. On the other hand, increasing the thickness of the P3HT:N2200 layer from 50 nm to 500 nm significantly improves the overall device PCE for the BHJ device. This enhanced performance of the BHJ structure compared to the bilayer structured configuration has motivated the photovoltaic research community to focus future investigations on the BHJ architecture.

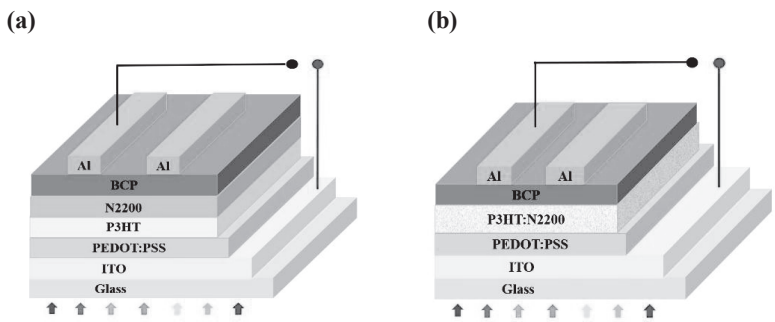

Figure 1: Device architectures of (a) bilayer and (b) bulk-heterojunction photovoltaic device for SCAPS simulation.

Abstract No: 70

High-Pressure First-Principles Insights into BeCN2: A Promising Ultra-Wide Band Gap Semiconductor for Next-Generation Electronics

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Abstract

This Study presents a comprehensive first-principles investigation of $BeCN_2$ at pressures of 0, 20, and 40 GPa using CASTEP. Structural optimizations were performed with the GGA-PBE functional, and band gaps were determined more accurately using the HSE06 hybrid functional, yielding an ambient pressure band gap of ≈ 5.276 eV. Electronic structure analyses (band structure, DOS), optical spectra, elastic constants, phonon dispersion, population (bonding) analysis, and electron density difference (EDD) maps are computed to assess stability, bonding, and optoelectronic performance under compression. We furthermore examine the elastic anisotropy of $BeCN_2$ using ELATE plots: 3D and 2D visualizations of directional Young's modulus, shear modulus, linear compressibility, and Poisson's ratio reveal non-negligible anisotropy, with increasing directional variation under applied pressure. Mechanical stability is confirmed (no negative eigenvalues of the elastic tensor) throughout. Elastic moduli (bulk, shear, Young's) increase with pressure, indicating stiffening, while the optical absorption edge and dielectric response shift toward higher photon energies. The phonon dispersion curves show no imaginary modes at all studied pressures, establishing dynamical stability. Population and EDD analyses show enhanced charge transfer and more directional bonding under compression. Overall, $BeCN_2$ emerges as a mechanically robust, dynamically stable ultra-wide band gap semiconductor with significant anisotropy, which could be advantageous for targeted applications in deep-UV optics, high-power and high-frequency devices.

Keywords: Ultra-wide band gap semiconductor, Deep-UV transparency, Pressure-tuned electronic structure, Elastic anisotropy, Hybrid HSE06 predictions.

Figure: Band Structure at 0 GPa.

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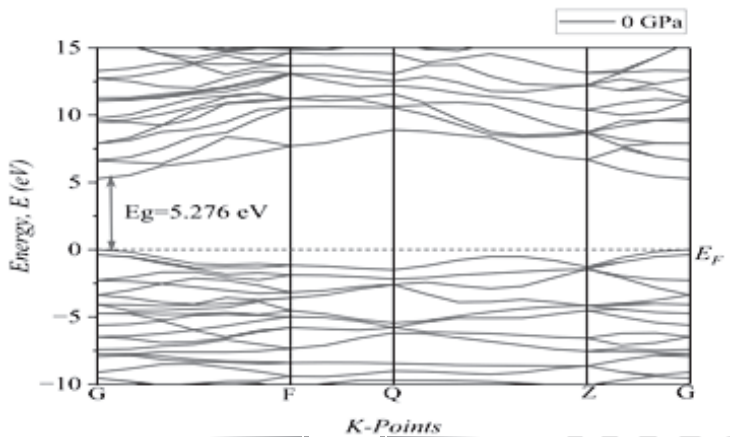

Abstract No: 71

Nuclear and Radioactive Waste Management in Bangladesh: Present Status and Future Challenges

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Abstract

The Rooppur Nuclear Power Plant (RNPP) is a big change for the country's energy sector. To ensure public and environmental safety, effective management of nuclear and radioactive waste is crucial. The Bangladesh Atomic Energy Commission (BAEC) established the Central Radioactive Waste Processing and Storage Facility (CWPSF) at Savar for processing low-level radioactive waste from research reactors and medical applications. In 2019, the government also approved a National Policy on the Management of Radioactive Waste and Spent Nuclear Fuel. The objective is to establish a state-owned company for waste management, although implementing these frameworks remains challenging.

There is a deficiency of thorough analyses concentrating on the amalgamation of waste management strategies with the operational timelines of the RNPP. Moreover, the enduring viability of waste disposal techniques, especially in relation to high-level radioactive waste, continues to be insufficiently investigated. The hypothesis indicates that Bangladesh's current infrastructure and regulatory frameworks are insufficient for managing the expected increase in radioactive waste from the RNPP, requiring significant improvements in technology and policy enforcement.

Goals of the research include evaluating the adequacy of existing waste management facilities and regulatory frameworks in handling the anticipated increase in radioactive waste originating from the RNPP. The research highlights shortcomings in the infrastructure and technology currently used for waste management, and it looks at the viability and efficiency of suggested disposal techniques, especially geological ones.

Advanced waste treatment technologies like vitrification and deep geological disposal should be developed for Bangladesh's geology and economy. Capacity building and nuclear facility safety require collaboration with nuclear agencies and international specialists.

Abstract No: 72

Exploring the Properties of Double Perovskite Pr2CoCrO6 through DFT: An Analysis of Electronic and Optical Properties

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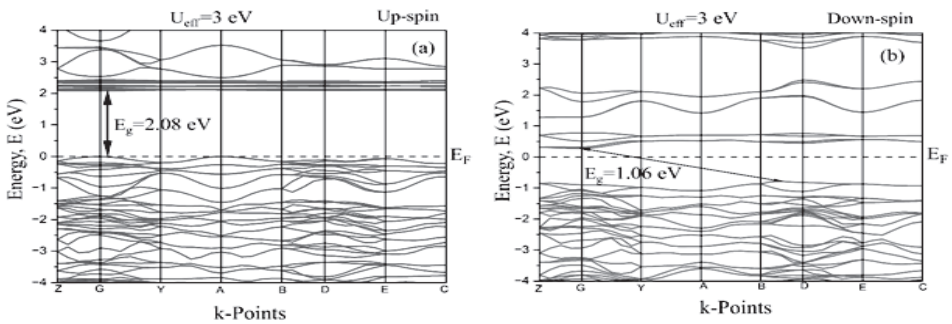
Abstract

In this study, the electronic structure and optical properties of the double perovskite compound Pr2CoCrO6 (PCCO) were investigated using DFT and DFT+U techniques, where U stands for the Hubbard correction potential. The band structure calculations accomplished without the Hubbard U correction (Ueff = 0 eV) indicated metallic behaviour due to the overlap of the valence and conduction bands at the Fermi level. This contradicts with the experimentally obtained semiconducting nature of PCCO. To resolve this discrepancy, the DFT+U technique, incorporating Ueff = 3 eV and 5 eV, was employed. We observed semiconducting nature for Ueff = 3 eV and 5 eV. For Ueff = 3 eV, we calculated a direct band gap of 2.08 eV for the up-spin channel and an indirect band gap of 1.06 eV for the down-spin channel (Figure 1), which is reasonable with the experimental observation of 2.9 eV. Total and partial densities of states (TDOS and PDOS) analyses demonstrate that the electronic states near the Fermi level are mainly contributed by the Pr-4f, Cr-3d, and O-2p orbitals, with noticeable modifications under the influence of the Hubbard U correction. The predominant contribution to the density of states originates from the electrons in the Pr-4f orbitals. The optical properties were also systematically evaluated. The static real dielectric constant decreased from nearly 23 to 8.1 when the Hubbard correction potential (3 eV or 5 eV) is applied. Plasma frequencies of 29.43 eV, 29.06 eV and 29.05 eV were computed using the energy loss spectrum for Ueff = 0 eV, Ueff = 3 eV, and Ueff = 5 eV, respectively. Moreover, the optical absorption spectra revealed strong absorption in the ultraviolet region. This signifies the potential use of PCCO in ultraviolet photodetectors and solar-blind photonics in the UV range [1].

Figure 1: Electronic band structure of Pr2CoCrO6 double perovskite compound for Ueff = 3 eV. The blue curves (a) represent the Up-spin orientation, while the red curves (b) correspond to the Down-spin orientation. The energy ranges from– 4 eV to 4 eV, with the Fermi energy set as the zero reference.



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Abstract No: 74

Tuning Charge Dynamics through La^{3+} Substitution in CoFe2O4: Insight for Energy Storage Efficiency

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Abstract

La^{3+}-substituted cobalt ferrite nanoparticles, CoLaxFe2-xO4 (x = 0.00-0.16), were synthesized via sol-gel auto-combustion to examine the influence of La3+ substitution on charge dynamics and energy storage performance. X-ray diffraction confirmed the cubic spinel phase, with secondary α-Fe_2O_3 detected for x ≥ 0.04. Rietveld refinement indicated a reduction in crystallite size from 35.47 nm (x = 0.00) to 26.72 nm (x = 0.04), accompanied by increased lattice strain, reflecting structural distortions that affect charge transport. The x = 0.12 composition demonstrated optimized electro-structural characteristics, including a crystallite size of 28.7 nm, moderate lattice strain (0.0041), minimal dielectric loss (tan δ = 0.09 at 10 MHz), and suppressed DC conductivity (0.08×10^{-5} S/m). Impedance and modulus analyses confirmed strong grain boundary relaxation, suggesting enhanced charge confinement. Although the x = 0.16 composition exhibited the highest capacitance (~427 μF) and energy density (~3.8×10^5 J/m³), the x = 0.12 sample provided the best balance of dielectric stability, conduction control, and structural integrity. These findings demonstrate that La^{3+} substitution effectively tunes charge transport pathways in $CoFe_2O_4$, positioning the x = 0.12 composition as a promising candidate for high-efficiency energy storage and multifunctional nanoelectronics applications.

Keywords: Cobalt ferrite, electron density, dielectric properties.

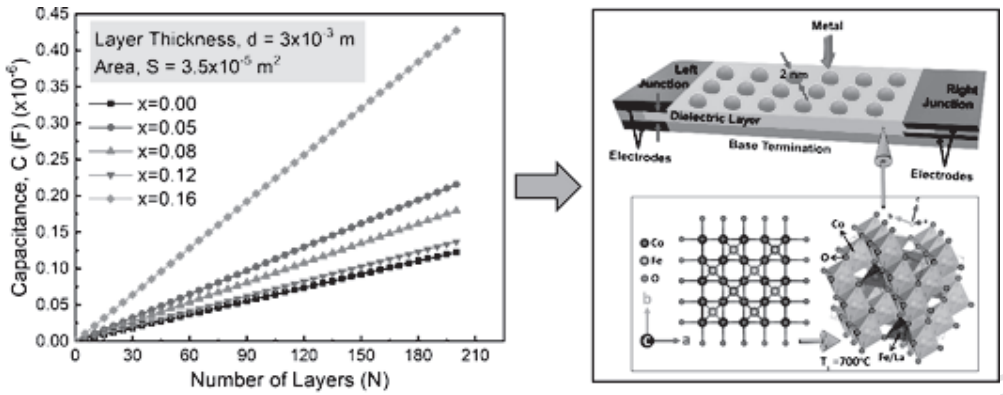

Fig. 1. Layer-dependent capacitance determined for CoLaxFe2-xO4 (x = 0.00-0.16)

Abstract No: 75

Detection of Pion-Decay Gamma-Ray Signatures in Type IIP Supernova Remnants with Fermi LAT

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Abstract

Type IIP supernovae (SNe IIP) represent one of the subclasses of core-collapse supernovae, characterized by their distinct plateau phase in the optical light curve [ref~1]. Investigate SN 2017eaw (RA/DEC: 308.684°/60.193°) to establish Type IIP supernovae as significant gamma-ray sources, focusing on hadronic processes via neutral pion decay from proton-proton collisions in dense circumstellar media, and constrain cosmic-ray acceleration efficiency to position SNe IIP as primary sites for studying pion decay. In this study data from the Large Area Telescope (LAT) onboard the Fermi Gamma-ray Space Telescope [ref~2] to search for gamma-ray signatures from selected SNe IIP. The analysis involves the use of the standard Fermi Science Tools Fermipy [ref~4] and Easyfermi [ref~3] for event selection, background modeling, and likelihood analysis. To further characterize the hadronic contribution, I applied the Naima [ref~5] package to model non-thermal particle distributions and simulate the resulting gamma-ray emission spectra.

The spectral index for the gamma-ray emission from the source (4FGL J2042.3+5758c) associated with SN 2017eaw depends on LogParabola (LP) and Power-Law with Exponential Cutoff (PLEC) spectral models in the energy range of 100MeV to 300000MeV, the spectral index is represented by the parameter alpha, which is 2.844±0.0001508 from the standard fit and 〖1.040〗_(-0.030)^(+0.067) and 〖1.675〗_(-0.166)^(+0.732)from the MCMC analysis, Akaike Information Criterion (AIC)=11.274 and AIC=12.140 with significant spectral curvature at ~1000MeV and high test statistics value 4152.83 value indicate SN 2017eaw is a significant source of gamma rays. From the pion decay fit are consistent with the expected hadronic emission scenarios

No prior gamma-ray studies specifically target of type IIP supernova. This work demonstrates the insights of study pion decay in type IIP supernova, and this study suggests that type IIP supernova is a most significant gamma ray source of study pion decay.

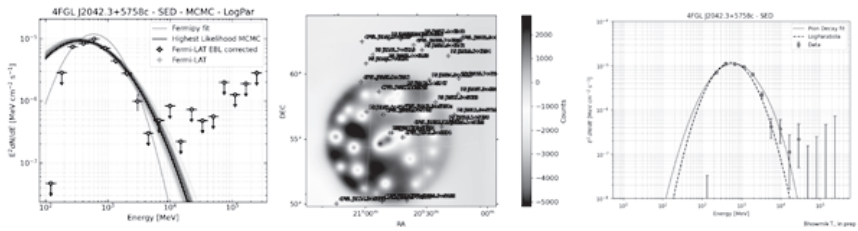

Figure 1: Gamma ray source (4FGL J2042.3+5758c) from SN 2017eaw: spectral energy distribution LogParabola model using MCMC (left plot), point source residual map (middle plot) and pion decay fit plot (right plot) (All plot: Bhowmik T. in prep)

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Abstract No: 77

Atomistic View of Molten Vanadium: Insights from Orbital-Free ab-initio Molecular Dynamics

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Abstract

Understanding the microscopic structure and transport properties are crucial for both fundamental science and industrial applications. Vanadium, is a refractory transition metal, exhibits high melting points and which is very important for high-temperature applications. Traditional experimental probes of liquid metals at high temperatures are challenging, making theoretical and computational methods indispensable. Here we have investigated liquid Vanadium (l-V) at a thermodynamic state 2173K using the Orbital-Free ab-initio Molecular Dynamics (OF-AIMD) approach.

The Hohenberg-Kohn theorem shows that the ground state energy of a many-electron system is a unique functional of the electron density. In standard Kohn-Sham DFT, this density is constructed from a set of auxiliary orbitals, which is computationally expensive. While in OF-AIMD treat the electronic energy as a functional of the electron density $E[\rho]$, eliminate the need of Kohn-Sham orbitals. The forces on the ions are derived through the Hellmann-Feynman theorem, which are consistent with the electronic ground state for each ionic configuration. The electron-ion interaction is described using a local pseudopotential. Which allows for efficient, fully quantum-mechanical simulations of several hundreds even thousands of atoms over picosecond timescales.
We have calculated pair distribution function, g(r), which gives short-range order and coordination number, the static structure factor, S(q) and compared with X-ray diffraction data. The self-diffusion coefficient is computed from the mean-squared displacement. The shear viscosity is evaluated from the Green-Kubo relation. While the dispersion relation gives the sound velocity in the l-V. A comprehensive comparison of our results with existing experimental data and other theoretical studies shows good agreement.

Keywords: OF-AIMD, DFT, Local Pseudopotential, Transport Properties.

Abstract No: 79

First-Principles Investigation of Pb-Free All-Inorganic Perovskite CsMgI3: A Promising Candidate for Eco-Friendly Optoelectronic Applications

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Abstract

Lead (Pb)-based metal halide APbX3 metal halides have recently attracted significant attention as promising semiconductors due to their unique physical and optoelectronic properties, and they also demonstrate remarkable efficiency from 3.8% to 26.7% [1]. However, their commercialization is limited due to Pb toxicity and poor stability (degradation under heat, electric field, and moisture). To overcome these issues, in this research work, Pb is fully replaced with Mg of CsPbI3 in the form of CsMgI3, which is studied using first-principles calculations based on the DFT in the framework of the CASTEP code software. Magnesium (Mg), a non-toxic, earth-abundant, and chemically stable element, emerges as a promising alternative. Previous studies have investigated partial substitution strategies, but complete replacement of Pb with Mg in all-inorganic perovskites has not been extensively explored. This study investigates the structural, mechanical, electronic, optical, thermal, electronic transport, and photocatalytic properties of CsMgI3. It is an all-inorganic lead-free alternative to Pb-based perovskite, exhibiting a larger band gap. The obtained results suggest that Pb-free CsMgI3 perovskite could be used to create an eco-friendly and sustainable material for future optoelectronic devices.

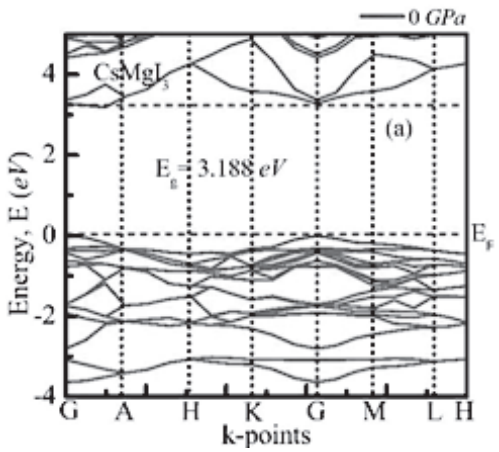

Figure 1. The calculated pressure dependent electronic band structure of CsMgI3 at 0 GPa.

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Abstract No: 80

Dynamic and Mechanical Stability of Ternary Semiconductor Na2CuP: A Theoretical Insight

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Abstract

The development of novel semiconductors for optoelectronic applications is critical for advancing energy-efficient technologies such as photovoltaics and photo detectors. In this study, we explore a first-principles investigation of the zintl-phase ternary semiconductor Na_2CuP, focusing on its potential for optoelectronic applications. Density functional theory (DFT) is employed to evaluate significant properties, including structural stability, mechanical stability and dynamical stability. Mechanical stability is confirmed through positive elastic constants and adherence to Born's stability criteria, while dynamic stability is verified by phonon dispersion curves showing no imaginary frequencies. Thermodynamic analysis yields a heat capacity of 94.7 cal/cell•K (using the Dulong-Petit limit), with Debye and Einstein temperatures of 381 K and 213.85 K, respectively, indicating favorable thermal properties for device operation. The findings reveal that Na_2CuP is a promising candidate for stable, high-performance optoelectronic devices, showcasing effective performance across different temperature ranges, thus contributing to the advancement of energy-efficient technologies.

Keywords: Na2CuP semiconductor, density functional theory (DFT), structural and mechanical stability, phonon dispersion, optoelectronic applications

Figure: Graphical abstract of ternary semiconductor Na_2CuP.

Abstract No: 81

Comparative Study of Ion and Neutron Properties in Low-Energy Plasma Focus Devices

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Abstract

The experimental characterization of neutron and ion beam from 1.1 kJ plasma focus (PF) device was demonstrated by R. Niranjan et al., 2024 [1] and 0.1 kJ by Rout et al., 2013, respectively. In this studies, this PF device is simulated using their measured current trace by the Lee code. Initially, the computed current trace is first fitted to the measured one at 2.25 Torr deuterium (D2). The obtained best-fitted values of the model parameters are found as fm = 0.035, fc = 0.75, fmr = 0.12, and fcr = 0.72. Having fixed these parameters, the effect of operating pressure on ion properties (flux, fluence, pinch voltage) neutron yield at different operating of pressures D2 are studied. The simulation approach is validated by benchmarking the 1.1 kJ device against measured ion fluence, neutron yield, and pinch voltage. In addition, the obtained results in 1.1 kJ and 0.1 kJ are compared. Comparing these two energy levels shows that while absolute ion outputs decrease with decreasing capacitor energy, core plasma behavior are maintained under energy scaling. These results shed light on how to choose the best operating pressure for a PF system, especially in small-scale setups meant for targeted ion beam applications.

Keywords: Current profile, Ion flux, Ion fluence, Neutron Yield, Lee Code

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Abstract No: 82

Excitation of Electrostatic Dust Modes in Magnetized Dusty Plasma

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Abstract

Electrostatic dust modes in a magnetized dusty plasma containing massive, negatively charged dust grains are theoretically analyzed using fluid model of plasma. A general dispersion relation governing these dust modes is derived, from which various wave modes—namely dust-acoustic (DA), ion-acoustic (IA), dust-lower-hybrid (DLH), and ion cyclotron (IC) modes—are obtained under specific plasma conditions. The analysis reveals that the phase velocity of the DLH mode is lower compared to those of the DA, IA, and IC modes. Furthermore, it is found that a specific condition must be satisfied to excite the DLH mode in laboratory plasma experiments. The behaviours of these dust modes is explored and graphically represented using relevant dusty plasma parameters, offering insights into their propagation characteristics under different plasma environments.

Abstract No: 85

Generalization and Efficiency of Graph Neural Networks for Crystal Formation Energy Prediction

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Abstract

Accurately predicting crystal formation energies is a key goal in computational materials science, as these energies determine a material's thermodynamic stability, phase behavior, and synthesizability. Although density functional theory (DFT) provides reliable results, its high computational cost makes large-scale screening impractical. Graph neural networks (GNNs) have recently emerged as a promising alternative, capable of learning structure–property relationships directly from atomic configurations. However, their generalization across datasets and computational efficiency still pose important challenges for high-throughput applications.

In this work, we develop a GNN model that predicts formation energies directly from atomistic graphs constructed from Crystallographic Information Files (CIFs). Each crystal is represented as a graph, where nodes correspond to atomic species and edges encode interatomic interactions. The model is trained on the Materials Project dataset and evaluated on the independent Matbench Formation Energy benchmark. It achieves a mean absolute error (MAE) of 0.0802 eV/atom and an R^2 of 0.9798 on the testing set, and generalizes well to Matbench with an MAE of 0.0948 eV/atom and R^2 = 0.9730. The workflow is also computationally efficient, with an average CIF-to-graph conversion time of 0.52 seconds and an inference time of about 4.4 milliseconds per crystal. Overall, these results indicate that the proposed GNN achieves a practical balance between computational efficiency and accuracy, making it a valuable tool for screening materials.

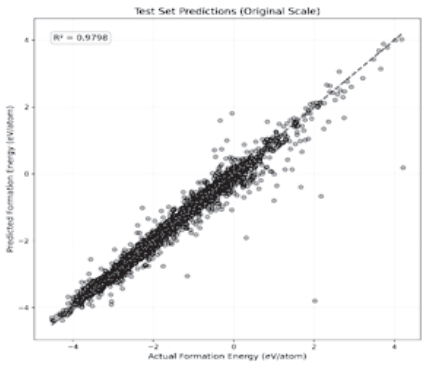

Figure SEQ Figure * ARABIC 1: Model performance for predicting formation energy per atom. The parity plot compares predicted and actual formation energies, with a low error (MAE) of 0.0802 eV/atom and high coefficient of determination (of 0.9798.

Abstract No: 87

Band Gap Engineering and Lattice Distortion in Co- and Cu-Doped BaTiO3 Ceramics for advanced optoelectronic applications

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Abstract

In this study, Co- and Cu-doped barium titanate (BaTiO3) ceramics were successfully synthesized via a conventional solid-state reaction route to explore the influence of transition-metal substitution on their structural, optical, and vibrational properties. X-ray diffraction confirmed the formation of a single-phase perovskite structure, indicating that both Co2+ and Cu2+ ions were effectively incorporated into the BaTiO3 lattice by substituting Ti4+ sites. UV–visible absorption spectra revealed a distinct red-shift in the absorption edge for the doped samples compared to undoped BaTiO3, suggesting band structure modification due to dopant-induced localized states. The Co-doped BaTiO3 exhibited an absorption edge near 380 nm corresponding to a band gap of ~3.1 eV, while Cu doping further extended the absorption into the visible region with a reduced band gap of ~2.9 eV. The decrease in band gap energy is attributed to impurity levels and enhanced charge-transfer interactions arising from transition-metal substitution and oxygen vacancy formation. Fourier transform infrared (FTIR) analysis showed characteristic absorption bands of prominent Ti–O stretching vibrations around 560–600 cm^{-1}, confirming the retention of the perovskite structure. The slight shifts and intensity variations in FTIR bands indicate lattice distortion and modifications in the Ti–O bonding environment induced by dopant incorporation. Overall, controlled Co and Cu doping in BaTiO3 effectively tailors its electronic and optical properties, making these ceramics promising candidates for visible-light-driven photocatalysis and advanced optoelectronic applications.

Keywords: BaTiO3 ceramics, Perovskite, UV–visible absorption, Band gap, Optoelectronics.

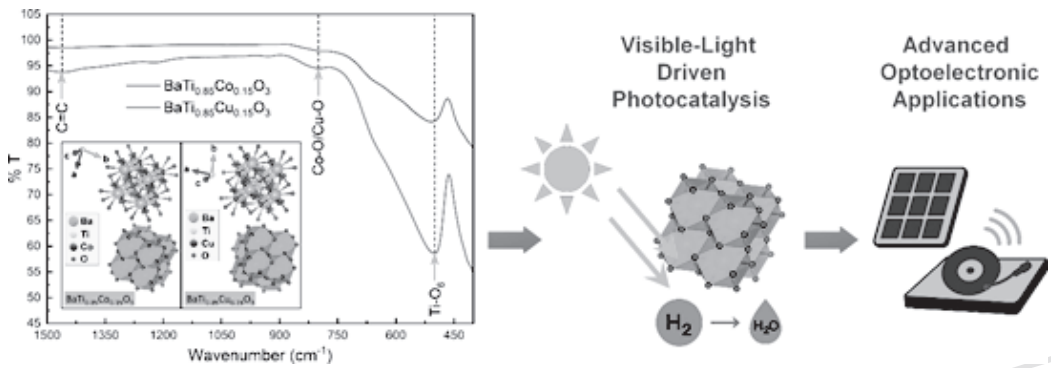

Fig.1. FTIR spectra of Co- and Cu-doped BaTiO3 with inset of unit cell structures and schematic of visible-light-driven photocatalysis and potential optoelectronic applications.

Abstract No: 89

Sintering effect on electro-magnetic properties of Mn-Zn ferrites by green synthesis route

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Abstract

In this study, Mn-Zn ferrites spinal ferrites is developed using green synthesis method. The developed composites were sintered at 9300C, 10300C, 11300C, 12300C & 13300C respectively. The sintering temperatures significantly influenced the superexchange properties as well as frequency dependent dielectric and magnetic properties. The X-ray diffraction analyzed the crystallographic properties of samples. XRD showed the single phase with Fd3m lattice group and further verified using the Rietveld analysis method. Gaussian fits on 311 peaks were used to calculate the grain size of the samples. The TEM image was used to demonstrate the nano materials of the Mn-Zn ferrites and the samples sizes were found 20nm-50nm. The frequency dependent magnetic and the electrical properties of the samples sintering at different temperatures was studied using LCR bridges. The initial magnetic permeability increased with rising sintering temperature of the Mn-Zn ferrites. The operating frequency range decreased as the sintering temperature and permeability increased. Eventually, the efficient production of Mn-Zn ferrites with various temperature is discovered by the initial result of the Mn-Zn ferrites as potential materials for biomedical applications.

Keywords: Sintering Temperature, Green Synthesis, Rietveld Refinement, Electromagnetic Properties.

Abstract No: 91

Optimization of the superparamagnetic properties of Fe2+ replacing by Al3+ of Zn-Mn ferries for biomedical applications

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Abstract

MnZn ferrite is an attractive and promising soft magnetic material for different potential applications. Achieving optimal structural stability and improved magnetic performance, controlling grain size, reducing energy loss in ferrites remains a challenge due to cation distribution and dopant concentration for achieving high-performance applications. In this study, Al3+ doped MnZn ferrite synthesized through a controlled solid state reaction method from high-quality metal oxide precursors pre-sintered at 1250°C for 6 hours at sintered at 1350°C for 4 hours respectively. XRD analysis showed the cubic spinel of fd-3m groups with no impurity peaks and the lattice parameters were observed to increase. The average unit cell volume and the crystallite size were found 553.93 (A˚) and 32.44 nm respectively. The bulk density and the X-ray density were decreased and the porosity increased with increasing Al3+ contents. The saturation magnetization was found to reduce linearly from x = 0.6 to x = 1.0 with increasing Al^{3+} content. This is due to the non-magnetic nature of Al^{3+} ions and the dilution of magnetic interactions. Permeability studies showed that Al3+ doping reduced initial permeability at the frequency 106 Hz and lowered magnetic losses. Al3+ substitution in Mn–Zn ferrite offers a balance of structural sincerity and controlled magnetic response. The optimizing Al3+ doped Mn-Zn ferrites is a good platform for biomedical applications.

Keywords: Al3+ doped Mn-Zn ferrites, Solid state reaction method, XRD analysis, Superparamagnetic Properties, Biomedical Applications

Abstract No: 92

Doppler Lensing in Cosmic Voids: Relativistic N-Body Simulation Insights

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Abstract

Doppler lensing, induced by galaxy peculiar velocities, offers a novel probe of the large-scale structure (LSS) at low redshifts, complementing the weak gravitational lensing signals. Our preliminary analyses reveal distinct Doppler convergence signatures across cosmic void scales, extracted from void catalogs in Gevolution [1] simulation snapshots (Fig. 1). Here, we compare Doppler lensing convergence maps from two relativistic N-body simulation frameworks: the full Gevolution code and its cosmic screening approach (Screening) [2] for voids of varying sizes. Screening closely matches Gevolution results on medium scales, enabling efficient statistical analyses via the Doppler lensing algorithm [3]. However, discrepancies emerge for smaller voids due to Screening's linearization. To address this, we propose a scale-dependent strategic approach: employing Screening for rapid processing in large surveys like Euclid and DESI, while reserving Gevolution for high-precision modeling at sub-Mpc scales. This strategy optimizes computational efficiency without sacrificing accuracy, thereby enhancing constraints on cosmological parameters. Our findings offer guidance for relativistic treatments in future astrophysical surveys.

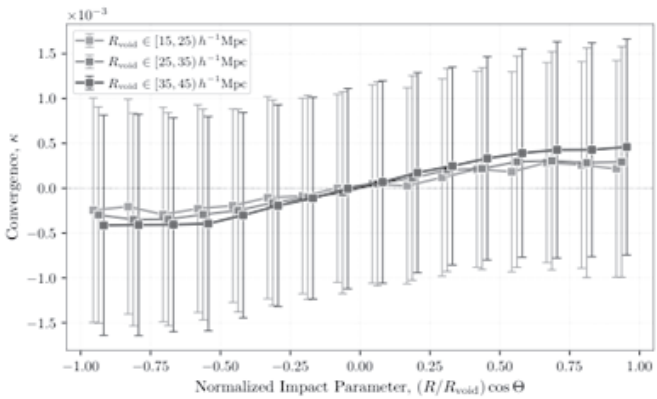

Figure 1. Doppler convergence trends for three void radius ranges versus normalized impact parameter.

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Abstract No: 93

Structural, morphological, magnetic and dielectric properties of Nd3+doped zinc ferrites using conventional solid state reaction technique for high frequency applications

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Abstract

Nd-doped Zinc ferrite is most prominent compound for high frequency application for its excellent magnetic and dielectric properties. The polycrystalline compound of $Zn1\text{-}xNdxFe_2O_4$ (x= 0-0.08) prepared by solid state reaction technique pre-sintered at 1100°C and sintered at 1230°C respectively. The XRD results showed a single-phase cubic spinel (Fd–3m) structure with faint orthoferrite traces for high Nd concentration without extra impurity peaks. SEM reveals uniform, finer micro-structure particle sizes and no pronounced agglomeration observed from the SEM images. The FTIR spectrum between 400 and 600 cm^{-1} demonstrates well-defined tetrahedral and octahedral spinel stretches. The electrical and magnetic analysis exhibit that the optimized composition has high permeability and conductivity and low dielectric loss. Cumulatively, the tuned ferrite composition is suitable for high-frequency soft magnetic applications

Keywords: Nd-Zn Ferrites, Solid State Reaction Technique, Permeability and Dielectric Constant

Abstract No: 94

Sintering temperature dependent electromagnetic properties of gold (Au3+) doped cobalt based ferrites for different potential applications

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Abstract

In this work, gold-doped cobalt ferrite (GDCF) of the composition $CoFe_{1.994}Au_{0.006}O_4$) were synthesized via the solid-state reaction method and sintered at 8000C, 9000C, 10000C, and 11000C to investigate the effects of sintering temperature on their structural, magnetic, and electromagnetic properties. The distribution of cations among the tetrahedral (A) and octahedral (B) sites was estimated via Rietveld refinement of XRD patterns, revealing that the developed samples exist as mixed-type spinels. FTIR spectra displayed characteristic absorption bands of octahedral and tetrahedral metal–oxygen vibrations, confirming the spinel framework. SEM images revealed homogeneous microstructures with temperature-dependent grain growth, while EDS spectra verified the presence of Co, Fe, O, and Au. Grain size distribution analysis further highlighted the effect of sintering temperature on the microstructure properties. Electromagnetic studies showed systematic variations in matching impedance (Z/η_0) and transmission wavelength (λ) with sintering temperature. The magnetic modulus spectra ($M\mu'$, $M\mu''$) shifted toward higher frequencies with increasing temperature, indicating reduced relaxation time and enhanced magnetic coupling. Nyquist plots demonstrated decreasing arc radii with temperature, suggesting reduced grain boundary resistance and improved charge mobility. Frequency-dependent magnetic permeability (μ', μ'') exhibited a clear cut-off frequency (fc), while magnetic loss tangent ($\tan\delta\mu$) and quality factor ($Q\mu$) indicated improved magnetic response and reduced loss. Similarly, the electric modulus ($M\varepsilon'$, $M\varepsilon''$) and dielectric parameters (ε', ε'', $\tan\delta\varepsilon$, $Q\varepsilon$) reflected thermally activated relaxation processes, interfacial polarization, and enhanced dielectric stability due to Au3+ doping. The developed composites is a promising candidate for high-frequency electromagnetic, spintronic, and energy storage applications.

Keywords: Sintering temperature, GDCF, Rietveld refinement, electromagnetic properties

Abstract No: 96

Exploring The Chaotic Dynamics of Diverse Laser Systems via Lorenz-Type Models

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Abstract

This work explores the emergence of chaos in different laser systems, He-Ne, CO_2, Nd:YAG, and semiconductor lasers, through numerical simulation of Lorenz-type equations derived from the Maxwell-Bloch formalism. The time series analysis, bifurcation diagrams, and Lyapunov exponents are computed as functions of the pumping rate. Interestingly, the results show that even the conventionally stable He-Ne laser exhibits chaotic oscillations for certain parameter sets, confirmed by a positive Lyapunov exponent (≈ 0.83). CO_2 and semiconductor lasers display richer nonlinear dynamics, while Nd:YAG remains comparatively stable. The study highlights how variations in relaxation rates and pumping conditions govern the transition from steady-state to chaos, providing insight into the control of laser instabilities and their potential applications in secure optical communication and photonic computing.

Abstract No: 98

A Machine-Learning Framework for Non-Invasive SpO_2 and Heart Rate Prediction from Photoplethysmography

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[2] Department of Mathematics and Physics, North South University, Dhaka, Bangladesh.

Abstract

The science of optics in biomedical applications have undergone significant changes in the last decade notable being the photoplethysmography (PPG) signals that uses the change in absorption of light intensity within human tissues that provide valuable information. With the rise of hand-held devices, the continuous monitoring of PPG signals opens opportunities to provide efficient health monitoring. Real-time signals monitoring and using machine learning to extract relevant information is a crucial step towards saving lives.

In this work, we explore the extraction of different vital PPG parameters, such as the heart rate and peripheral oxygen saturation (Sp02), through regression models that are trained using extracted time domain-based and statistical characteristic features of standard PPG signals. The linearity between these parameters and their statistical similarity in terms of correlation allows them to be found in conjunction through a real-time PPG signal data.

Datasets were obtained through a medical grade pulse oximeter. Through filtering techniques to de-noise high-frequency signals contributed by motion artefacts are taken into consideration. Various supervised learning algorithms for the use of processing PPG data are explored and compared in terms of their evaluation metrics, such as Root Mean Squared Error (RMSE) to gauge the accuracy of the model's prediction and Mean Absolute Error (MAE) to offset the outlier discrepancy of RMSE. The results were obtained via the train-validation split method.

The regression-based models demonstrated strong correlations achieving low error metrics (RMSE < 3.2, MAE < 2.5 %) across validation sets. The Random Forest regressor showed significant increase in accuracy compared to HistGradientBoosting regressor as it reduced MAE and RMSE. These outputs establish a data-driven link between physiological signatures of PPG signals, paving the way for intelligent, non-invasive vascular monitoring systems and wearable health analytic modalities.

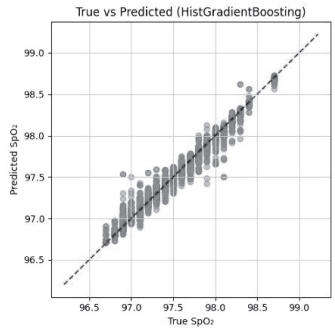

Figure 1. Performance evaluation of the HistGradientBoosting model showing the relationship between true and predicted SpO_2 values on the 80–20 train–validation dataset

Abstract No: 99

Comprehensive Analysis of Vertical Wind Shear on Intensity and Rainfall of Tropical Cyclones over the Bay of Bengal

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Abstract

This study examines the impact of vertical wind shear (VWS) on the intensity and rainfall of tropical cyclones (TCs) over the Bay of Bengal (BoB; 5°N–30°N, 70°E–100°E), utilizing data from the National Centers for Environmental Prediction (NCEP)-Global Data Assimilation System (GDAS) reanalysis data. These data have a horizontal grid resolution of 0.25° × 0.25° and a temporal resolution of 6 hours. The positions, intensities, and durations of the TCs are collected from the best track data provided by the Regional Specialized Meteorological Centre (RSMC) of the IMD. The BoB experienced 14 cyclones during 2015–2021, among them, 10 cyclones were found to be mature cyclones (with a maximum wind speed of ≥63kt or ≥32.41 m/s. Four cyclones are developed during the pre-monsoon season and six cyclones during the post-monsoon season. VWS was considered at three pressure levels: low-level (1000–850 hPa), mid-level (1000–500 hPa), and upper-level (850–200 hPa), and average VWS and rainfall rates are measured into four quadrants, within 5°× 5° area centered on the TCs. VWS at the low level emerges as the most critical factor, showing a positive trend and significant correlations with cyclone intensity (ranging from 0.82 to 0.97). The downshear-left quadrant at this level shows correlation values ranging from 0.67 to 0.99, all of which are statistically significant. Pre-monsoon cyclones show higher average rainfall rates (3.5 mm/hr), while post-monsoon cyclones have lower rates (average 2.43 mm/hr). Upper-level VWS has been found to enhance rainbands of post-monsoon cyclones, showing significant correlations (r ~0.6) with rainfall. These insights underscore the importance of seasonal monitoring of TCs to enhance rainfall and flood management in the BoB.

Keywords: Vertical wind shear, Tropical cyclone, Intensity, Bay of Bengal.

Abstract No: 101

Magneto-Dielectric Coupling in Mo and W Doped BaTiO3 Ceramics for Electronic and Biomedical Applications

Jannatul Ferdous Flora and Nasreen Akter

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Abstract

Achieving multifunctional integration of dielectric and magnetic properties in BaTiO3 ceramics remains a significant unresolved challenge. Therefore, BaTi0.95Mo0.05O3 (BTMO) and BaTi0.95W0.05O3 (BTWO) were synthesized with a focus on multifunctional applications ranging from electronics to biomedical applications. X-ray diffraction confirmed the tetragonal perovskite structure with reduced lattice strain and enhanced crystallinity upon doping. The FESEM micrographs of these samples revealed that Mo doping promoted abnormal grain coarsening while W suppressed growth. Dielectric measurements showed relaxor-type electric polarization in both Mo and W doped BaTiO3 compositions. Magnetic studies revealed defect-mediated weak ferromagnetism in Mo and W doped BTO while pure BTO is essentially non-magnetic. However, at 300 K, BTMO showed a saturation magnetization (Ms) of ~11.0 emu/g, coercivity (Hc) of ~116 Oe, and remanent magnetization (Mr) of ~0.4 emu/g, whereas BTWO demonstrated Ms ≈ 9.1 emu/g, Hc ≈ 150 Oe, and Mr ≈ 4.1 emu/g. Notably, BTWO achieved the highest magnetic energy product, (BH)max ≈ 260.8 MGOe, highlighting strong magneto-dielectric coupling. These properties weakened at 450 K due to thermal agitation but remained detectable, confirming temperature-dependent defect-driven magnetism. The coexistence of relaxor ferroelectricity and induced magnetism offers multifunctionality not only for tunable capacitors, sensors, and spintronic devices but also for biomedical applications like hyperthermia-based anticancer therapy, controlled drug delivery, and multifunctional therapeutic platforms.

Keywords: BaTiO3 ceramics, Microstructure, Magneto-dielectric coupling, Anticancer therapy.

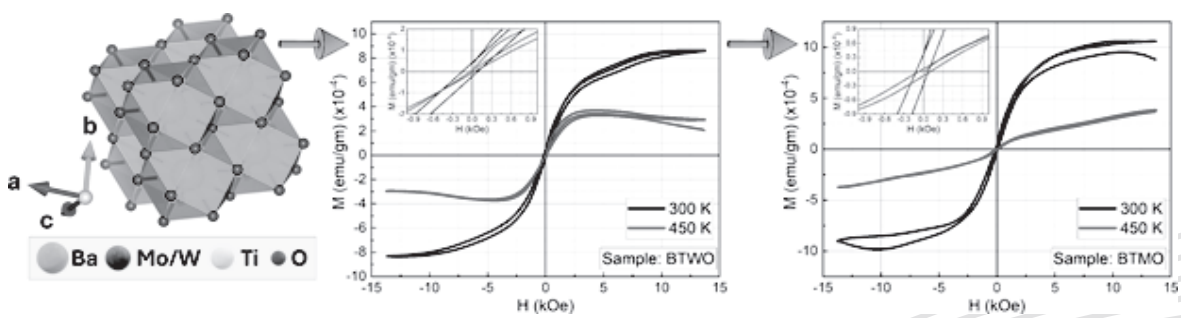

Fig. 1. Unit cell structure and magnetic hysteresis of Mo and W doped BaTiO3

Abstract No: 103

Modeling Built-up Area through Atmospheric Pollutants in Bangladesh using Random Forest Algorithm

Monim Abdullah[1], Bipro Acharjee[2], Sumia Akter Mim[1], Muntaha Alam Elma[1], Mahfuju[1] Haque[1], Utpol Chakraborty[1]

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Abstract

Urban expansion and environmental degradation are closely interconnected processes, particularly in developing countries like Bangladesh. This study investigated the spatial relationship between built-up surface areas and key atmospheric pollutants such as CO (carbon monoxide), NO_2 (nitrogen dioxide), O_3 (ozone), SO_2 (sulfur dioxide), Aerosol Index, and CH_4 (methane) using Random Forest Regression for 463 upazilas of Bangladesh.

A Random Forest model predicted built surface areas based on these environmental parameters. Best hyperparameters were selected with the Optuna framework to maximize R^2, and the dataset was split into training (60%), validation (20%), and testing (20%) sets. The label feature was the mean Normalized Difference Built-up Index (NDBI) from 2021–2024, while all atmospheric pollutants were predictors. Mean NDBI was derived from Sentinel-2 (band 8: NIR and band 11: SWIR) satellite images using Google Earth Engine, and atmospheric pollutants were 2024 mean values from Sentinel-5P TROPOMI data. Model performance was evaluated through R^2, MSE, RMSE, and MAE metrics.

The model achieved strong predictive performance, with MAE=0.0245, MSE=0.0014, RMSE=0.0373, and R^2=0.4790 for validation, while the test set showed slightly better performance (MAE=0.0230, MSE=0.0010, RMSE=0.0320, R^2=0.5433). Feature importance analysis revealed that Aerosol Index was the most influential predictor, while SO_2 showed the least importance. The remaining variables followed this order: CO > O_3, CH_4 > NO_2.

This study is limited by the lack of in-situ ppb/ppm data and reliance on satellite observations. Future work could integrate direct indicators like population and temperature, and test other machine learning or deep learning models. Overall, this study suggests that atmospheric pollutants can serve as effective predictors of urban expansion in developing countries.

Abstract No: 104

Structure based Electric Polarization in Mo and W Doped BaTiO3 Ceramics for Energy storage applications

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*Email: 24-58031-2@student.aiub.edu

Abstract

This study explores the structure–polarization relationship in Mo- and W-doped $BaTiO_3$ ceramics to enhance their dielectric and energy storage performance. BaTi0.90Mo0.10O3 (BTMO) and BaTi0.90W0.10O3 (BTWO) were synthesized via the solid-state reaction route. X-ray diffraction confirmed the formation of a tetragonal perovskite structure with improved crystallinity and reduced lattice strain upon doping. Microstructural analysis revealed that Mo incorporation promoted abnormal grain growth (~29.4 μm), whereas W doping effectively suppressed grain coarsening (~0.72 μm) due to boundary pinning. Dielectric studies exhibited relaxor-type behavior with diffuse phase transitions, characterized by Curie temperatures of 370 K (BTMO) and 334 K (BTWO), both lower than pure BaTiO3 (378 K). The increased diffuseness coefficients ($\gamma \approx$ 1.86 for BTMO and 1.94 for BTWO) confirmed the presence of polar nanoregions and enhanced dielectric tunability. Ferroelectric measurements demonstrated improved electric polarization and recoverable energy density, attributed to defect-induced local structural distortions and optimized grain boundaries. Additionally, weak defect-mediated ferromagnetism was observed, indicating magneto-dielectric coupling. The coexistence of enhanced dielectric polarization and moderate magnetic ordering suggests promising multifunctionality for high-performance energy storage, tunable capacitors, and multifunctional electronic devices. These findings reveal that controlled Mo and W substitution in $BaTiO_3$ effectively tailors the structure and polarization dynamics, offering a viable pathway toward next-generation energy storage ceramics.

Keywords: BaTiO3 ceramics, Microstructure, Relaxor ferroelectricity, Electric Polarization.

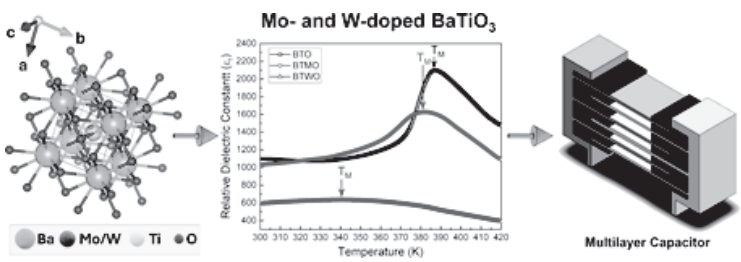

Fig.1. Structure base dielectric properties of Mo and W Doped BaTiO3 and a corresponding prototype model of multilayered capacitor.

Abstract No: 105

Electronic and optical properties of the ferromagnetic A2CrWO6 (A = Sr, Ba) for spintronic devices: A DFT insights

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Abstract

The discovery of half-metallic materials with improved properties is one of the current topics in applied science. The various properties, including the half-metallic nature of simple ABO3-type oxide perovskites with transition metals at the B-site, have been investigated. To explore new half-metallic materials, we have studied structural, electronic, optical, thermodynamic, vibrational, and various unrevealed physical properties of the cubic phase of double oxide perovskites A2CrWO6 (A = Sr, Ba) with ferromagnetic configuration using first-principles calculations. The optimized lattice parameter with a fully relaxed structure agrees with the available theoretical and experimental results, which assess the accuracy of our calculations. The Born stability criteria, formation energy, and phonon dispersion curves reveal mechanical, thermodynamic, and dynamical stability of the studied compounds. The soft nature of the studied compounds is explained by the failure mode study. The different anisotropy indices indicate the anisotropic nature of the A2CrWO6. The electronic band structures reveal half-metallic and metallic behavior of the Sr2CrWO6 and Ba2CrWO6, respectively. The microscopic origin of the transformation from half-metallic to metallic nature is examined. The magnetic properties and their microscopic origin are explained. The different types of optical and thermodynamic characteristics are studied as well. The electronic and optical properties denote that A2CrWO6 can be a potential candidate for application to spintronic devices.

Keywords: Physical properties, Electronic properties, Optical properties, Thermodynamic properties, Spintronic devices, DFT

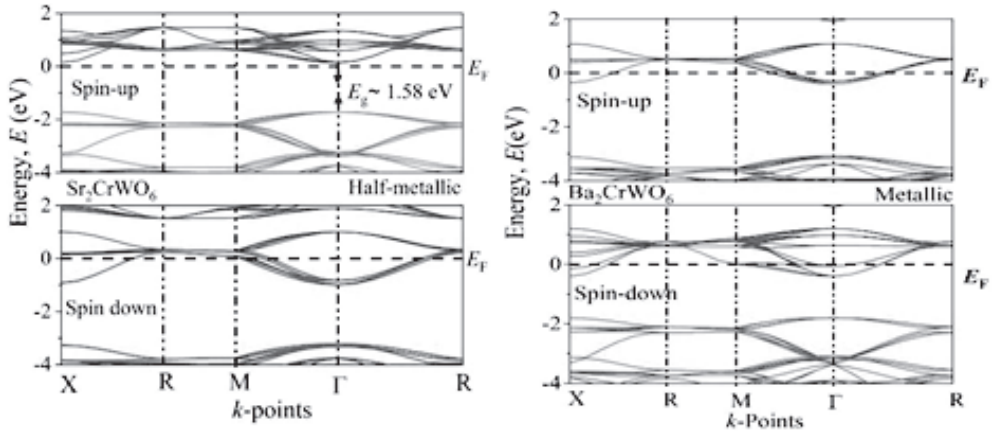

Figure 1: Spin-polarized electronic band structure of ferromagnetic A2CrWO6 within the DFT+U approximation.

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Abstract No: 107

Selective Separation Of Radiostrontium From Aqueous Waste Using Porous Macrocyclic Based Sorbent

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Abstract

Radiostrontium (r-Sr: 90Sr; t1/2, 28 yrs) poses severe environmental and health risks, particularly after nuclear accidents. Selective separation of r-Sr is therefore critical for remediation and monitoring. In this work, a porous macrocyclic based sorbent, created by grafting Di formyl dibenzo-18-crown-6-ether (DFDB18C6) onto amino-modified mesoporous silica (SBA-NH2) has been used for the selective removal of r-Sr from aqueous waste. The structural, morphological, and thermal characteristics of the sorbent were comprehensively investigated. The sorbent demonstrated high Sr sorption capacity at pH 6, reaching equilibrium within 6 h. Kinetic investigations showed that the sorption process followed pseudo-second order kinetics, whereas isotherm modeling demonstrated that the Langmuir model provided the most excellent fit, implying monolayer sorption. The thermodynamic study indicated that the sorption process is endothermic. The sorbent effectively removed 90Sr (~99.67%) from Chornobyl-derived radioactive wastewater in the presence of other ions, e.g., Ca2+, Mg2+, Na+, and K+. These findings underscore DFDB18C6@SBA-NH2 as a promising sorbent for r-Sr separation from aqueous waste matrices.

Key Words: Radiostrontium, Separation, Porous Macrocyclic-based sorbent, aqueous waste matrices

Abstract No: 108

Optimized D-Shaped PCF-SPR Biosensor Using HfO2 Adhesive Layer for MDA-MB-231 and MCF-7 Biomarker Detection

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Abstract

Early cancer detection is important for improving the survival rate since breast cancer is a serious public health concern. This paper introduces and analyses a novel surface plasmon resonance (SPR)-based photonic crystal fiber (PCF) biosensor for detecting breast cancer cells, specifically MDA-MB-231 and MCF-7 cell lines. The proposed design incorporates a thin layer of gold (Au) as the plasmonic material due to its excellent stability, while an adhesive layer of hafnium dioxide (HfO_2) is introduced to further enhance the sensor's sensitivity. A D-shaped structure is chosen to improve light-matter interaction, and periodic air holes around the fiber's core to enable effective coupling of the guided mode with surface plasmons. The finite element method (FEM) using COMSOL Multiphysics is used to optimize the HfAu-PCF sensor. Our objective is to take use of the special optical characteristics of Au and HfO2 that provide excellent performance metrics. By fine-tuning the air-hole diameter, core size, and layer thickness of the fiber, the proposed geometry is expected to achieve a confinement loss of approximately 165 dB/cm and a peak relative sensitivity within the refractive index (RI) range of 1.3–1.4 across the tested wavelengths. It is anticipated that MDA-MB-231 and MCF-7 cells will exhibit exceptional results in key performance parameters like wavelength sensitivity (WS), amplitude sensitivity (AS), sensor resolution (SR), and figure of merit (FOM), which have not yet been evaluated. This proposed biosensor has the potential to identify cancer cells, which could lead to early diagnosis.

Abstract No: 109

Assessment of Free Layer Volume Influence on switching energy, current, and stability of Spin-Transfer Torque Devices.

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Abstract

This study investigates the optimization of free layer volume in spin-transfer torque magnetic random-access memory (STT-MRAM) devices to achieve minimal switching energy while maintaining adequate thermal stability for reliable memory operation. Using a physics-based magnetic tunnel junction (MTJ) SPICE model, we systematically explore the relationship between free layer dimensions and key performance metrics through simulation-based experiments. This method is based on parametric analysis of the effects of free layer volume scaling, looking at changes in thickness from a few nanometers to several nanometers and changes in lateral dimensions across different technology nodes. The analysis also set material parameters like saturation magnetization, polarization, and magnetic anisotropy. Through systematic parametric sweeps of the free layer dimensions, the fundamental trade-offs between energy efficiency and device stability requirements are quantitatively assessed. The simulation framework predicts switching behavior under different operating conditions using realistic material properties and device physics. The findings highlight the size-scaling limits of STT-MRAM technology and offer design guidelines for optimizing free layer geometry for next-generation low-power, high-density memory applications in IoT and mobile

Keywords : STT-MRAM , Free layer optimization, Switching Energy, Spin-transfer torque (STT), Thermal stability.

Abstract No: 110

Spatio-Temporal Modelling of Solar Photovoltaic Potential across Sylhet District: A GIS-Based Multi-Criteria Approach for Sustainable Energy Planning

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Abstract

Sylhet District in northeastern Bangladesh possesses substantial yet underutilized solar photovoltaic (PV) potential, hindered by its complex topography and monsoon-influenced climate. This study bridges critical knowledge gaps by quantifying monthly capacity factors amid seasonal variability, assessing economically viable storage solutions for grid stability, and evaluating deployment strategies for sustainable energy planning. The research employs a high-resolution spatiotemporal model integrating Geographic Information System (GIS) with Multi-Criteria Decision Making (MCDM) and the Analytical Hierarchy Process (AHP). Key in puts include daily meteorological data (solar irradiation, rainfall, humid ity, and wind speed), Digital Elevation Models for terrain analysis, and historical extreme weather records. The model identifies the top 5% of land areas by monthly suitability for solar PV deployment, focusing on three archetypes: rooftop, floating, and degraded-land ground installations. Monthly capacity factors and levelized cost of electricity (LCOE) are estimated, accounting for monsoon-induced soiling and operational costs. Sensitivity analysis of AHP weights (±20% perturbation) ensures robustness in suitability assessments. Findings highlight high-potential zones in low-population regions with favorable topography, minimizing social displacement risks. The study delivers monthly capacity factor dis tributions, LCOE comparisons across deployment types, and optimized storage scenarios to achieve 80% grid firming. Additionally, lifecycle waste projections per MW and local recycling pathways are evaluated to address environmental sustainability. This work provides actionable insights for policymakers, aligning with Bangladesh's renewable energy goals and of fering a replicable framework for tropical regions facing similar seasonal challenges.

Keywords: Solar PV Potential, Spatiotemporal Modeling, GIS-MCDM, Analytical Hierarchy Process (AHP), Monsoon Climate, Energy Storage, Sustainable Deployment, LCOE.

Abstract No: 112

SPICE-Based Analysis of Thermal Effects on Magnetic Tunnel Junction Performance in STT-MRAM Applications

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Abstract

This study investigates the impact of thermal noise on the switching reliability and oscillatory behavior of spin-transfer torque (STT) magnetic tunnel junction (MTJ) devices through comprehensive SPICE-based simulations. A physics-based MTJ compact model is utilized to systematically analyze how temperature-induced magnetic fluctuations affect critical performance parameters in STT-MRAM and spin-transfer nano-oscillator (STNO) applications. The simulation framework incorporates random thermal noise fields to emulate realistic operating conditions across different temperature ranges. Two key aspects are examined: switching reliability under current pulse excitation and critical current threshold determination. For switching reliability analysis, controlled current pulses are applied while varying thermal noise levels, and switching probability, switching time distributions, and failure rates are measured across multiple simulation iterations. Critical current characterization is performed through stepwise current increases to identify the threshold. Oscillator performance is evaluated based on frequency spectrum analysis, line width broadening effects, and Q-factor degradation under thermal stress. Basic problems with the reliability of nanoscale magnetic devices are addressed, where thermal energy can be comparable to magnetic anisotropy energy and may lead to spontaneous switching events or switching failures. This simulation-based approach enables comprehensive statistical analysis without fabrication costs and supports the development of thermally stable magnetic devices for next-generation spintronic technologies.

Keywords: Magnetic tunnel junction (MTJ), Spin-transfer torque (STT), Thermal noise, Switching reliability, Critical current, Simulation.

Abstract No: 113

Vertical Wind Shear Dominates Over Sea Surface Temperature in Controlling Tropical Cyclone Persistence: A WRF-Based Analysis of Cyclone Remal (2024)

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Abstract

This study presents a comprehensive analysis of tropical cyclone persistence mechanisms using high-resolution WRF simulations of Cyclone Remal (May 2024, Bay of Bengal). We investigated the relative importance of thermodynamic factors (Sea Surface Temperature, moisture) versus dynamic factors (vertical wind shear) in controlling post-landfall decay. High-resolution WRF output, including twelve environmental predictors, was used, and an algebraic decay model was fitted to the storm intensity, yielding a half-life (τ) of 31.3 hours. The analysis revealed that optimal thermodynamic conditions (pre-landfall SST of 30.2°C and 99.9% atmospheric moisture retention) should have produced a persistence of $\tau \approx 173.6$ hours based on established global SST relationships (Li & Chakraborty, 2020; Phillipson & Toumi, 2021). However, Remal decayed 5.5 times faster than this prediction. This significant discrepancy is explained by the consistently high mean vertical wind shear of 19.3 m/s throughout the landfall period, which is well above the ≈10 m/s threshold known to inhibit cyclone structure (Chen et al., 2011). The dynamic forcing from wind shear completely dominated the decay process, overriding optimal thermodynamic conditions. The findings challenge the reliance on single-factor, SST-centric forecasts and necessitate the use of dynamic multi-factor models incorporating wind shear to accurately improve persistence forecasting for the Bay of Bengal region.

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Abstract No: 114

Strain Engineering and Hybrid Functional Insights into III–V Compounds and the 2D InSe Monolayer for Advanced Electronic Applications

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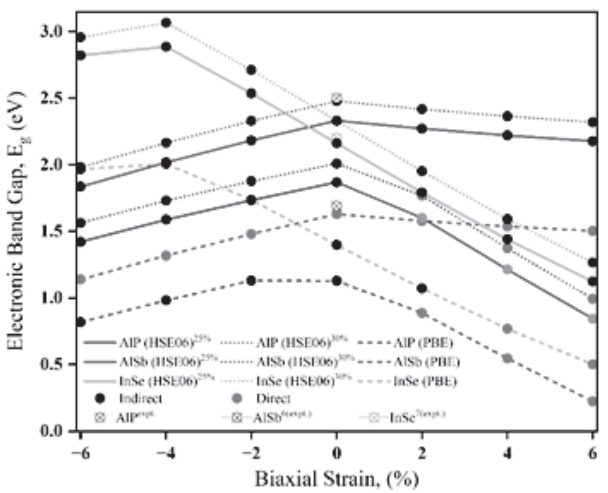
Abstract

Biaxial strain engineering represents a powerful strategy for tailoring the physical properties of semiconductors, providing unprecedented opportunities for advanced device optimization. This comprehensive study systematically investigates the strain-dependent structural, mechanical, electronic, and optical properties of bulk AlP, AlSb, and monolayer InSe through rigorous first-principles density functional theory calculations. The computational framework employs the projector augmented-wave (PAW) method implemented in VASP, utilizing both the generalized gradient approximation (PBE) and the screened hybrid HSE06 functional to enable robust comparative analysis. Phonon spectra calculations were performed at the PBE level using the finite displacement method implemented in Phonopy to assess dynamical stability comprehensively.

Under applied biaxial strain, AlP and AlSb undergo symmetry reduction, whereas InSe preserves its original lattice symmetry. Phonon calculations confirm dynamical stability throughout the −6% to +6% strain range, with only minor soft mode emergence observed at the Γ point for compressively strained InSe. The mechanical analysis reveals significant variations in elastic anisotropy under strain conditions, while optical absorption edges exhibit systematic shifts that correlate directly with the corresponding band gap evolution.

HSE06 calculations yield significantly more accurate and systematically larger band gaps compared to PBE predictions, with zero-strain values of 2.48 eV (AlP), 2.01 eV (AlSb), and 2.33 eV (InSe). Under applied strain conditions, both AlP and AlSb demonstrate non-linear band gap behavior, with AlSb undergoing a direct-to-indirect band gap transition under tensile strain. Notably, InSe exhibits the most pronounced band gap reduction under tensile strain, indicating exceptional sensitivity to lattice deformation.



These findings demonstrate that biaxial strain serves as a highly effective mechanism for modulating the optoelectronic properties of AlP, AlSb, and InSe, while emphasizing the critical importance of hybrid functionals such as HSE06 for achieving quantitatively accurate predictions essential for strain-engineered optoelectronic and nanoelectronics applications.

Abstract No: 115

Neutronic Assessment of SiC- and ZrC-Reinforced E110 Cladding for VVER-1200 Fuel Assembly Using OpenMC

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Abstract

Maintaining cladding integrity is important to avoid accidents in NPPs. There are several accidents happened in NPP due to cladding failure. For example, at Fukushima Daiichi (2011, Japan), a tsunami-induced station blackout led to loss of cooling, overheated zirconium cladding reacted with steam, generating large amounts of hydrogen and contributing to explosions and severe core damage. ATF (Accident-tolerant fuel) strategies can give a solution here. They try to incorporate cladding systems that improve oxidation resistance and strength. It may cause increase or decrease core reactivity in a range that is acceptable.

The paper focuses on analyzing zirconium–niobium (E110) cladding reinforced with silicon carbide and zirconium carbideas effective cladding material in VVER-1200 assembly. Using OpenMC we analyze the neutronic impact for 4.5 wt% U-235 UO_2 fuel. Behavior of E110 with E110+SiC and E110+ZrC is studied under same geometry, temperature and boundary conditions. Volume fraction of reinforcements were set at 2%, 5% and 10% in order to get reactivity and feedback trends. K-effective, burnup, spectrum shifts and reactivity coefficient relevant to safety were simulated. Depletion simulations are done to see isotopic evolution and burnup dependent reactivity behavior for each cladding type. All the factors of 6 factor formula is simulated, analyzed and compared for each reinforced claddings. The simulated value is compared to the value that we got directly from 6 factor formula. Fission, absorption and capture reaction-rate tallies were analyzed for each type of cladding.

The results indicate that SiC and ZrC reinforced E110 claddings are able to provide benefits with acceptable neutronic trade offs. They also have core-level follow up analysis and coupled neutronic-thermal hydraulic analysis.

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Abstract No: 116

Semiconducting and Self-Regulating Characteristics of BaTi0.80-Mo0.20O3 Ceramics for heat sink application on microprocessor

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Abstract

The temperature-dependent transport behavior of BaTi0.80Mo0.20O3 (BTMO) ceramics sintered at 1250 °C and 1350 °C was systematically investigated to explore their semiconducting nature and potential applications in thermistor and self-regulating devices. The BTMO samples exhibited a clear transition from a negative temperature coefficient of resistance (NTCR) to a positive temperature coefficient of resistance (PTCR) within the temperature range of 300–420 K, indicating semiconducting-to-insulating behavior across the ferroelectric–paraelectric transition. The PTCR effect was attributed to the formation of an n–i–n intergranular junction caused by a core–shell microstructure, where donor-type Mo6+ ions induced excess oxygen during sintering, creating space-charge regions at the grain boundaries. Activation energy values obtained from Arrhenius plots revealed two distinct conduction mechanisms corresponding to the ferroelectric and paraelectric regions. The BTMO sample sintered at 1350 °C exhibited higher PTCR sensitivity (+3.1% K-1 at 410 K) than the sample sintered at 1250 °C, due to improved grain growth and barrier potential at the grain boundaries. These findings demonstrate that 20% Mo-doped BaTiO3 ceramics exhibit excellent self-regulated heating and overcurrent protection characteristics, making them promising candidates for temperature sensors, thermistors, and energy-efficient electronic components.

Keywords: Mo doped BaTiO3, Transport properties, Activation energy, self-regulating heater.

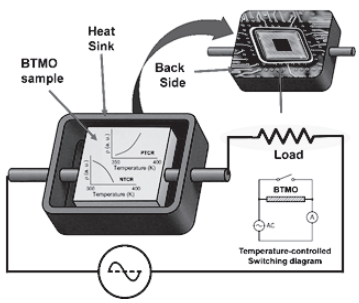

Fig.1. A prototype model of the heat sink with self-regulating heaters and circuit protection made of Mo-doped BaTiO3 designed to be used underneath of circuit (microprocessor)

Abstract No: 117

Star-Shaped Photonic Crystal Fiber Coated with Silver-Graphene Layers for Monitoring Water Pollution

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Abstract

The finite element method (FEM) is used to build and numerically analyze a surface plasmon resonance (SPR) sensor based on photonic crystal fiber (PCF) coated with silver–graphene layers for the purpose of detecting water pollution through refractive index (RI) sensing. The suggested construction has air holes organized in a star pattern on a silica basis. The presence of two different air-hole diameters results in the introduction of birefringence properties. Applying a graphene coating to the silica's exterior creates a dielectric layer that is very resistant to oxidation. A silver coating is subsequently applied on top of the graphene for plasmonic interaction. Graphene layer enhances overall performance of the PCF sensor. On the outermost surface, the silica-based perfectly matched layer (PML) is placed to reduce interference from the environment. Analyte RI ranges from 1.35 to 1.46, the linear sensing area spans from 1.35 to 1.38, and the sensor's highest sensitivity expected around 12,800 nm/RIU. It is expected that this work shows strong promise for future biosensing applications and water pollution monitoring.

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Abstract No: 118

Thermal Performance Improvement of Zr-1%Nb (E110) Cladding Reinforced with 2–15% SiC Nanoparticles for VVER-1200 Fuel Rods Using ANSYS

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Abstract

The thermal performance of fuel cladding is very important for nuclear reactor safety. The outer fuel rod barrier is cladding, used to prevent the emission of radioactive fission products and helps to transfer heat between fuel and coolant in nuclear reactor. In VVER-1200 nuclear reactor, which is a pressurized light water reactor (PWR) uses Zr-1%Nb (E110) as a cladding material for fuel protection. The thermal performance of Zr-1%Nb (E110) cladding reinforced with 2–15% silicon carbide (SiC) nanoparticles using ANSYS simulations are shown in this study. The characteristics of SiC nanoparticle has high thermal conductivity, excellent temperature stability and corrosion resistance. This can enhance the performance of conventional E110 cladding. Adding SiC nanoparticle in cladding material of VVER-1200 reactor improves heat flow, reduces peak fuel temperatures, spreads heat more evenly and lowers thermal stress in the cladding. Adding 2-5% of SiC in E110 Cladding, which is lower percentage can moderately decrease the peak fuel temperature. But when higher amount of SiC nanoparticle is added in the E110 Cladding, the temperature at the fuel center drops. adding higher percentage of SiC nanoparticle make heat transfer more efficient, minimize hotspots, and increase fuel safety margins, making the cladding more tolerant to accident conditions. Gradually Increasing SiC nanoparticle content in E110 Cladding from 2% to 15% improves temperature distribution and reduces the temperature difference between the fuel center and cladding surface. These enhancements in VVER-1200 reactors demonstrate that E110-SiC composite cladding could be a viable accident-tolerant fuel (ATF).

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Abstract No: 119

Design and Realization of Plasmonic Solar Cell Platform

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Abstract

In this study, we discuss a strategical approach to design a plasmonic solar cell platform via optimizing shell thickness of core(metal)@shell(semiconductor) nanoparticles(NPs). The Ag@TiO2 NPs were synthesized by bottom-up method and characterized by SEM-EDS and TEM images. The SEM-EDS analysis revealed the presence of Ag, Ti, and O, which is consistence with the precursor materials. The TEM images of Ag@TiO2 NPs confirmed the core-shell NPs and showed optimized shell thickness is 2nm while simultaneous absorption-scattering peaks appeared, monitored using UV-Vis. spectroscopy. As prepared, the Ag@TiO2 NPs were deposited onto a solid support(glass/quartz) and thin films of the etched and unetched NPs were prepared to extract optical properties. The thin film of etched NPs showed SPR absorption in the visible region, peak centering at 458nm while the unetched NPs showed no absorption except two scattering peaks at 491nm and 641nm respectively. Electrochemical analysis, including voltametric measurements, will be conducted to evaluate the photo-generated current density and photon-to-current conversion efficiency of the thin films. Preliminary observations suggest that optimizing the shell thickness significantly enhances plasmon-induced charge separation and photocurrent generation efficiency, demonstrating the potential of $Ag@TiO_2$ nanostructures for plasmonic solar energy conversion.

Key Words: SPR absorption, acid-etching method, thin film, photocurrent, optical properties, core-shell NPs

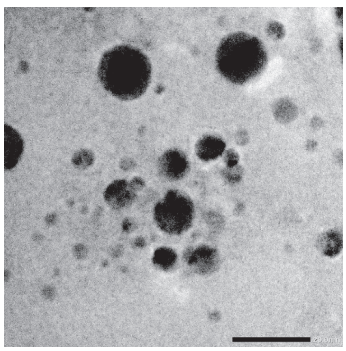

Figure: TEM image of $Ag@TiO_2$ NPs

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Abstract No: 120

Modulation of peripheral blood flow due to Pulsed Electromagnetic Field Exposure: A Prototype study

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Abstract

Pulsed Electromagnetic Field (PEMF) stimulation has shown promise in vascular modulation; however, the underlying physical mechanisms influencing blood flow remain insufficiently characterized. This study presents a controllable in-vitro prototype developed to replicate peripheral arterial flow and quantitatively assess the hemodynamic effects of PEMF using Doppler ultrasound. A 2 mm-radius saline channel, driven by an Arduino-controlled DC motor, generated pulsatile flow patterns approximating 60 cycles per minute, closely resembling physiological arterial rhythm. The PEMF was applied using a 200-turn solenoidal coil energized at 24 V, delivering 100 µs square pulses at 10 Hz, positioned 8 cm away from the probe. Doppler audio signals were recorded at 48 kHz under PEMF and non-PEMF conditions and analyzed in MATLAB to extract over 30 parameters, including velocity indices, acceleration metrics, and velocity-area ratios.

When the coil was placed flat over the flow channel—creating a transverse magnetic field (B flow) and an induced axial electric field (E flow)—distinct hemodynamic modulations were observed. Compared to baseline, Peak Systolic Velocity decreased slightly (−1.3%), while Peak Diastolic Velocity increased (+5.9%) and Time-Averaged Velocity rose markedly (+14.3%), indicating smoother and more sustained flow. Flow displacement increased by 10%, alongside a moderate rise in Resistive Index (+6%) and higher systolic and diastolic area-to-peak ratios (+8% and +2%), reflecting a redistribution of flow energy toward a steadier waveform.

These findings suggest that PEMF exposure induced mild magnetic damping of ionic motion during systole and enhanced diastolic recovery through Lorentz-force–mediated modulation of ionic currents. The combined effect of the transverse magnetic field and induced axial electric field likely promoted boundary-layer thickening and flow stabilization, yielding a more resistive yet uniform hemodynamic profile. Overall, the results align with the proposed magnetohydrodynamic hypothesis that PEMF can modulate ionic transport and flow dynamics under controlled in-vitro conditions.

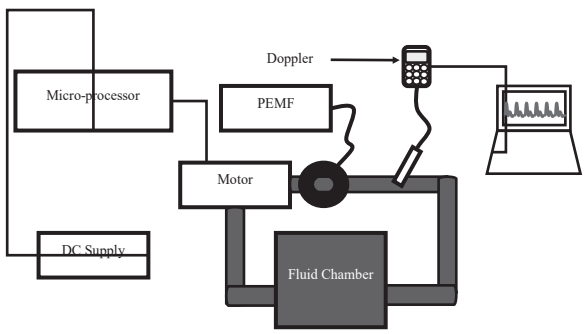

Figure: Block diagram of the experimental setup.

Abstract No: 122

Advanced SCAPS-1D Simulation of Multi-Junction Lead-Free Perovskite Solar Cells Based on Bismuth-Based Halides.

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Abstract

This study proposes a novel numerical investigation of triple-junction bismuth-based halide(CH_3NH_3I,Cs3Bi2l9, etc) perovskite solar cells utilizing the SCAPS-1D simulation environment. The research aims to design an innovative lead-free photovoltaic architecture incorporating three distinct perovskite absorber layers with graded band gap engineering to maximize spectral absorption and carrier collection efficiency. Bismuth-cobalt halide perovskites, selected for their environmental benignity and improved stability relative to tin-based alternatives, form the basis of this device structure. Advanced interface grading and tunnel junction optimization are implemented within SCAPS-1D to minimize recombination losses and facilitate efficient intercell charge transport. The simulation framework employs multi-objective optimization techniques to fine-tune layer thicknesses, doping densities, and defect parameters for performance maximization. The expected outcomes include achieving power conversion efficiencies exceeding 30% with enhanced stability and reduced toxicity. This work aims to set a new paradigm in sustainable, high-efficiency perovskite photovoltaics by exploring an uncharted material system and sophisticated multi-junction device design.

Keywords: Bismuth-base , halides,Lead-free, perovskites,riple-junction, solar cells, SCAPS-1D simulation

Abstract No: 124

An Investigation on the Efficiency of CIGS solar cell by applying ZnSe buffer layer and Zn-MgO Electron Transport Layer: A Simulation Approach by SCAPS-1D

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Abstract

In this work, a high-efficiency CIGS solar cell structure incorporating two absorber layers (CIGS and Si) was investigated using the SCAPS-1D simulation tool. This work focuses on evaluating the effects of varying thickness, bandgap, donor density, and acceptor density across four functional layers: the CIGS and Si absorbers, the ZnSe buffer layer, and the ZnMgO electron transport layer (ETL). The study reveals that the device achieves a maximum power conversion efficiency (PCE) of 34.88%, corresponding to an open-circuit voltage (Voc) of 0.9390 V, a short-circuit current density (Jsc) of 47.98 mA/cm², and a fill factor (FF) of 77.41%, obtained at a CIGS bandgap of 1.0 eV. Additionally, the study found that the CIGS absorber layer with 1.5 μm thickness shows the highest efficiency, while the thickness variations of the ZnSe buffer and ZnMgO ETL layers have minimal influence on overall device performance. When the bandgap of the CIGS absorber layer was varied from 1.0 to 1.7 eV, the PCE showed a significant change, ranging from 31.48% to 34.88%. Furthermore, the variations in acceptor density of the Si absorber and donor density of the buffer and ETL layers did not cause significant changes in the device performance. This simulation-based study offers valuable insights into optimizing CIGS-based double-absorber and eco-friendly ETL designs, contributing to the development of next-generation high-efficiency thin-film solar cells.

Abstract No: 125

Mathematical Modelling of Binary Stability: From Gravitational Binding to Evolutionary Disruption

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Abstract

Binary stability is a self-regulating equilibrium where the balance between gravitational binding and evolutionary perturbations determines whether two stars will remain together or drift apart over the course of time. This study follows an approach to build a complete mathematical model/-framework of binary stability that will minimize the gap between gravitational binding dynamics and evolutionary perturbations like mass transfer, radiation pressure or changes, magnetic braking etc. To derive the conditions of pseudo-binary star system, we combine Lagrangian stability analysis with energy-momentum invariants. Our approach aims to unify the predictive capacity of existing numerical models such as RMHD, MHD, SPH, Disk Fragmentation Model etc. The model self-consistently combines the evolution of gravitational potential, angular momentum exchange, and energy decay processes to evaluate criteria for determining long-term binary stability. Within a single framework which will be able to define dimensionless stability parameters that can determine when the binary star system transitions from being in gravitational equilibrium i.e. in stable condition to eventual disruption and vice-versa. Ultimately, our attempt lays down the foundational work for a universal stability map for binary and pseudo-binary star formation. The simulation results show that even small changes in accretion asymmetry or magnetic flux density can significantly affect the binding energy limit, causing the system to be in a stable, quasi-stable, or disrupted state. This can largely influence the stellar evolution codes, population synthesis and interpretation of binary-derived gravitational wave-source.

Keywords: Binary Star Stability, Gravitational Binding Energy, Dynamical Disruption, Stellar Evolution Modelling, Two-body Evolution.

Abstract No: 127

Controlled Deposition of Photothermally Active Ag@TiO2 Coreshell onto Nano-cellulose Hydrogels Matrix for the Application of Wound Healing

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Abstract

Binary stability is a self-regulating equilibrium where the balance between gravitational binding and evolutionary perturbations determines whether two stars will remain together or drift apart over the course of time. This study follows an approach to build a complete mathematical model/-framework of binary stability that will minimize the gap between gravitational binding dynamics and evolutionary perturbations like mass transfer, radiation pressure or changes, magnetic braking etc. To derive the conditions of pseudo-binary star system, we combine Lagrangian stability analysis with energy-momentum invariants. Our approach aims to unify the predictive capacity of existing numerical models such as RMHD, MHD, SPH, Disk Fragmentation Model etc. The model self-consistently combines the evolution of gravitational potential, angular momentum exchange, and energy decay processes to evaluate criteria for determining long-term binary stability. Within a single framework which will be able to define dimensionless stability parameters that can determine when the binary star system transitions from being in gravitational equilibrium i.e. in stable condition to eventual disruption and vice-versa. Ultimately, our attempt lays down the foundational work for a universal stability map for binary and pseudo-binary star formation. The simulation results show that even small changes in accretion asymmetry or magnetic flux density can significantly affect the binding energy limit, causing the system to be in a stable, quasi-stable, or disrupted state. This can largely influence the stellar evolution codes, population synthesis and interpretation of binary-derived gravitational wave-source.

Keywords: Binary Star Stability, Gravitational Binding Energy, Dynamical Disruption, Stellar Evolution Modelling, Two-body Evolution.

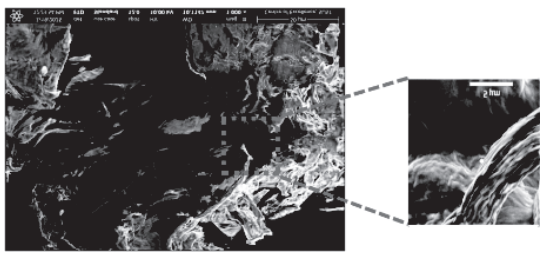

Figure: SEM Image of nanocellulose phosphate at two magnifications

Abstract No: 129

Spectroscopy-Based Tracking and Timing Calorimetry for Enhanced Sensitivity in Muon–Electron Conversion Searches

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Abstract

Charged lepton flavor violation (CLFV) in muon–electron conversion refers to one of the new physics beyond the Standard Model theories. In this work, we are exploring an alternative configuration - multiple stopping-target design results in increased muon-stopping rate, improved background suppression and enhanced detector efficiency. Using detailed GEANT4 simulations, we evaluate a spectroscopy-based dual-purpose tracker-calorimeter that can disentangle electrons from different origin via energy and timing measurements. For separating the contribution of different stopping-targets, we propose a dual approach combining energy spectroscopy and time evolution. The proposed high-resolution momentum tracking is approximately ~100 KeV for the near endpoint energy to be distinguished from signal peak. Our work indicates to push ΔE to ~50 - 100 KeV to allow target separation. This indicates a factor of 2-3 improvement over the Mu2e's baseline resolution (~200 KeV). The assumed timing precision is around 0.5 ns to 1 ns, ideally 0.2 ns, which allows clean rejection of prompt backgrounds. Our procedure requires ultrafast crystal calorimetry (e.g., BaF2, LYSO, etc.) coupled with SiPM readout for achieving timing resolutions below 500ps. The results indicate that a spectroscopy-driven calorimeter can significantly reduce background leakage while maintaining high signal efficiency, aiming at sensitivities around ~(1-1.5)×〖10〗^(-17), tightening constrains on Effective Field Theory Wilson coefficients by approximately a factor of 2. This framework demonstrates the procedure of multiple stopping-target geometry and spectroscopy-based tracking, resulting a significant technological advancement in maximizing discovery potential in CLFV searches.

Keywords: Charged Lepton Flavor Violation (CLFV), Spectroscopy-based calorimetry, High-resolution tracking, Decay-in-orbit, Leptoquark, SUSY

Abstract No: 130

An Artificial Intelligence Approach Towards Noise Analysis In Electrical Circuits Using Neural Networks And Reinforcement Learning

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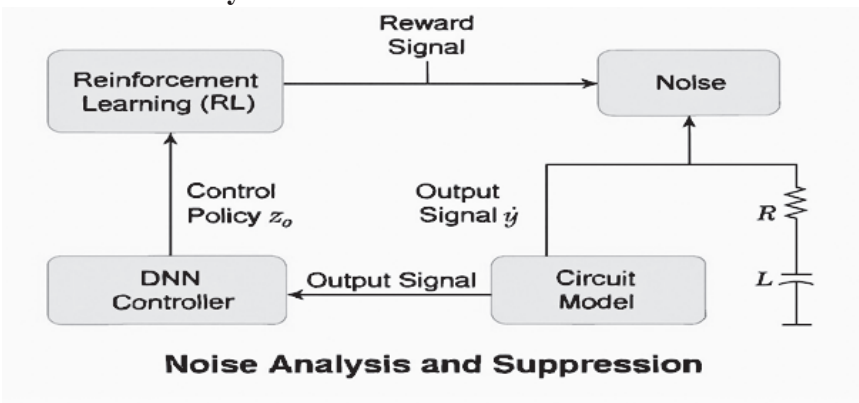
Abstract

Noise in electrical circuits poses a persistent challenge to the reliability and efficiency of electronics systems. Conventional analytical and statistical tools have often failed to measure the nonlinear, dynamic and stochastic nature of noise propagation. This study presents an artificial intelligence driven approach which employs reinforcement learning and deep neural networks to model, predict and mitigate noise in electrical circuits.

This proposed methodology employs reinforcement learning agents which adaptively optimize noise suppression strategies under varying circuit conditions, while neural networks work to approximate complex nonlinear mappings between input disturbances and output responses. Circuit models were simulated using LTSpice with injected Gaussian and Non Gaussian noise sources in order to generate training and validation datasets. The RL agents learned control policies which succeeded to minimize distortions and the DNNs achieved high predictive accuracy across multiple frequency bands.

This integrated system was evaluated against conventional filtering and regression techniques. Results show a 25 percent reduction in mean squared error for noise prediction and an 18 percent improvement in signal to noise ratio on benchmark test circuits, demonstrating the framework's ability to adaptively suppress noise.

Figure 1. Process Of The Analysis



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Abstract No: 134

Optoelectronic and Kinetic Properties of Pt-Bipyridine Complexes as Triplet Emitters in OLEDS: A Computational Study

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Abstract

In recent years, there has been much interest in the organometallic complexes that contain transition metals in the center. In this work, we aim to perform computation on the two Pt-bipyridine complexes, Pt-biPy-CH3 and Pt-biPy-Ph, to investigate their potential as triplet emitters. We used density functional theory (DFT) to observe the strength and effect of spin-orbit coupling due the presence of platinum. We optimize the geometry of the complexes in ground and excited states using Gaussian 16w software package utilizing APFD functional and mixed basis sets, SVP for C, H, N and LanL2DZ for Pt. Both platinum complexes have large HOMO-LUMO separations of 2.31 eV and 2.40 eV leading to small energy gaps between the lowest excited singlet and triplet states (ΔEst) of 0.13 eV and 0.15 eV which is ideal for intersystem crossing (ISC) from singlet excited state, S1 to triplet excited state, T1. We calculated the spin-orbit coupling matrix elements (SOCME) using Orca 5.0.3 software which revealed strong SOC between S1 and T1 due to the presence of heavy platinum atoms. Using the values of ΔEst, SOCME and reorganization energy, we find the rates of ISC (KISC) of the order of 1013 s-1 and 1010 s-1, respectively, for Pt-biPy-CH3 and Pt-biPy-Ph complexes. Such extremely high KISC values make these Pt-bipyridine complexes perfect candidates as triplet emitters in organic light emitting diodes.

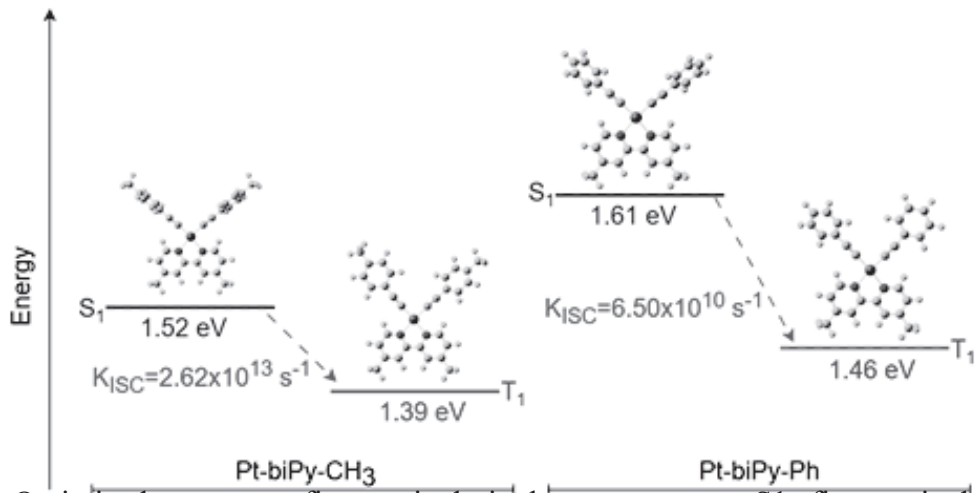

Figure: Optimized geometry, first excited singlet state energy, S1, first excited triplet state energy, T1, and rate of intersystem crossing from S1 to T1 state, KISC of Pt-biPy-CH3 and Pt-biPy-Ph complexes.

Abstract No: 135

AI-Based Inverse Design of Metamaterials for Electromagnetic Cloaking

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Abstract

The advancement of electromagnetic cloaking has emerged as a transformative technology capable of guiding incident waves around objects to achieve near-invisibility. Traditional metamaterial design techniques, largely dependent on transformation optics and iterative parameter sweeping, suffer from long simulation times, high computational demands, and limited adaptability across frequency ranges. To address these challenges, this paper proposes an artificial intelligence (AI)-driven inverse design framework that enables rapid and accurate prediction of metamaterial geometries and material parameters for electromagnetic cloaking applications. A comprehensive dataset of unit cell structures was generated using full-wave CST simulations, incorporating variations in geometric dimensions, substrate materials, and operating frequencies. A deep neural network (DNN) was first trained to learn the forward mapping between design parameters and electromagnetic responses. Subsequently, a conditional generative adversarial network (cGAN) was developed to perform the inverse task predicting optimal structural configurations based on desired scattering or reflection profiles. Physics-informed constraints were integrated to ensure compliance with Maxwell's equations and practical realizability. Simulation results demonstrated that the AI-generated metamaterials achieved significant cloaking efficiency with a mean absolute prediction error below 3% while reducing the overall design cycle time by more than 90% compared to conventional methods. The proposed framework ensures superior efficiency improvement due to AI-driven inverse design and marks a substantial step toward intelligent metamaterial engineering, enabling adaptive, broadband, and low-cost electromagnetic cloaks for future stealth and communication applications.

Table 1. Cloaking Performance Comparison

Design Method	Bandwidth (GHz)	RCS Reduction (dB)	Simulation Time (min)	Design Iterations
Traditional Parametric Sweep	1.5	15	320	40
GA Optimization	2.1	18	220	25
Proposed AI-Based Design	3.4	25	25	1 (instant)

Table 1 presents a performance comparison of different cloaking design methods. It clearly shows that the proposed AI-based design achieves the highest RCS reduction and widest bandwidth with minimal simulation time and iterations.

Abstract No: 137

Structural, Optical, and Electrical Properties of FAPbI3 Perovskite Film and Simulation of the Perovskite Solar Cells

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Abstract

Extensive research is continuing around the globe on the Perovskite Solar Cells (PSCs) to exceed their present power conversion efficiency (PCE) of 26.95%. This work is focused towards investigating the factors that effects the PCE of PSCs. Here, we have fabricated a FAPbI3 film of 565 nm thickness inside a Nitrogen Filled glove box to maintain the inert atmosphere. One step spin coating technique has been followed to fabricate this perovskite film. Structural, optical, and electrical characterization were performed. XRD and SEM of the film were recorded to confirm the formation and to investigate the surface morphology, respectively, of the perovskite film. From the optical absorption spectroscopy, we find the band gap of 1.56eV. Bulk carrier concentration, mobility, conductivity etc. of the film were obtained from Hall effect measurements. Employing the parameters obtained from our experimental investigations and from literature, we have designed and simulated a perovskite solar cell of the device architecture FTO/TiO2/ FAPbI3 Perovskite/Sprio-OMeTAD/Ag utilizing Solar Cell Capacitance Simulator1D (SCAPS 1D) software. We find a short circuit current density of 23.88 mA/cm2, open-circuit voltage of 1.25 V, fill factor of 86.72 % and a significantly enhanced PCE of 25.91%.

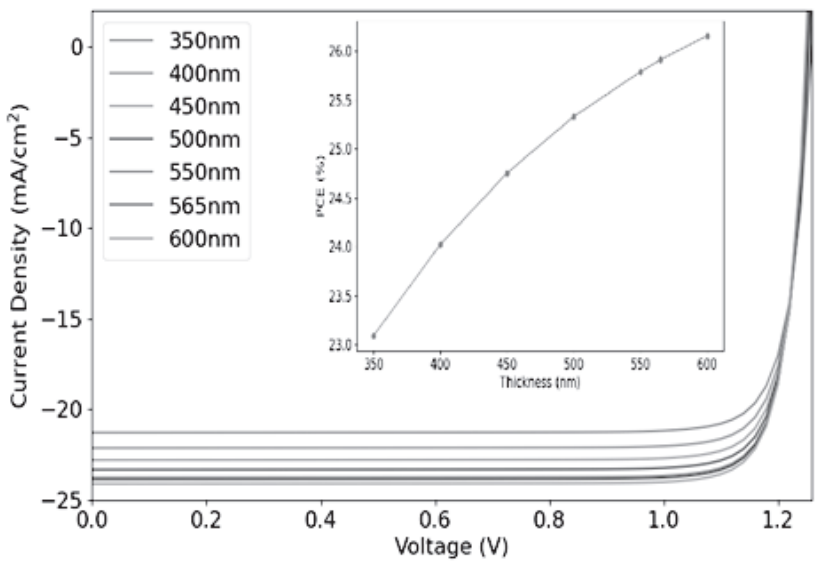

Figure: Current-voltage curves and PCE for different thicknesses of FAPbI3 films

Abstract No: 138

Photoelectric effect on dust acoustic mode in ionospheric dusty plasmas with dust charge fluctuation

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Abstract

In ionosphere, micron or sub-micron sized charged dust grains are present and formed dusty plasmas. In such plasma, dust grains can be charged by absorbing electrons and ions streaming onto their surface. Since the streaming velocity of electrons is much more than that of the ions, they readily sit on the surface of the dust grains and make them negatively charged. The dust charge can be negative in irradiated dusty plasmas when the irradiation frequency becomes less than the threshold frequency of the dust grain material, otherwise the dust grains become positively charged.

In this paper, we have studied the instability of the dust acoustic (DA) mode in irradiated, streaming dusty plasmas to understand the photoelectric effects on the plasma properties in the space and laboratory dusty plasmas. In this study, the radiation effects on DA mode are included through the dust charge fluctuation. So far, in the dust charge fluctuation model, the piled-up electrons on the dust grains are neutralized through the absorption of ions by the dust grain. On the other hand, in the present dust charge fluctuation model, photoelectron emission is included. In this model, the piled-up electrons on the dust grains are considered to be reached to its equilibrium value through the combined effects of absorption of ions by the dust grain and the emission of electrons from the dust grain surface by irradiation. In this case, it is considered that the work function of the dust grain's material is higher than the photon energy and hence, the dust grains are negatively charged.

It is found that the DA mode becomes unstable significantly due to photoelectric effect compared to the streaming of lighter particles and collision of the charged particles with the neutrals in un-magnetized dusty plasmas. Since, the instability of the DA mode due to photoelectric effect make the dusty plasma unstable, i.e., plasma parameters such as plasma density and temperature are fluctuated, it is thus concluded that the present study should be applied specially in understanding the formation of radar echoes in the polar mesosphere and communication of information from satellite to the Earth in the presence of solar radiation.

Abstract No: 139

Synthesis and Characterization of Sm Doped Cu -Zn Ferrite for High Frequency devices

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Abstract

The present research investigates the influence of Samarium (Sm) doping on the structural, magnetic, and electrical properties of Cu-Zn ferrites. Ferrite samples with the composition Cu0.85Zn0.15SmxFe2-xO4, where x=0.00, 0.015, 0.035, and 0.075 were synthesized using the conventional solid-state reaction method. The samples were pre-sintered at 850 °C for 4 hours and subsequently sintered at 1150 °C for 3 hours. Phase identification and lattice parameter determination were carried out using X-ray diffraction (XRD). The XRD results confirmed the formation of a single-phase cubic spinel structure in all samples, with no evidence of secondary phases. A gradual increase in lattice parameter with Sm doping was observed. While the bulk density slightly decreased with increasing Sm content, the X-ray density showed a continuous rise across the doping range. Microstructural analysis was performed using Scanning Electron Microscopy (SEM). SEM micrographs revealed a homogeneous surface morphology characterized by well-defined, nearly spherical grains. The average grain size, calculated using ImageJ software, was found to increase with Sm concentration. The magnetic permeability, dielectric properties, loss tangent, and quality factor of the samples were investigated over a frequency range of 1 kHz to 120 MHz using an impedance analyzer. The results of all samples reveal that the real part of the magnetic permeability initially decreases at lower frequencies but shows an increasing trend at higher frequencies. Both the magnetic loss tangent ($\tan\delta_m$) and dielectric loss tangent ($\tan\delta_e$) were found to decrease with increasing Sm^{3+} concentration. Consequently, the Sm-doped samples exhibited enhanced magnetic and dielectric quality factors compared to the undoped sample. Additionally, the incorporation of Sm significantly improved the conductivity characteristics of the Cu0.85Zn0.15SmxFe2-xO4 system. These combined enhancements suggest that Sm^{3+}-doped Cu-Zn ferrites hold great potential for use in advanced magnetic and electronic devices.

Table1: For 1KHz frequency the comparison between permeability, magnetic loss tangent, dielectric constant, dielectric loss tangent of Cu0.85Zn0.15SmxFe2-xO4, [Where x=0.00, 0.015, 0.035, and 0.075] ferrites sintered at 11500 C holding time 3 hours.

Content	Magnetic Permeability	Dielectric Constant	Magnetic Quality Factor	Dielectric Quality Factor
x = 0.00	110.85941	555.02542	0.11074	0.42113
x = 0.015	155.21533	19.50223	0.15092	1.36352
x = 0.035	152.761	71.68773	0.14015	0.92183
x = 0.075	136.04891	416.03507	0.12387	0.59427

Abstract No: 140

Title: Application of Bloom's Taxonomy in Teaching Physics: A Critical Analysis

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Abstract

This study critically examines the application of Bloom's Taxonomy in the teaching of Physics at the secondary school level in Bangladesh. Guided by the cognitive framework of Bloom's hierarchical model, the research explores how teachers interpret, implement, and integrate various cognitive levels ranging from knowledge to evaluation—within instructional and assessment practices. Adopting a qualitative research design, data were collected through in-depth interviews and focus group discussions (FGDs) with secondary-level Physics teachers from diverse educational settings. The study aims to understand the extent to which Bloom's Taxonomy informs lesson planning, teaching strategies, and evaluation methods, while also identifying challenges encountered by teachers in applying this pedagogical framework. Findings are expected to reveal variations in teachers' conceptual understanding and classroom application, alongside systemic constraints such as limited training, rigid curricula, and exam-oriented teaching cultures. The research further seeks to propose contextually relevant strategies for enhancing the effective use of Bloom's Taxonomy in Physics instruction. By critically analyzing current practices and offering informed recommendations, this study contributes to improving pedagogical quality, promoting higher-order thinking skills, and fostering meaningful learning experiences within Bangladesh's secondary education system.

Keywords: Bloom's Taxonomy, Physics Education, Qualitative Research, Teaching Practices.

Abstract No: 141

Risk assessment of natural and artificial radioactivity levels in sediment and surface water samples from Bhairab and Rupsha River from Khulna, Bangladesh

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Abstract

Radioactivity naturally occurs in the environment. River biology and mineralogical properties in the catchment area determine a river's radioactive content. The main causes of naturally occurring radionuclides in sediments include rainfall and other depositional phenomena like gravitational settling and precipitation, as well as weathering and recycling of terrestrial minerals and rocks (igneous or metamorphic) containing 40K and radionuclides of the uranium and thorium radioactive series. The purpose of this study was to establish a baseline background for the region and conduct a thorough radiological assessment of natural and human caused radioactivity for river water and sediment samples from the Bhairab and Rupsha rivers in Khulna. The samples were analysed using a gamma ray spectrometer equipped with a high-purity germanium (HPGe) detector. Five water and five sediment samples were taken at five distinct locations over a 10-kilometer stretch for the Bhairab and Rupsha rivers in Khulna, Bangladesh. The researched area's radiation dangers were computed. The study's findings may be crucial baseline radiometric data for next epidemiological investigations and local monitoring programs.

Keyword: Radioactivity, Environment, Gamma spectrometry, River.

Abstract No: 142

The Investigation of the Cancer Cell's Fate by Integrating Agent-Based Modeling and Predictive Machine Learning

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Abstract

It is well established that microenvironmental stressors such as hypoxia and mechanical pressure influence cancer cell fate, the exact order in which these factors act is still unclear. To explore this, we developed a combined computational and machine-learning approach. We first used the PhysiCell agent-based model to simulate a 3D tumor and ensure that model accurately reproduced fundamental aspects of tumor biology. Following successful model validation, we ran a high-throughput 2D version to generate enough data for a detailed analysis. Interestingly, the simulated tumor grew in a way that followed a logistic pattern and limited by a carrying capacity of approximately 10,800 cells within the quazi-2D simulation domain. This growth wasn't random, it emerged from a self-organized microenvironment, with a hypoxic core (median and a mechanically stressed edge (median We then trained a Random Forest classifier using only environmental and spatial features, and it predicted single-cell fate with 97.3% accuracy. The most striking finding was that oxygen availability stood out as the dominant factor, contributing more than half (53.2%) of the predictive power. We also noticed that nuclear shrinkage (pyknosis) consistently marked apoptotic cells.

Keywords: Cancer cell fate, Agent-based modeling, Machine learning, PhysiCell simulation, Hypoxia and mechanical stress

Abstract No: 143

Impact of GPS Sensor Tracking on Astronauts' Retina to outbreak of unexpected eye disease

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Abstract

Human space travel is closely linked to the prevalence of satellite sensor technology throughout the universe. Space travel is a wonderful adventure for mankind. Astronauts are using advanced satellite sensor technology, but no one is fully aware of its effects on the retina during space travel. Space experts and health professionals have been unable to determine the root cause of astronauts' illnesses for several years. To determine the effects of satellite GPS sensor tracking on astronauts' eyes and to create a globally unique model based on their travel potential. Primary field surveys were used to collect data on retina, human travel and atmospheric digital activity through GPS sensor tracking, while secondary data was collected from various sources. The study evaluated the effect of ISNAPHO in the laboratory, testing it in light and dark environments at specific GPS locations on the eyes of animals. The study found that people are getting sick instantly due to GPS gravity passive sensor tracking on specific parts of the body and the level of illness is also increasing due to the increase in the level of e-body code. GPS sensor tracking is being done in people's eyes using device that causes eye diseases, and they were all feeling sick with eye inflammation due to photoreceptor code activation in the cloud satellite sensor network. The study also noted that due to the lack of adequate security, cybercriminals are using satellite GPS sensor tracking systems to digitally control spacecraft and astronauts. The study found that astronauts face the threat of disease-causing sensor tracking from digital killers in space travel. Personal body area sensor network control units are essential for astronauts, but such awareness is not widely recognized and safety assurance support for space travel is still poor. These results reflect the importance of state provided health protection for astronauts in space travel.

Keywords: Sensor tracking, Retina code, Space travel, eye disease, protection.

Abstract No: 145

Wigner-based Monte Carlo Simulation of Three-Flavor Neutrino Oscillation in Vacuum

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Abstract

Neutrino oscillation refers to the transition between different neutrino flavor states during propagation, as a direct consequence of neutrinos having non-zero and non-degenerate masses. The phenomenology of neutrino oscillation marks the first experimental evidence of physics beyond the standard model and is typically studied within a simple quantum mechanical framework, in which neutrino flavor states are treated as a coherent superposition of mass eigenstates, each undergoing Schrödinger-like time evolution. In this work, we present a phenomenological description of three-flavor neutrino oscillation in vacuum, employing the Wigner representation of quantum mechanics as an alternative framework. We adapt a Monte Carlo method based on the Wigner formalism, utilizing the quasi-probability distribution function and density matrix in Wigner phase-space, to demonstrate the real-time evolution of neutrino mass eigenstates, where conventional Monte Carlo approaches prove inadequate. We make use of the rich Wigner phase-space structure to study the real-time propagation of neutrino wave packets and to derive neutrino flavor transition probabilities. Our results highlight CP violation, decoherence due to wave-packet separation, the evolution of von Neumann entropy as a measure of decoherence, and the intrinsic phase-space dynamics of neutrino oscillation within the Wigner formalism of quantum mechanics.

Abstract No: 146

Electronic and Charge Transport Properties of Metal Bathocuproine complexes utilizing Quantum Chemical Calculation

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Abstract

Bathocuproines (BCPs) have been used in organic light emitting diodes and organic photovoltaic cells due to their versatile functionality, including hole-blocking, exciton-blocking layer, electron transport medium and buffer layer. However, the charge transport behavior of BCP is limited because of its wide bandgap. Therefore, we theoretically investigated the electronic and charge transport properties of Metal-Bathocuproine (Metal = Al, Mg, Ca, and Sr) complexes by using density functional theory (DFT). We analyzed a range of metrics for BCP and BCP-Metal complexes, including frontier molecular orbitals, electronic structures, reorganization energies, ionization potential, electron affinity and charge transfer rates. The molecular geometries of BCP-metal and their cationic and anionic states were optimized using the B3LYP functional and mixed basis sets 6-31G and LanL2MB. The presence of a metal atom in BCP leads to a significant decrease in the HOMO-LUMO energy gap. The HOMO-LUMO gaps for BCP-Al, BCP-Mg, BCP-Ca, and BCP-Sr complexes measure 1.91 eV, 1.23 eV, 0.93 eV, and 0.90 eV, respectively, all of which are notably lower than the energy gap of BCP. The Marcus formalism is used to calculate the charge transport rates. The hopping rate of BCP-Ca is found to be significantly higher than the rate of all other BCPs in the investigated series. We suggest that BCP-Mg, BCP-Ca, and BCP-Sr complexes are suitable for the application as hole transporting layer in optoelectronic devices.

Figure: The intermolecular charge hopping rates of hole, khole and electron, kelectron of BCP and BCP-metal complexes

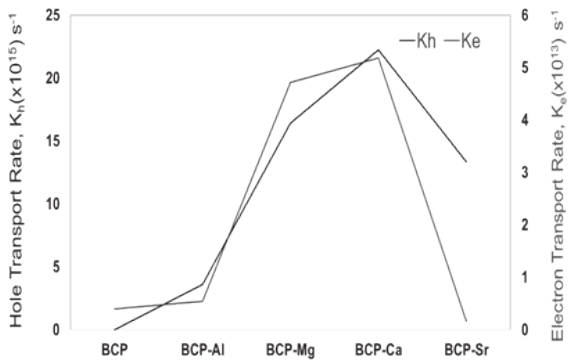

Figure: The intermolecular charge hopping rates of hole, khole and electron, kelectron of BCP and BCP-metal complexes

Abstract No: 147

Investigation of Semiconducting and Optical Properties of Spray-Coated Ag–Sn Dual-Doped CdO Thin Films for Optoelectronic Applications

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Abstract

Charged lepton flavor violation (CLFV) in muon–electron conversion refers to one of the new physics beyond the Standard Model theories. In this work, we are exploring an alternative configuration - multiple stopping-target design results in increased muon-stopping rate, improved background suppression and enhanced detector efficiency. Using detailed GEANT4 simulations, we evaluate a spectroscopy-based dual-purpose tracker-calorimeter that can disentangle electrons from different origin via energy and timing measurements. For separating the contribution of different stopping-targets, we propose a dual approach combining energy spectroscopy and time evolution. The proposed high-resolution momentum tracking is approximately ~100 KeV for the near endpoint energy to be distinguished from signal peak. Our work indicates to push ΔE to ~50 - 100 KeV to allow target separation. This indicates a factor of 2-3 improvement over the Mu2e's baseline resolution (~200 KeV). The assumed timing precision is around 0.5 ns to 1 ns, ideally 0.2 ns, which allows clean rejection of prompt backgrounds. Our procedure requires ultrafast crystal calorimetry (e.g., BaF2, LYSO, etc.) coupled with SiPM readout for achieving timing resolutions below 500ps. The results indicate that a spectroscopy-driven calorimeter can significantly reduce background leakage while maintaining high signal efficiency, aiming at sensitivities around ~(1-1.5)×〖10〗^(-17), tightening constrains on Effective Field Theory Wilson coefficients by approximately a factor of 2. This framework demonstrates the procedure of multiple stopping-target geometry and spectroscopy-based tracking, resulting a significant technological advancement in maximizing discovery potential in CLFV searches.

Keywords: Charged Lepton Flavor Violation (CLFV), Spectroscopy-based calorimetry, High-resolution tracking, Decay-in-orbit, Leptoquark, SUSY

Abstract No: 148

Synthesis and Structural Characterization of Mn Doped $SrFeO_3$ as Perovskite

Ariful Alam[1]*, Md. Ridwanul Hasan[1], Shahzad Hossain[2], Jobair Maudood[2], Md. Saiful Islam[2],Nazmul Islam Tanvir[3], Suravi Islam[4], Md. Shah Alam[5]

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Abstract

Clean energy derived from renewable and zero-emission sources is crucial for mitigating environmental pollution. Among various clean energy conversion technologies, solid oxide fuel cells (SOFCs) have gained considerable attention owing to their high conversion efficiency, fuel flexibility, and low environmental impact. In this study, Mn-doped SrFeO3with the nominal composition SrFe1-xMnxO3 (x = 0.1, 0.2, 0.3, and 0.4) were synthesized via the solid-state reaction route. The precursor mixtures were calcined at 900 °C for 6 h and sintered at 1100 °C for 6 h to ensure phase formation. The Goldschmidt tolerance factor was calculated to evaluate structural stability, confirming the formation of a stable cubic perovskite structure. X-ray diffraction (XRD) analysis revealed sharp and well-defined peaks, indicating high crystallinity and single-phase cubic formation with space group Pm–3m. The Rietveld refinement provided detailed structural parameters, including lattice constants, unit cell volumes, and crystallite sizes, while the Nelson–Riley extrapolation method was employed to further validate the lattice parameters.The electron density mapping and polyhedral visualization were performed to analyze the atomic coordination and verify the uniform substitution of Mn within the Fe–O framework. These analyses confirmed minimal lattice distortion and strong structural integrity across the doped series.The synthesis and structural analysis successfully confirmed the materials as an efficient perovskite.

Abstract No: 150

A Comparative DFT Study of Pb-Based and Pb-Free Ruddlesden-Popper Cs_2B-Cl_2I_2, (B = Pb, Ge) Perovskites for Next-Generation Optoelectronic and Solar Cell Applications

Md. Rafiqul Islam[1]*, Sanzeda Parvin[1], Monira Martin Mitu[1], Al Mahafujar[1], Ranzan Kumar[1], M Kamruzzaman[1], Tania Nusrat[1], Shah Azharul Islam[1]

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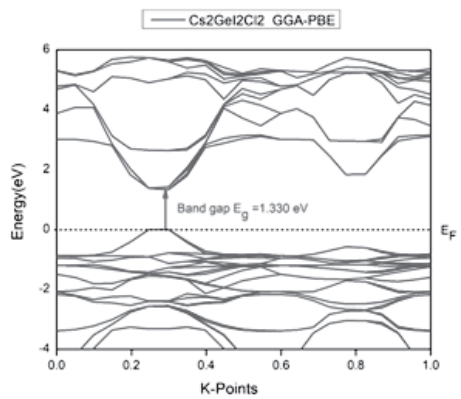
Abstract

Inorganic Ruddlesden–Popper (RP) type perovskites have recently gained attention for next-generation optoelectronic and photovoltaic devices due to their structural tunability, environmental stability, and cost-effective synthesis. Particularly, 2D RP-type perovskites have gained enormous interest due to intriguing electronic and optoelectronic properties, and high stability alternatives to 3D perovskites for efficient solar cells and light-emitting diodes. In our research, all-inorganic RP phase Pb-based and Pb-free halide perovskites of $Cs_2PbI_2Cl_2$ and $Cs_2GeI_2Cl_2$ are studied for comparative study. This development is performed by first-principles calculations using density functional theory (DFT) within the GGA-PBE framework in CASTEP code software. $Cs_2PbI_2Cl_2$ is optimized under the space group I4/mmm, and calculations reveal electronic direct band gaps of 2.50 eV and 1.33 eV for $Cs_2PbI_2Cl_2$ and $Cs_2GeI_2Cl_2$, respectively. DOS analysis indicates that the VBM is primarily dominated by halogen I- 5p and Cl- 3p orbitals, while the CBM arises from Pb-6p and Ge- 4p orbitals, suggesting strong orbital overlap at the band edges. The optical properties are studied for both perovskites. $Cs_2GeI_2Cl_2$ exhibits a sharp absorption onset in the visible range with a maximum absorption coefficient $>1.3 \times 10^5$ cm^{-1}, which is comparable to other efficient photovoltaic Pb-based absorbers. The photoconductivity shows strong peaks around 5-7 eV, indicating interband optical transitions, while the dielectric function demonstrates a high static dielectric constant. The refractive index is $n \approx 2.0$ at low photon energies, ensuring efficient light confinement. Overall, this comparative analysis highlights that replacing Pb with Ge enables band gap tuning and enhanced absorption in the visible spectrum, which is promising for futuristic applications in optoelectronics.

Keywords: Ruddlesden–Popper (RP) type, Two-dimensional, solar cell, DFT, Optoelectronic, semiconductor.

Presentation Type: Oral

Figure: Band structure of $Cs_2GeI_2Cl_2$ along the high symmetry direction in the BZ



Abstract No: 151

Study of Heat Waves and Their Effects with Frequencies in different Hotspots of Bangladesh

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Abstract

Heatwaves have become increasingly common across the globe and pose a serious threat to human health, agriculture, and livelihoods in Bangladesh. Despite their growing frequency, comprehensive analyses of heatwave trends, causes, and regional hotspots in Bangladesh remain limited. This study investigates the temporal variability, spatial distribution, and potential drivers of heatwaves across Bangladesh from 1991 to 2021. Daily maximum temperature (Tmax) data from 32 meteorological stations, obtained from the Bangladesh Meteorological Department (BMD), were analyzed using R, Python, and Microsoft Excel. Following the BMD's operational definition, heatwave days were identified when Tmax ≥ 36 °C. Trend analysis was performed using the non- parametric Mann-Kendall test and Theil-Sen slope estimator, while spatial mapping techniques were employed to identify persistent hotspots. Results indicate a statistically significant increase in both the frequency and intensity of heatwaves over the last three decades, particularly in southwestern Bangladesh. The year 2021 recorded the highest number of heatwave days within the study period. These findings suggest that climate change is a key factor driving the intensification of heatwave events in the region. The observed warming trend poses substantial challenges to public health awareness, agricultural productivity, and socio- economic stability.

Keywords: Heatwave frequencies; variabilities of Tmax; Mann-Kendall and Sen's slope techniques; BMD; Bangladesh.

Abstract No: 152

Elemental Characterization of Coal by INAA and the Environmental and Health Implications of Heavy Metals

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Abstract

The coal is an abundant fossil fuel on the earth that comprises about 75% of the total fuel resources and contributes more than one-third of total electricity production all over the world as well as being burnt to generate heat or liquefied to produce gas and diesel fuel. However, while coal mining greatly contributes to a country's economic development, it also has significant effects on the ecosystem. This study has investigated the concentrations of trace and minor elements in coal samples collected from different underground levels (Level-1: −470m, Level-2: −430m, and Level-3: −400m) at Barapukuria Coal Mine Company Limited (BCMCL), Bangladesh using Instrumental Neutron Activation Analysis (INAA). The primary aim of this work is to determine the concentration variations among these three levels and also compare both with other coal samples collected from conveyor belts and ash samples. The ranges and arithmetic mean of the concentrations of trace and minor elements in the coals are assessed and validated with certified values. The results indicate that no significant variations in concentrations were found. Additionally, the study has investigated the environmental issues and health hazards due to heavy metals using Enrichment Factor (EF) and Pollution Index (PI).

Keywords: Coal, INNA, Enrichment Factor, Environmental Impacts, BCMCL.

Abstract No: 154

Theoretical investigation and experimental validation of ZnCr2O4 for structural, mechanical, electronic and thermal property

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Abstract

The spinel family of compounds has been broadly studied owing to their wide-ranging functional properties. Spinel zinc chromite (ZnCr2O4) was synthesized via a solid-state reaction method. The structural, mechanical, and thermal properties of the ZnCr2O4 spinel compound were analyzed using X-ray diffraction (XRD) and Fourier-transform infrared (FTIR) spectroscopy. Structural characterization of the prepared sample has been carried out using XRD analysis. XRD confirm its phase composition and determine the particle size. FTIR spectrum displays the two vibrational peaks of Cr–O, and Zn–O at 395 cm−1 and 603cm−1, correspondingly. These vibrational bonds were correlated with ZnCr2O4 and revealed the production of ZnCr2O4. FTIR studies also confirm the formation of spinel structure. The chemical purity and state of the prepared samples are characterized by X-ray photoelectron spectroscope (XPS). Moreover, the mechanical properties and electronic structure of ZnCr2O4 were investigated through Density Functional Theory (DFT) calculations with Hubbard correction, presenting compatible theoretical validation to the experimental findings. This study examines the structural stability and fundamental properties of spinel ZnCr2O4, which are vital for its potential application in catalytic, sensing, and environmental applications.

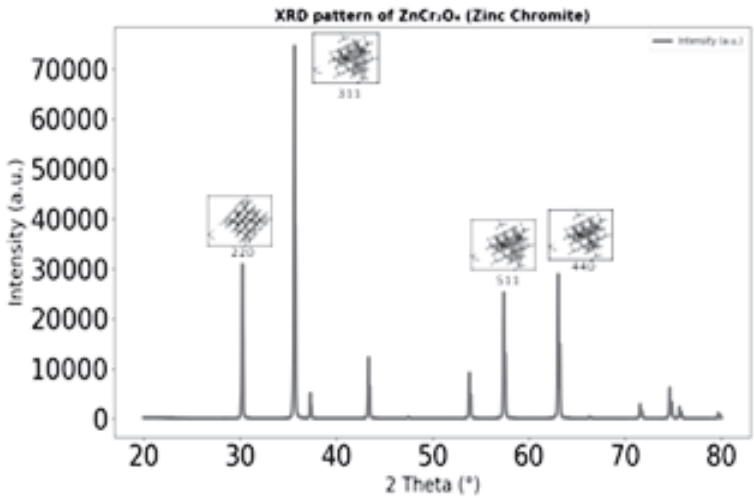

Figure 1: XRD Patterns of ZnCr2O4

Abstract No: 155

The Magnitude Distribution of Declustered Earthquakes in Bangladesh

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Abstract

Earthquake is a significant threat for Bangladesh and its surrounding regions. This study has estimated the seismic parameter like the Gutenberg-Richter b-value for better understanding of the behavior of earthquakes. The binned distribution densities of magnitudes in both the declustered and complete earthquake catalogs of Bangladesh show two different branches that are substantially different from each other. Considering declustered earthquakes, the b-values of these two portions exhibit remarkable variance. This variance indicates the lack of self-similarity through a wide range of magnitudes in the declustered earthquake distribution provides information on the application of a scale-independent assumption to the occurrences of main-shock earthquakes. The scale-independent assumption poses uncertainty on the verification of declustering earthquakes as inherently unpredictable. The assumption of scale-independence in comprehensive regional earthquake catalogs does not arise from a universal self-organization process that predicts future significant earthquakes; rather, it is the outcome of the universality of the aftershock-producing process, which primarily regulates complete catalogs. This study may have a great impact of earthquake prediction in Bangladesh and its surrounding regions.

Keywords: Earthquake, Gutenberg-Richter b-value, Variance, Declustered earthquake catalogs, Frequency-magnitude distribution.

Abstract No: 156

Forecasting of Lightning Flash Density in Bangladesh by Using the WRF Model

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Abstract

Lightning is one of the most significant natural disasters and a characteristic of severe weather; therefore, there is a clear need to develop a precise and highly reliable lightning prediction method that might enhance safety for both the public and aviation, as well as for electrical power systems. The Lightning Potential Index (LPI) evaluates the potential of charge creation and dispersion that results in lightning flashes within convectional thunderstorms. This study aims to investigate the Lightning Potential Index (LPI) lightning parameterization and its implementation for lightning prediction in Bangladesh during three pre-monsoon lightning events (06 June 2022, 13 June 2023 and 14 June 2024). Additionally, this study assesses the sensitivity of the WRF model using five microphysics and three planetary boundary layer schemes. Lightning simulations were conducted using the WRF-ARW model with several physics schemes, including two nested domains with resolutions of 12km and 4 km, respectively. The model-simulated LPI values for the selected events were evaluated using the NASA LIS (Lightning Imaging Sensor) datasets. Results indicate that there is satisfactory consistency in both the location and intensity of lightning occurrences between the model outputs and observations. Analytical expressions have been introduced to use the LPI to investigate the hourly density of lightning flash. LPI is highly correlated with observed lightning, and it may be a useful predictor for lightning over the study area.

Keywords: Lightning Flash density, NASA LIS, LPI, WRF model.

Abstract No: 157

Effect of Ce^{3+} Doping on the Structure and Mechanical Properties of Cu0.5Cd0.25Co0.25Fe2-xO4 spinel nano-ferrites

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Abstract

Spinel nano-ferrites have attracted significant attention due to their exceptional properties in diverse fields such as electronics, sensors, and biomedical devices. Among these notable properties, elastic behavior is particularly important. This work investigates the structural and elastic properties of Ce^{3+} doped Cu0.5Cd0.25Co0.25CexFe2-xO4 spinel nano-ferrites. Fourier transform infrared spectroscopy (FTIR) shows the characteristic peaks of spinel structure and analyze the elastic moduli to confirm the effect of cerium doping on the microstructural and mechanical characteristics. Ce^{3+} doping changes the mechanical strength and density of spinel ferrites. With increasing Ce^{3+} concentration, both the bulk modulus and Young's modulus increase, indicating enhanced mechanical stability. Variations in Poisson's ratio further reflect changes in bonding characteristics, while Debye temperature calculations provide clarity into the thermal stability of the system. This study examines that Ce^{3+} doping changes the elastic behavior of Cu0.5Cd0.25Co0.25CexFe2-xO4 spinel nano-ferrites and making them potential for high-temperature and mechanically demanding applications.

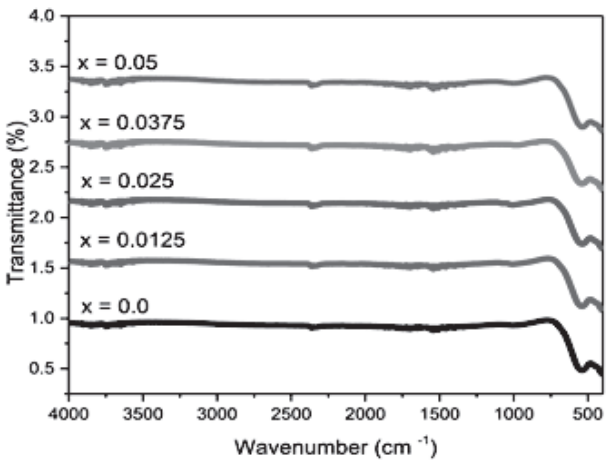

Figure 1: FTIR patterns of Ce3+doped Cu0.5Cd0.25Co0.25CexFe2-xO4 sintered at 1023K.

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Abstract No: 158

Towards an EMI-Free Hospital Communication System in Bangladesh: A VLC-Based Approach

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Abstract

The deployment of wireless networks within hospitals introduces severe electromagnetic interference (EMI). The interference threatens the operation of most critical medical devices. The scenario is particularly dangerous in regions such as Bangladesh, where power grids are weak and hostile environmental conditions prevail, like high humidity. As a countermeasure to this challenge, this study considers Visible Light Communication (VLC). VLC is an emerging technology that utilizes the use of light from common LEDs for safe data transmission. The system uses the advantages of optical wireless communication, including being low in cost and widely available, as well as immunity to EMI. The test bed was created and tested, and the testing revealed stable transmission of vital patient alarms and monitoring data without provoking any noticeable interference with surrounding hospital equipment. Simulations performed under MATLAB were proved to be in good agreement with experimental data, with consistent connection and data rate under proper setup of the LED drive current. Therefore, VLC is an affordable and efficient technology to enable Bangladesh to shift to safer and smarter digital healthcare systems.

Keywords— Electromagnetic Interference (EMI), Visible Light Communication (VLC), Optical Wireless Communication, Healthcare Infrastructure, Prototype Validation, Channel Modeling, Bangladesh.

Abstract No: 160

Impact of high sintering temperature on frequency dependent magnetic & dielectric properties of $(Mg_{0.25}Ni_{0.25}Co_{0.25}Zn_{0.25})_2SiO_4$ high-entropy ceramics

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Abstract

Nowadays high entropy ceramics attract a great attention to the researchers for diversified applications. However, modifying the sintering temperature, specimens and preparation routes one can developed high entropy ceramics. In the current research, (Mg0.25Ni0.25Co0.25Zn0.25)2SiO4, high entropy ceramics is developed using the solid-state reaction routes and further studied the sintering temperature effect. The samples were sintered at five different temperatures (1150°C, 1200°C, 1250°C, 1300°C, 1350°C) for 6 hours for improving the magnetic & dielectric properties. The XRD analysis data confirmed the forsterite formation with single phase orthorhombic crystalline structure. The porosity is found to increase with increasing sintering temperatures. The bulk density is also found to increase. SEM image showed the larger particle size with increasing sintering temperature. The frequency dependent magnetic permeability was found to improve significantly with increasing the sintering temperatures. The loss factor was found to reduce with lower frequency zones and become frequency in sensitives with higher frequency region. The dielectric constant is signifyingly affected with sintering temperature. The Cole-Cole plots clearly showed the impact of the grain and grain boundary effects on the magnetic and dielectric properties. Thus, the optimized electromagnetic properties of Mg0.25Ni0.25Co0.25Zn0.25)2SiO4 ceramics showed as an ideal candite for microwave-absorption.

Keywords: Sintering temperature, solid state reaction routes, electromagnetic properties, Microwave absorption.

Abstract No: 161

A comprehensive first-principles analysis of X2AgIrBr6 (X = Rb, Cs) halide double perovskites for advanced optoelectronic and energy conversion applications

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Abstract

In this study, the structural, electronic, optical, and thermoelectric properties of halide double perovskites X2AgIrBr6 (X = Rb, Cs) were systematically investigated using density functional theory (DFT). The optimized crystal structures exhibit both mechanical and dynamical stability, while the calculated Goldschmidt tolerance and octahedral factors fall within the expected stability range for double perovskite systems. Negative formation energies further confirm their thermodynamic stability. Electronic structure calculations performed with the Tran–Blaha modified Becke–Johnson (TB-mBJ) potential reveal direct band gaps of 1.52 eV for Rb2AgIrBr6 and 1.47 eV for Cs2AgIrBr6, suggesting efficient visible-light absorption and p-type semiconducting behavior with high carrier mobility. Bonding analysis based on electronegativity differences indicates a mixed ionic-covalent character, contributing to the compounds' chemical robustness. Optical parameters, including the dielectric function, refractive index, reflectivity, and absorption spectra, demonstrate pronounced optical activity across the visible spectrum, underscoring their suitability for optoelectronic applications. Thermoelectric analysis yields high Seebeck coefficients (191 μV/K for Rb and 184 μV/K for Cs) and exceptional figures of merit (ZT ≈ 3.0–3.8) confirming their strong thermoelectric potential. Collectively, the synergistic optoelectronic and thermoelectric properties establish X2AgIrBr6 (X = Rb, Cs) as promising candidates for next-generation multifunctional energy conversion and photovoltaic devices.

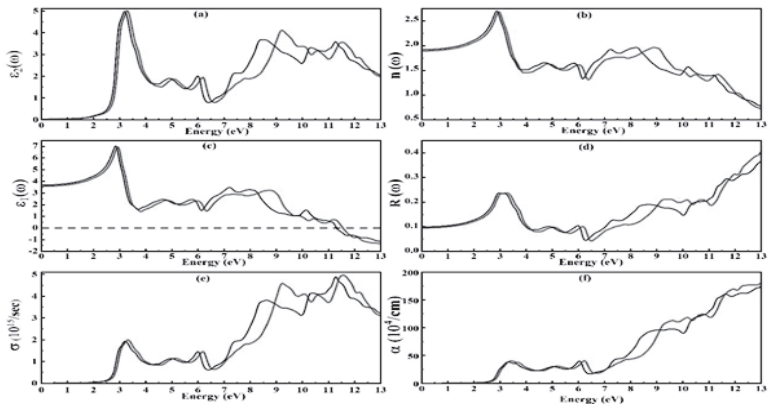

Figure: Calculated optical characteristics, which include the (a) imaginary dielectric function (ε_2 (ω)), (b) refractive index (n(ω)), (c) real dielectric function (ε_1 (ω)), (d) optical reflectivity (R(ω)), (e) real part of optical conductivity (σ(〖10〗^15/sec)) and (f) absorption coefficient αα(ω)), Rb_2 AgIrBr_6 (red) and 〖Cs〗_2 AgIrBr_6 (blue).

Abstract No: 162

Structural, Electronic, and Optical Properties of Al2O3 Nanomaterials: A Comparative Study of DFT Predictions and UV–Vis Experimental Analysis

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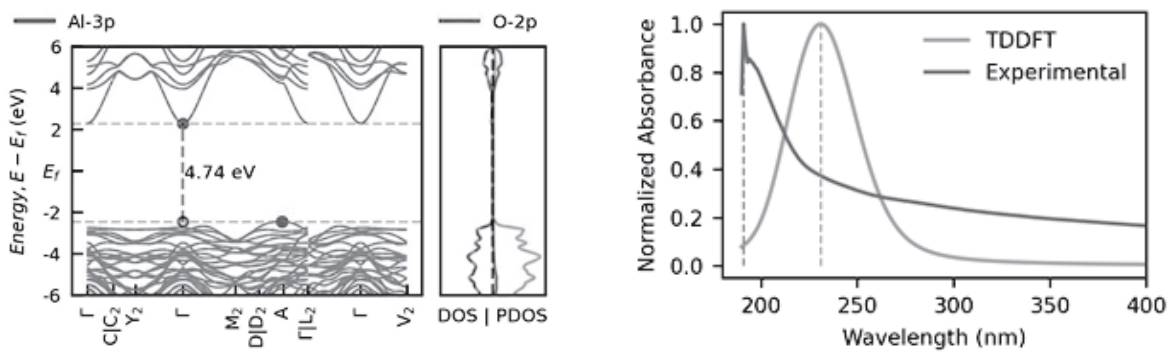
Abstract

We theoretically investigate the structural, electronic, and optical properties of aluminum oxide (Al2O3) and compare the results with nanoparticles produced using the laser ablation method. Aluminum oxide nanoparticles were synthesized experimentally, forming nearly spherical particles with a uniform size distribution. Ultraviolet–visible (UV–Vis) spectroscopy of the prepared nanoparticles shows a strong absorption peak at 200 nm, and the corresponding Tauc plot indicates an indirect optical band gap of approximately 4.6 eV. To understand these observations from a theoretical perspective, Density Functional Theory (DFT) calculations were performed using both Local Density Approximation (LDA) and Generalized Gradient Approximation (GGA) pseudopotentials to investigate the stability and electronic characteristics of the material. The calculated results reveal that Al2O3 possesses an indirect band gap in the range of 4.6–4.74 eV, which is in excellent agreement with experimental data. Furthermore, Time-Dependent Density Functional Theory (TDDFT) predicts a strong optical absorption peak near 230 nm, indicating the material's capability to absorb ultraviolet light efficiently. The close agreement between theoretical predictions and experimental measurements demonstrates the reliability of our combined approach in describing the optical and electronic behavior of Al2O3 nanomaterials.

Keywords: Al2O3 nanoparticles, laser ablation, DFT, TDDFT, UV–Vis spectroscopy.



(a) (b)

Figure 1. (a) Band structure, density of state, and projected density of state of Al2O3 for PBE pseudopotential, (b) UV-Vis absorption spectra of Al2O3

Abstract No: 163

Z-Scan Profiling of Sunlight-Exposed Cholecalciferol in Pharmaceutical Formulations

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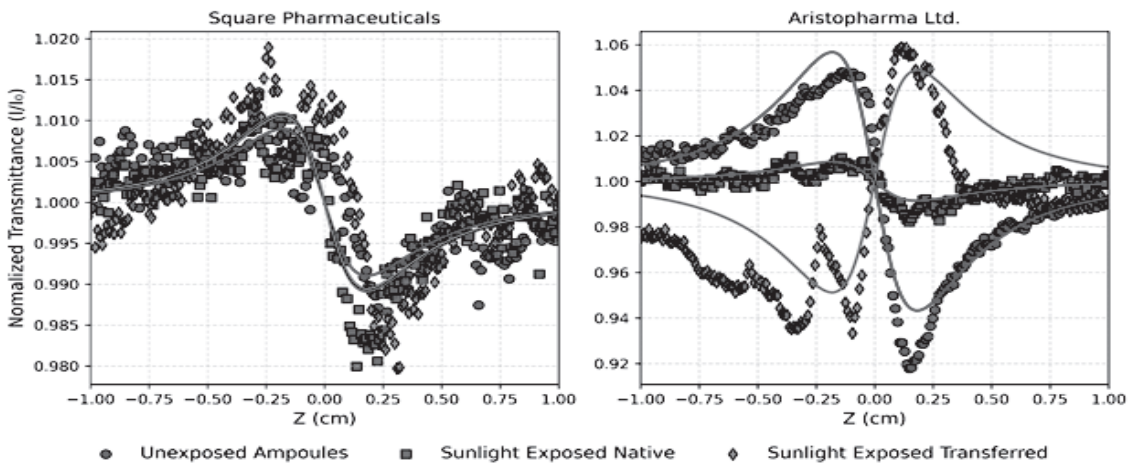
Abstract

The deficiency of Vitamin D_3 (cholecalciferol) is a global health concern, thereby affecting the bone and immune system of the human body. As cholecalciferol is highly photosensitive, it undergoes changes and breaks down under UV exposure. While pharmacopeial guidelines recommend amber (Type I) glass, some companies unfortunately use clear glass for light-sensitive products, raising questions about their stability. To assess the photostability of cholecalciferol and evaluate the performance of the Z-scan technique, 200,000 IU/ml cholecalciferol injections from Square Pharmaceuticals (amber glass) and Aristopharma Ltd. (clear glass) were tested. Characterization was performed using the open- and closed-aperture Z-scan technique with a 655 nm diode laser operating at 35–172 mW. Formulations, including excipients, were probed across three scenarios: (i) unexposed from original ampoules, (ii) exposed to sunlight in native containers, and (iii) transferred to syringes before sunlight exposure. Closed-aperture Z-scan measurements showed $n_2 \sim 10^{-10}$ cm²/W for amber samples across all conditions, with peak–valley profiles indicating negative Kerr lensing (self-defocusing). Clear-glass samples exhibited higher n_2 ($\sim 10^{-9}$ cm²/W for unexposed, dropping to $\sim 10^{-10}$ cm²/W post-exposure). All samples except the transferred–exposed formulation displayed self-defocusing, while the transferred–exposed sample showed a valley–peak profile (self-focusing). Noticeable nonlinear Z-scan responses appeared above 140 mW, marking the onset of measurable third-order nonlinearities. These findings suggest that higher laser powers and prolonged exposure could reveal distinct nonlinear optical signatures useful for stability assessment and structural monitoring of photosensitive formulations.

Keywords: Z-scan technique, Light-sensitive pharmaceuticals, Vitamin D_3, Kerr effect



Abstract No: 165

Investigating the relationship between Lightning Potential Index and Microphysical Volume of Hydrometeors using Weather Research and Forecasting Model over Bangladesh

Nishan Paul[1]*, Ranzan Kumar[1], Mst.Tosiba Akhter[1], Tony Chandra Sarker[1], Dr. Bakul Kumar Chakravorti[1], Maruf Md Rabbani Pramanik[1], Khan Md Golam Rabbani[2]

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Abstract

A precise interpretation of how microphysical processes influence cloud electrification is essential for advancing lightning prediction. This study investigates the relationship between the Lightning Potential Index (LPI) and the volume of microphysical properties of thunderstorms over Bangladesh. LPI represents a measure of the potential for charge generation and separation that leads to lightning flashes. The microphysical volume of hydrometeors denotes the total volume of hydrometeors, including the contents in ice and liquid phases, i.e., supercooled liquid droplets, ice crystals, graupel, and other mixed-phase components within the temperature range of $0°C \geq T \geq -20°C$ in the atmosphere. Three lightning-intensive events on 09 June 2022, 19 June 2023, and 22 June 2023 were simulated using the WRF-ARW model. For each event, LPI, maximum radar reflectivity, and accumulated rainfall were analyzed. These parameters collectively describe the evolution of electrification and precipitation within each system. A positive association between high reflectivity cores, enhanced rainfall, and elevated LPI values indicates that mixed-phase microphysical processes favor lightning generation. The outcome shows that storms with greater microphysical volume exhibit stronger lightning potential. The findings aim to advance regional lightning prediction by linking LPI to physically interpretable microphysical parameters derived from high-resolution numerical simulations.

Keywords: LPI; WRF-ARW; accumulated rainfall; mixed-phase.

Abstract No: 166

Fourier-Domain Filtering for Enhanced Visualization of Plant Cell Microstructures

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Abstract

Microscopic image analysis is central to life sciences, medicine, and materials research, where extracting fine structural details is often limited by noise and resolution. Fourier Transform offers a robust frequency-domain framework for enhancing such images. In this work, plant cell images were captured using a Nikon Diaphot TMD phase-contrast inverted microscope under non-monochromatic illumination and analyzed through Fourier-based filtering. Low-pass filters reduced noise, high-pass filters emphasized edges, and their combination enabled clear identification of cellular structures such as the wall, nucleus, and cytoplasm. Gaussian smoothing further improved frequency response, balancing noise reduction with structural continuity. These results highlight Fourier filtering as a powerful approach for improving visualization and interpretation of microscopic images.

Keywords: Fourier Transform, Microscopic Image Processing, Frequency-Domain Filtering, Cellular Structure Identification, Gaussian Smoothing

Abstract No: 167

FFT-Based Noise Filtering in Low-Power Z-Scan Measurements

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Abstract

Noise in Z-scan measurements can make it difficult to extract accurate nonlinear optical parameters; specifically in the region where optical nonlinearity started to develop. This study explores the use of Fast Fourier Transform (FFT)-based filtering to reduce noise in Z-scan data and compares its performance with a simple block averaging method. The FFT filter effectively removes high-frequency noise while preserving the main features of the signal, resulting in smoother data and more consistent fitting parameters. In contrast, block averaging reduces data resolution and can distort signal behavior, leading to poorer fitting accuracy. The results show that FFT-based filtering offers a more reliable and efficient approach for processing noisy Z-scan data and improves the accuracy of nonlinear optical analysis.

Keywords: Z-scan Measurement, Fast fourier transform, FFT filtering, Non-linear phase shift.

Abstract No: 168

A Density Functional Theory Study of the Optical and Electrical Properties of Methylammonium Tin Iodide Perovskite for the Application in Solar Cells

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Abstract

As a promising alternative to lead-based perovskites for solar energy applications, methylammonium tin iodide ($CH_3NH_3SnI_3$) was investigated for its electronic and optical properties. Using molecular dynamics and density functional theory (DFT), the material's behavior was modeled at room temperature. The calculations show that $CH_3NH_3SnI_3$ has a direct band gap of 1.1 eV, an essential feature for efficient light absorption and electron excitation. Analysis of the electronic structure, particularly the density of states, reveals that tin and iodine ions dominate the electronic activity near the band gap, while the methylammonium cation mainly contributes to the structural stability of the perovskite lattice. Optical property analysis including absorption coefficient, refractive index, reflectivity, optical conductivity, dielectric function, and energy loss function confirms strong light absorption and other favorable optoelectronic characteristics.

Overall, $CH_3NH_3SnI_3$ demonstrates excellent room-temperature performance, highlighting its potential as an efficient and environmentally friendly absorber material for next-generation solar cells.

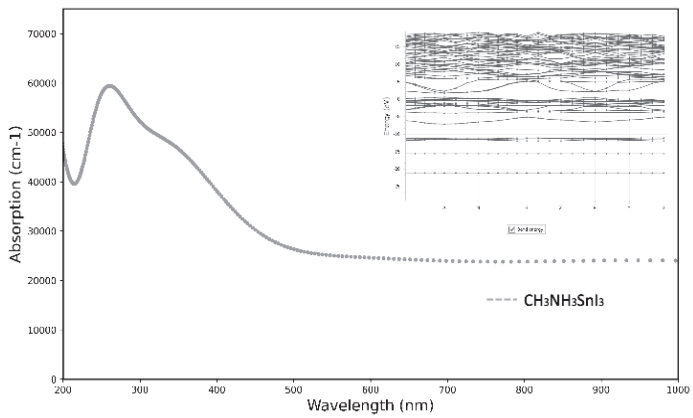

Figure: Optical Absorption curve and energy band diagram of CH3NH3SnI3 at room temperature.

Keywords : Methylammonium tin iodide, Lead-free perovskites, Solar cells, Density Functional Theory (DFT), Absorber layer.

Abstract No: 169

A Density Functional Theory Study of the Optical and Electrical Properties of Methylammonium Tin Iodide Perovskite for the Application in Solar Cells

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Abstract

The precise identification of the copper oxide phase formed during laser ablation remains a significant challenge, as the process can yield either Cu^{+} (Cu_2O) or Cu^{2+} (CuO) species. In this work, we aim to determine the phase of laser-ablated copper oxide nanoparticles by combining experimental observations with first-principles calculations. The structural, electronic, and optical properties of CuO and Cu_2O were systematically investigated using Density Functional Theory (DFT), DFT+U, and Time-Dependent DFT (TDDFT) within both the Local Density Approximation (LDA) and Generalized Gradient Approximation (GGA) frameworks. Conventional DFT underestimated the electronic band gaps, while DFT+U yielded indirect band gaps of 1.15–1.18 eV for Cu_2O and 1.72–2.19 eV for CuO. TDDFT calculations revealed maximum optical absorption at 460 nm for Cu_2O and 232 nm for CuO. Experimentally, the nanoparticles produced via laser ablation exhibited a dominant absorption peak at 217 nm and an indirect band gap of approximately 2.2 eV. The strong correspondence between experimental and theoretical results for CuO clearly indicates that the synthesized nanoparticles predominantly consist of the Cu^{2+} phase. This integrated theoretical–experimental approach provides a reliable pathway for phase identification and advances the understanding of the optoelectronic characteristics of laser-fabricated copper oxide nanostructures.

Keywords: Laser ablation, copper oxide nanoparticles, UV–Vis spectroscopy, Tauc plot, DFT, TDDFT.

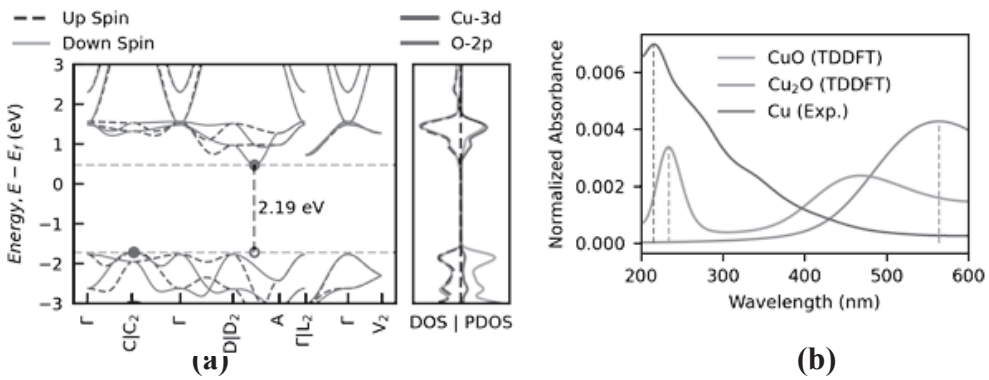

Figure 1. (a) Band structure, density of state, and projected density of state of CuO for PBE pseudopotential, (b) UV-Vis absorption spectra of CuO and Cu_2O with experimental .

Abstract No: 170

Numerical Investigation of Proton Structure-Dependent Radiative Corrections in Electron–Proton Elastic Scattering

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Abstract

The proton's internal structure, revealed through electron–proton elastic scattering, pro- vides fundamental information on the electric and magnetic form factors, GE and GM . Persistent discrepancies between Rosenbluth separation and polarization transfer mea- surements have highlighted the need for precise evaluation of radiative corrections in experimental analyses.

In this work, we perform a numerical investigation of QED radiative corrections in elas- tic electron–proton scattering, focusing on the proton vertex, proton self-energy, and bremsstrahlung contributions. The analysis incorporates the proton's finite structure by including both elastic intermediate states and selected resonance excitations in the virtual amplitudes. The study is carried out over kinematics relevant to recent experiments such as PRad, OLYMPUS, and CLAS, extending up to Q2 ≈ 5GeV 2.

We further explore the dependence of the corrections on different proton elecctromagnetic form factor parameterizations. Preliminary numerical trends suggest that parameteriza- tion choices can introduce notable variations in the corrected observables. The complete results and comparative assessments will be presented at the conference. This work aims to clarify how structure-dependent radiative effects shape the interpretation of modern electron–proton scattering data and refine our understanding of the proton's electromag- netic properties.

Keywords: electron-proton scattering, radiative corrections, form-factors, proton-vertex, self-energy, bremsstrahlung

Abstract No: 171

A Quantum ESPRESSO recipe for Z_2 invariant of 2D topological material 1T′-WTe_2

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Abstract

Quantum ESPRESSO (QE) can be used not only to obtain ground-state properties but also to generate topology-ready electronic data. We present an extended QE application to monolayer 1T′-WTe_2 that computes the spin–orbit–coupled electronic structure (band structure and density of states) and prepares a Wannier tight-binding model for topological diagnostics. In our work-flow, QE provides self-consistent states and exports wavefunctions to Wannier90 to construct maximally localized spinor Wannier functions; from these we obtain a Hamiltonian suitable for Wilson-loop analysis of the Z_2 invariant. The Z_2 invariant classifies time-reversal-symmetric insulators and signals quantum spin Hall behavior by the odd winding of hybrid Wannier charge centers, with a complementary Fu–Kane parity check at time-reversal invariant momenta. The emphasis is on a clear, reproducible recipe that keeps QE at the center of the pipeline while inter-facing minimally with Wannier90 for interpolation and topology, enabling others to replicate the results and adapt the same QE-based approach to related two-dimensional materials. All inputs, scripts, and exact software versions will be made available.

Keywords: Quantum ESPRESSO; spin-orbit coupling; Wannier90; Z_2 invariant; quantum spin Hall effect; 1T'-WTe_2.

Abstract No: 173

Re-examining the Proton's Electric Form Factor: From Classical Fits to Deep Learning Insights

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Abstract

The precise relationship between the proton's electric form factor, GE(Q2), and the squared four-momentum transfer, Q2, continues to be a subject of fundamental importance in understanding the proton's internal structure. Accurate determination of GE(Q2) plays a critical role in resolving longstanding discrepancies in the measured proton charge radius and in benchmarking theoretical models of nucleon structure.

In this work, we analyze unpolarized electron–proton elastic scattering data using the Rosenbluth separation method to extract GE(Q2) independently. Several fitting frameworks, including rational functions, polynomial expansions, spline interpolations, and modern deep learning-based models, are employed to describe the Q2 dependence of the form factor. Each model's parameters are optimized through direct fits to the measured cross sections, and a global fit is subsequently performed across multiple experimental datasets to obtain a unified and continuous representation of the electric form factor.

From the resulting fits, the proton charge radius is extracted with enhanced stability and reduced model bias. The comparative study highlights the sensitivity of the extracted radius to different parameterizations and fitting methodologies, offering new insights into the interplay between model flexibility, data consistency, and physical interpretability in proton structure studies.

Keywords: Proton electric form factor, charge radius, Rosenbluth separation, curve fitting, deep learning, electron–proton scattering

Abstract No: 174

Target-Normal Single-Spin Asymmetry in Elastic Electron–^{3}He Scattering from Two-Photon Exchange

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Abstract

The target-normal single-spin asymmetry( ) in elastic electron–^{3}He scattering serves as a sensitive probe of two-photon exchange (TPE) effects and the electromagnetic substructure of the helium-3 nucleus. In this work, we evaluate by considering the elastic ^{3}He state as the intermediate state in the TPE box diagram. The ^{3}He nucleus is treated as an effective spin-½ Dirac particle, and the calculation follows a methodology analogous to recent analyses of electron–nucleon scattering. The latest parametrizations of the ^{3}He electromagnetic form factors are used as input to compute the imaginary part of the TPE amplitude that generates a nonzero asymmetry. The results are presented for the kinematics corresponding to the Jefferson Lab measurement, which employed unpolarized electron beams of 1.245, 2.425, and 3.605 GeV incident on a transversely polarized ^{3}He target, yielding average four-momentum transfers Q^2 = 0.127, 0.460, and 0.967 GeV^2 at a scattering angle of 17°. The calculated elastic-state contribution is compared with the experimentally observed negative asymmetries, clarifying the relative importance of the elastic channel within the overall TPE amplitude. This study extends the formalism of target-normal asymmetries from nucleon to few-body nuclear systems, providing a theoretical baseline for interpreting future measurements of spin-dependent observables in light nuclei.

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Abstract No: 175

Numerical Solution to Schrödinger Equation for μH and Verification of Sensitivity of Ground State Energy to Higher Order Multipole Potentials

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Abstract

In this work, we numerically solved the Schrodinger equation for muonic hydrogen using Numerov method to find 1s energy eigenvalue. We ran our codes on Mathematica. The calculation carried out is rather typical, except for the additional inclusion of multipole expansion effects up to 3rd order. We find the ground state energy to be -2815.2 eV, which appears to be no different from the typical value. The motivation behind this calculation was to check the sensitivity of 1s energy to anisotropic finite-size effects arising from multipole expansion of the proton's Coulomb potential. This calculation can be extended to check the impact of said effects on 1s HFS as well, which can help improve the precision of predictions for the upcoming experimental data on 1s HFS in muonic hydrogen.

Abstract No: 176

Title: Optimizing Deposition Of Platinum Nanoparticles On Functionalized Graphene Oxide

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Abstract

In this research, we explored different parameters for depositing platinum nanoparticles on sulfonated graphene oxide (S-GO). Platinum nanoparticles (NPs) were formed in situ by reduction of a platinum precursor with sodium borohydride in presence of a S-GO matrix. Prior to the deposition, GO was functionalized with sulphonic acid groups using a method developed in our research laboratory to improve the colloidal stability of GO in aqueous medium. The deposition process was optimized by varying the ratio of platinum precursor to S-GO (mass). The deposition was found to rely on the ratio of platinum cations to NaBH4 (mole) as well as the reaction temperature and time. Chemical changes in GO due to reduction were followed with Fourier-transform Infrared Spectra (FT-IR) while elemental analysis was carried out by X-ray Photoelectron Spectroscopic technique (XPS), and size and shape of the platinum NPs was confirmed by analyzing Transmission Electron Microscopic (TEM) images.

Keywords: Graphene oxide (GO), Sulfonated graphene oxide (S-GO), Pt NPs.

Abstract No: 177

Reinforcement Learning for Autonomous Control in Plasma Confinement

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Abstract

Plasma confinement is a central challenge in realizing controlled nuclear fusion, where maintaining stability in a nonlinear, high-dimensional plasma system is critical. Traditional controllers such as Proportional–Integral–Derivative (PID) and Model Predictive Control (MPC) often fail to adapt to the rapid temporal variations and nonlinearities present in plasma behavior. To address these limitations, this study proposes a Reinforcement Learning (RL)-based autonomous control framework for dynamic plasma confinement in magnetic fusion reactors. The approach employs the Deep Deterministic Policy Gradient (DDPG) algorithm to regulate control coil currents and heating power, ensuring plasma equilibrium and minimizing radial displacement. A reduced Magnetohydrodynamic (MHD) model is incorporated to simulate realistic plasma dynamics, while a physics-informed reward function penalizes instability and encourages long-duration confinement. The RL agent is trained using GPU-accelerated computation for 1.2×10^6 episodes, achieving convergence with an average reward improvement of 43% over baseline control systems. Simulation results demonstrate that the proposed RL controller reduces radial displacement error from 0.032 m to 0.020 m, increases average confinement time from 2.6 s to 3.6 s, and decreases response time from 145 ms to 104 ms compared to PID control. The controller also maintains stability under ±15% magnetic field perturbations, highlighting its robustness and adaptability. Implementation in Python (TensorFlow) and MATLAB Simulink enables efficient model training and evaluation. Overall, the proposed RL-based control system shows strong potential for next-generation intelligent plasma regulation, offering enhanced precision, adaptability, and efficiency in sustaining plasma confinement for future fusion energy applications.

Table 1. Performance Summary of Control Methods for Plasma Confinement

Control Method	Radial Displacement Error (ΔR, m)	Confinement Time (τ, s)	Response Time (ms)
PID Controller	0.032	2.6	145
MPC Controller	0.028	3.0	120
Proposed RL-Based Controller	0.020	3.6	104

Table 1 illustrates the comparative performance of three control strategies for plasma confinement. The proposed RL-based controller achieves superior confinement stability and faster response time compared to traditional PID and MPC methods, demonstrating its effectiveness for real-time plasma control applications.

Abstract No: 178

Investigation of the Insulator to Metallic Phase Transition of $LaCoO_3$

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Abstract

$LaCoO_3$ was synthesized by the solid-state reaction technique to investigate the presence of a semiconducting region between the insulating and metallic (IM) phases and the IM phase transition at 533K1. X-ray diffraction confirmed that the crystal structure matches with the previous report2. Temperature-dependent capacitance and complex impedance were studied within the temperature 303 K – 773 K and frequency range 2 MHz– 120 MHz with interval 2MHz. The temperature-dependent real part of the dielectric constant demonstrates phase transition is the frequency independent. The real part of the impedance (Z1) shows that the I-M phase transition started at 56 MHz and terminated at 64 MHz. Temperature dependence real part exhibits negative slope at lower frequencies than 56 MHz and positive slope at higher frequencies than 64 MHz. However, at 64MHz positive and negative slopes coincide at 503 K and the value is 23.0 Ohm. Positive slopes sustain till 88 MHz. From this experimental result, we can conclude that there is no intermediate i.e., semiconducting state between I-M phase transitions.

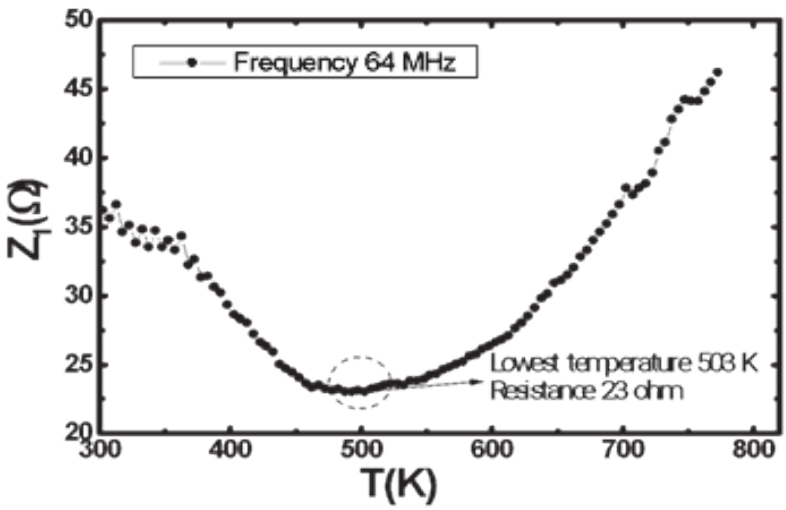

Figure 1: Temperance dependence of the real part of impedance of $LaCoO_3$ for 64MHz

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Abstract No: 179

Addressing False Positives: A Combined NLO and Spectroscopic Strategy for Differentiating Cancerous and Deeply Colored Non-Cancerous Plasma

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Abstract

This study addresses a critical challenge in biophotonic cancer diagnostics: the overlap in nonlinear optical (NLO) Z-Scan parameter values between cancerous (CA) individuals and a subset of non-cancerous (Non-CA) individuals exhibiting deeply colored plasma. Previous Z-Scan methodology, built upon established NLO lab protocols (including patient identification, blood drawing, and cuvette fabrication), demonstrated high initial detection accuracy, but inconsistent results were observed in these specific colored samples.

Experimental Z-Scan findings confirmed this overlap, further showing that the phase shift value increases proportionally with higher laser power (reducing noise) and that the NLO effect is more pronounced in all deeply colored samples regardless of cancer status. Complementary UV Spectroscopy provided essential insight, revealing common absorption peaks across all samples (visible 410–415 nm, far-UV 225–235 nm) but demonstrating a wider spread of values in CA samples compared to the tighter coincidence observed in Non-CA samples.

To resolve the diagnostic ambiguity, the research methodology is being enhanced by classifying all blood samples into distinct groups based on their visual appearance/coloration. This strategy allows for targeted analysis of the NLO overlap causes and provides a pathway to a definitive solution. The future work focuses on expanding the clinical sample size for statistical robustness and integrating the combined Z-Scan and UV data to pinpoint the precise molecular origins of the observed nonlinear response. This research aims to fundamentally characterize the NLO behavior of these complex biological systems, thereby contributing to more robust and accurate diagnostic technologies.

Abstract No: 180

Mitigating Climate Change: The Role of Applied Physics and Environmental Technology in Bangladesh

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Abstract

Bangladesh is confronted with severe environmental challenges due to climate change, including higher greenhouse gas (GHG) emissions, temperature irregularities, and sea-level rise. The application of concepts in applied physics and environmental technologies provides a robust foundation for understanding and mitigating these effects. Applied physics enables quantitative modeling through the application of thermodynamics, system dynamics, and energy balance, while environmental technologies such as renewable energy, energy efficiency, and carbon capture offer real-world solutions. Despite various national policies, there is still limited empirical evidence demonstrating the link between these technologies and measurable emission outcomes in Bangladesh.

This study examines applied physics and environmental technology as part of support for climate change mitigation in Bangladesh for the period 1995-2025. The overall objectives are to determine interdependencies between carbon capture, GHG emissions, renewable energy, energy efficiency, policy stringency, and R&D spending; establish a Low-Carbon Performance Index (LCPI); and determine optimized mitigation scenarios.

A quantitative longitudinal study was conducted with nine variables: GHG emission, renewable energy adoption, energy efficiency, carbon capture, policy strength, R&D spending, temperature anomaly, sea-level rise, and sustainability. Data used in this study is secondary in nature, collected from national and international databases. Statistical methods such as descriptive analysis, multiple regression, and correlation were used with the assistance of Microsoft Excel and other statistical software. Low Carbon Performance Index (LCPI) has been formulated with the assistance of normalized mitigation indicators and cross-checked against the sustainability index.

Between 1995 and 2025, GHG emissions decreased from 152.6 to 96.9 $MtCO_2e$, and the use of renewable energy increased from 6 to over 44 percent, and energy efficiency was significantly enhanced. Strong negative correlations of emissions with renewable energy (-0.96), energy efficiency (-0.93), carbon capture (-0.96), policy strength (-0.94), and R&D expenditure (-0.95) were observed. These results confirm that policy and technology innovation have effectively encouraged sustainability.

The findings indicate how the combination of applied physics–based modeling and environmental technologies has helped Bangladesh significantly in attaining a low-carbon transition, both propelling emission mitigation and sustainable development.

Keywords

Applied Physics, Environmental Technology, Climate Change Mitigation, Renewable Energy, Energy Efficiency, Carbon Capture.

Abstract No: 181

Concentration-Driven Higher-Order Nonlinear Optical Responses in Triarylmethane Chromophore

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Abstract

In this work, we determine the concentration-dependent third- and fifth-order nonlinear optical properties of a blue food-grade chromophore in aqueous solution using the Z-scan technique under continuous-wave laser excitation. At low concentrations and low input powers, the material exhibits purely third-order nonlinearity with negligible nonlinear absorption; the nonlinear phase shift is negative and varies linearly with the incident power, indicating self-defocusing behavior. As the concentration and excitation power increase, nonlinear absorption becomes significant. Analysis of the nonlinear absorption mechanisms at higher concentrations and powers was performed to distinguish between possible two-photon, three-photon, or excited-state absorption (ESA) processes. Based on the observed concentration and power dependence, as well as the fitting results, the dominant mechanism is found to be reverse saturable absorption (RSA), primarily governed by three-photon absorption (3PA). The system transitions from a purely third-order to a combined third- and fifth-order nonlinear response, where the phase shift exhibits a nonlinear dependence on power: the third-order contribution remains negative, while the fifth-order component becomes positive. These findings demonstrate the potential of this chromophore for optical limiting and other photonic device applications. To the best of our knowledge, this study represents the first observation of fifth-order nonlinearity in thermal lensing for this type of system.

Keywords: Nonlinear Optics, Z-Scan, Higher-Order Nonlinearity, Three-Photon Absorption, Reverse Saturable Absorption, Chromophore.

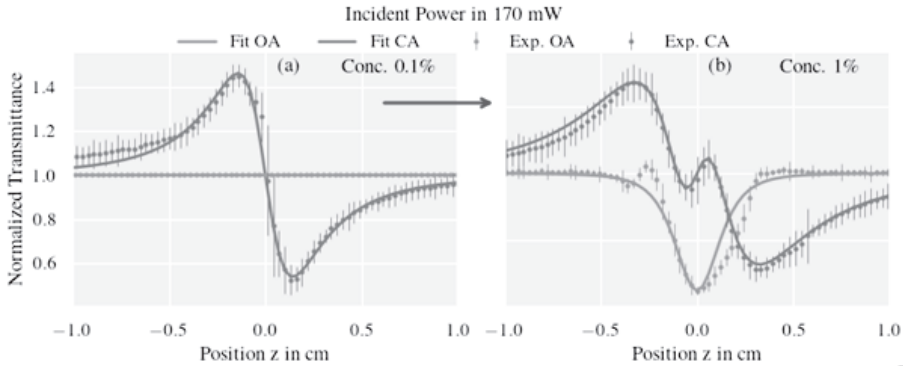

Fig. Illustration of nonlinear optical responses: (a) third-order nonlinearity and (b) fifth-order nonlinearity, showing the transition from the third- to the fifth-order effect.

Abstract No: 182

Excitation of Ion Acoustic Mode in Magnetized Dusty Plasma

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Abstract

Electrostatic ion acoustic mode in magnetized dusty plasma (IA-B mode) with massive negatively charged dust grains is theoretically investigated. In this study fluid model of plasma is used. A general dispersion relation for dust modes is derived. From the dispersion relation IA-B mode is obtained using necessary plasma conditions. Behavior of the IA-B mode is graphically illustrated using the values of appropriate dusty plasma parameters. The properties of the IA-B mode comparted to the ion acoustic mode of unmagnetized dusty plasma (IA mode) is done. This investigation helps the laboratory experiment to justify the IA-B modes in unmagnetized dusty plasmas. Detailed results of the study and the excitation conditions of the IA-B mode are given in the paper.

Keywords: Dust mode, Dispersion relation, magnetized dusty plasma, magnetized dusty plasma, Ion-acoustic mode

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Abstract No: 183

Thermally Induced Nonlinear Optical Effects in Ni (II), Co (II), and Cu (II) Complexes of L-Phenylalanine: A CW Z-Scan Analysis

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Abstract

The thermal nonlinear optical (NLO) characteristics of L-phenylalanine complexes made with nickel (II) chloride hexahydrate, cobalt (II) chloride hexahydrate, and copper (II) sulfate pentahydrate are examined in this work. Following synthesis in aqueous solution, the prepared complexes were characterized using X-ray Diffraction (XRD), Fourier Transform Infrared (FTIR) spectroscopy, Thermal Gravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), and Ultraviolet-visible (UV-Vis) spectroscopy. Distinct peak- valley patterns were seen in closed-aperture nonlinear optical measurements using the continuous wave (CW) Z-scan method, suggesting thermal self-defocusing effects related to absorption. These results demonstrate the strong thermally induced nonlinear optical behavior of the complexes.

The thermal nonlinear characteristics of the complexes showed significant differences. The Cu (II) and Co (II) complexes exhibited modest nonlinearity, with thermal nonlinear refractive indices (n2thermal) in the order of 10-15m2/W and a shared thermo-optic coefficient (dn/dT) of approximately -3.8×10-4 K-1 with the corresponding nonlinear absorption coefficient (β) of (- 4.45 ±0.15)×10-6 and (-5.42 ± 0.14)×10-6 m/W, respectively. However, the Ni (II) complex displayed a much stronger thermal response. The nickel complex's n2thermal was significantly higher at (-5.8±0.26)×10-12 m2/W, and its dn/dT value was about seven times greater at roughly -27.0×10-4 K-1.

These results validate that the nonlinear optical response in all three complexes is dominated by thermal effects, leading to strong self-defocusing behavior. These L-phenylalanine metal complexes' strong thermal nonlinearities make them attractive candidates for passive photonic devices and biophotonics applications that need precise light modulation through thermally induced changes in refractive index.

Keywords: Thermal nonlinearity, CW Z-scan, L-phenylalanine, metal complexes, self-defocusing, Biophotonics.

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Abstract No: 184

A Self-Consistent Computational Design of Fe-Doped CsGeCl3 for Flexible Perovskite Solar Cells

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Abstract

To address the urgent need for non-toxic, high-performance solar perovskites, Cesium Germanium Chloride (CsGeCl3) and its enhancement via Manganese (Mn) and Iron (Fe) doping are investigated. The study utilizes a self-consistent computational pathway that directly links first-principles quantum mechanics with device-level performance simulation. Surface Density Functional Theory with Hubbard-U correction (DFT+U) calculations provide the critical parameters for the Solar Cell Capacitance Simulator (SCAPS-1D). Results demonstrate that while pristine CsGeCl3 exhibits a wide 3.44 eV bandgap and a low 5% simulated efficiency, strategic Fe-doping offers a transformative enhancement. The Fe-doping obtains an optimal 1.21 eV bandgap by creating a functional intermediate band, which significantly boosts sub-bandgap photon absorption. Consequently, SCAPS-1D simulations predict a remarkable power conversion efficiency (PCE) of 31.6% for the Fe-doped structure (CsGe0.875Fe0.125Cl3). This analysis further confirms that doping improves mechanical ductility and stability, indicating high suitability for flexible solar applications.

Abstract No: 185

Exploring the photovoltaic performance of ternary ZnSiAs2 pnictide: A DFT and SCAPS-1D approach

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Abstract

We report a ternary pnictide ZnSiAs2 using an ab-initio method based on the density functional theory (DFT) and SCAPS-1D simulations due to its exciting applications, especially in solar photovoltaics. The energy dispersion reveals that the studied pnictide is a direct transition type semiconductor with an energy gap of 1.8 eV, consistent with the optical band gap estimated from the optical absorption. The other optical properties such as conductivity, dielectric constant, energy loss function, refractive index, and reflectivity are also discussed. In addition, an estimation regarding the excitonic properties like lower exciton binding energy (14 meV) and larger exciton Bohr radius (53 Å) indicates that ZnSiAs2 pnictide could be a potential candidate, as an effective photovoltaic absorber, in solar photovoltaics. In the proposed device structure, indium sulphide (In2S3) and molybdenum sulphide (MoS2) are utilized as the window and back surface field (BSF) layers, respectively. By employing $ZnSiAs_2$ as the absorber layer, the simulation yielded a short-circuit current density (Jsc) of approximately 17.1 mA/cm², an open-circuit voltage (Voc) of 1.43 V, a fill factor (FF) of 61.90% and an overall power conversion efficiency (PCE) of 15.12%.

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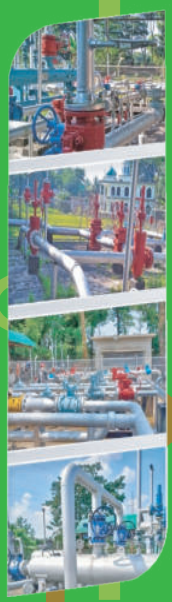
গ্যাস ব্যবহারে সাশ্রয়ী হোন এবং সময়মত গ্যাস বিল পরিশোধ করুন

প্রিপেইড গ্যাস মিটার ব্যবহার গ্রাহকদের সাশ্রয়ী স্মার্ট ও টেকসই সমাধান

বিনা কারণে গ্যাসের চুলা জ্বালিয়ে রাখা আর বিপদকে ডাকা একই বিষয়

জালালাবাদ গ্যাস



- প্রাকৃতিক গ্যাস একটি অতি গুরুত্বপূর্ণ জাতীয় সম্পদ।
- প্রাকৃতিক গ্যাস অফুরন্ত কোন সম্পদ নয়। এ সম্পদের অপচয় রোধ করা ও সুষ্ঠু ব্যবহার নিশ্চিত করা দেশের প্রতিটি নাগরিকের একান্ত দায়িত্ব ও কর্তব্য।
- গ্যাস ব্যবহারে সাশ্রয়ী হোন এবং সময়মত গ্যাস বিল পরিশোধ করুন।
- বদ্ধ ঘরে গ্যাসের চুলা জ্বালাবেন না। দুর্ঘটনা এড়াতে রান্নার পর গ্যাসের চুলা নিভিয়ে ফেলুন।
- আপনার আঙ্গিনায় গ্যাস রেগুলেটর বা লক উইং কক লিক হলে সাথে সাথে সংশ্লিষ্ট কার্যালয়ের মাধ্যমে পরিবর্তনের ব্যবস্থা নিন।
- জালালাবাদ গ্যাসের অনুমোদিত ও তালিকাভুক্ত ঠিকাদার ব্যতীত অন্য কারো মাধ্যমে গ্যাস বিষয়ক কোন কাজের পদক্ষেপ নেবেন না।
- অবৈধভাবে গ্যাস ব্যবহার এবং তিন মাসের অধিক বকেয়া বিল পরিশোধের ব্যর্থতায় গ্যাস সংযোগ বিচ্ছিন্ন করা হচ্ছে।
- "বাংলাদেশ গ্যাস আইন, ২০১০" অনুযায়ী গ্যাসের অবৈধ ব্যবহারের জন্য সর্বোচ্চ ৫ (পাঁচ) বছর কারাদন্ড, অর্থদন্ড অথবা উভয়দন্ডে দন্ডিত হওয়ার বিধান রয়েছে।
- সিলেট বিভাগের আর্থ-সামাজিক উন্নয়নে প্রাকৃতিক গ্যাস সরবরাহ ও বিপণন কাজে নিয়োজিত।

জালালাবাদ গ্যাস

জালালাবাদ গ্যাস ট্রান্সমিসন এ্যান্ড ডিস্ট্রিবিউশন সিস্টেম লিঃ

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- এ নগর আমাদের সকলের। আসুন সবাই মিলে নিজ নিজ আঙ্গিনা পরিষ্কার-পরিচ্ছন্ন রেখে দূষণমুক্ত সুন্দর নগর গড়ি।
- আপনার শিশুর স্বাস্থ্য সুরক্ষায় সময়মতো টিকা দিন।
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- যথাসময়ে সিটি কর্পোরেশনের হোল্ডিং ট্যাক্স, পানির বিল ও বর্জ্য ফি পরিশোধ করে নাগরিক সেবার সুযোগ দিন।
- ট্রেড লাইসেন্স করে ব্যবসা পরিচালনা করুন। ট্রেড লাইসেন্স যথাসময়ে নবায়ন করুন।
- ফুটপাত ও সড়ক দখল করে ব্যবসা পরিচালনা করবেন না।
- সিটি কর্পোরেশনের নির্ধারিত স্থানে পশু জবাই করুন।
- সিটি কর্পোরেশনের অনুমতি নিয়ে বিল্ডিং কোড মেনে নতুন দালানকোঠা নির্মাণ করুন।
- গভীর নলকূপ স্থাপনে সিটি কর্পোরেশনের অনুমতি নিন।
- খাল, ছড়া এবং ড্রেনে ময়লা আবর্জনা ফেলবেন না। প্রতিদিন ঘরবাড়ির সকল আবর্জনা একত্র করে রেখে সিটি কর্পোরেশনের ভ্যান/ট্রাকে তুলে দিন।
- হোটেল রেস্টুরেন্টের আবর্জনা/উচ্ছিষ্ট খাবার নির্ধারিত স্থানে ফেলুন।
- যে কোনো প্রয়োজনে সিটি কর্পোরেশনের কন্ট্রোল রুম নম্বরে (০১৯৫৮-২৮৪৮০০) যোগাযোগ করুন।

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