UMT 2nd International Conference on Emerging Trends in Physics

Abstract Book-ICP-25

April, 14-15, 2025

(ISBN: 978-969-9368-97-4)

DEPARTMENT OF PHYSICS
UNIVERSITY OF MANAGEMENT AND TECHNOLOGY,
LAHORE PAKISTAN.

UMT 2nd International Conference on Emerging Trends in Physics

Conference Patrons

Ibrahim Hassan Murad
President ILM Trust,
President UMT

Prof. Dr. Asif Raza *S.I. H.I.*
Rector, UMT

Ahmad Abdullah
DG UMT

Conference Chair

Prof. Dr. Sammia Shahid
Dean SSC

Dr. Tanvir Hussain
Chairperson

Conference Secretary

Dr. Qayyum Zafar

Member Organizing Committee

- Prof. Dr. Arshad Majid Mirza
- Prof. Dr. M.A.K. Lodhi
- Prof. Dr. Muhammad Imran Jamil
- Prof. Dr. Zaheer Hussain Shah
- Dr. Qurat ul Ain
- Dr. Muhammad Tahir
- Dr. Sidra Khalid
- Dr. Saira Shaheen
- Dr. Shamsa Kanwal
- Ms. Sidra Ashraf
- Ms. Hira Yaseen
- Ms. Hudabia Murtaza
- Mr. Syed Nasrullah Ali Qazi
- Ms. Rabia Nasar
- Mr. Muhammad Anas Toheed
- Mr. Joun Ali Faraz
- Mr. Qurban Ali
- Mr. Muhammad Bilal
- Mr. Imtiaz Ali
- Mr. Abdul Rehman
- Mr. Usman Saleem
- Mr. Adil Shehzad

Preface

Welcome to the Abstract Book of the UMT 2nd International Conference on Emerging Trends in Physics (ICP-2025). It is with great pleasure that we welcome you to the 2nd International Conference on Emerging Trends in Physics (ICP-2025), organized by the Department of Physics at the University of Management and Technology (UMT), Lahore. Following the success of ICP-2024, this year's conference aims to build upon the foundation of knowledge and collaboration established in the inaugural event, further expanding the horizons of cutting-edge research and scientific discourse in physics.

This abstract book serves as a comprehensive compilation of the research contributions presented at ICP-2025, offering valuable insights into the latest advancements and scientific discussions that have taken place throughout the conference. It encapsulates a diverse array of research topics, methodologies, and findings, reflecting the dynamic and interdisciplinary nature of modern physics.

Physics, as a field of study, is in a constant state of evolution and expansion, driven by scientific curiosity, technological innovation, and collaborative research efforts across the globe. The rapid progression in various branches of physics has led to transformative discoveries and advancements that impact not only the academic community but also industries, healthcare, energy, and the environment.

ICP-2025 provides an essential platform for physicists, engineers, researchers, and industry experts to come together, share their latest findings, and explore new research avenues. By fostering an environment of knowledge exchange, the conference facilitates interdisciplinary discussions, the formation of collaborative networks, and the encouragement of novel research directions.

The theme of ICP-2025 encompasses emerging trends in physics, aiming to highlight the groundbreaking discoveries and technological innovations that define the current era. The conference brings together leading theorists, experimentalists, and applied physicists to discuss advancements in condensed matter physics, particle physics, quantum mechanics, astrophysics, nanotechnology, materials science, biophysics, computational physics, and many other specialized domains.

The abstracts featured in this book represent contributions from esteemed academicians, researchers, and industry professionals, addressing fundamental questions and practical applications of physics. Some key areas of focus include:

- **Condensed Matter Physics:** Exploring novel materials, superconductivity, and phase transitions.
- **Quantum Mechanics and Quantum Computing:** Investigating quantum coherence, entanglement, and computational breakthroughs.

- **Astrophysics and Cosmology:** Advancements in black hole physics, gravitational waves, and cosmic evolution.
- **Particle Physics and High-Energy Physics:** Insights from collider experiments and theoretical particle models.
- **Plasma Physics and Fusion Energy:** Addressing sustainable energy solutions through controlled nuclear fusion.
- **Biophysics and Medical Physics:** Applications of physics in healthcare, imaging technologies, and biomaterials.
- **Computational and Theoretical Physics:** Leveraging numerical simulations and AI-driven physics modeling.
- **Optics and Photonics:** Innovations in lasers, optical communications, and metamaterials.
- **Applied and Engineering Physics:** Industrial applications, smart materials, and emerging technologies.

Each abstract in this book encapsulates a unique scientific contribution, demonstrating the profound impact of physics in unraveling the fundamental principles governing the universe and devising innovative solutions to real-world challenges. The success of ICP-2025 would not have been possible without the dedication and collaborative efforts of numerous individuals and organizations. We extend our sincere gratitude to:

- All the authors and researchers who submitted their high-quality abstracts and contributed to the rich scientific content of this conference.
- The esteemed panel of reviewers, whose meticulous evaluation ensured the scholarly integrity and relevance of the submitted abstracts.
- The organizing committee members, for their unwavering commitment to planning and executing a successful conference.
- Session chairs and moderators, for facilitating insightful discussions and maintaining an engaging academic environment.
- Keynote and invited speakers, for sharing their expertise and inspiring the participants with thought-provoking presentations.
- Sponsors and institutional partners, for their valuable support and contributions towards the success of ICP-2025.
- Volunteers and staff members, for their relentless dedication in managing the logistics and ensuring a seamless experience for all attendees.

As we move forward, the research presented in ICP-2025 will continue to serve as a catalyst for future discoveries and innovations. We encourage researchers to utilize the ideas, methodologies, and collaborations initiated at this conference to drive scientific progress in their respective fields.

We hope that the abstracts compiled in this book will provide inspiration, knowledge, and motivation for continued exploration in the fascinating world of physics. Whether you are an

early-career researcher or an experienced scientist, the insights gained from this conference will undoubtedly contribute to your academic and professional growth.

The University of Management and Technology (UMT), Lahore, remains committed to fostering a culture of scientific inquiry, innovation, and excellence. We are confident that ICP-2025 will serve as a stepping stone for future breakthroughs in physics, further strengthening global collaborations and research endeavors.

We thank you for your participation and contribution to ICP-2025. We eagerly look forward to welcoming you to future editions of the International Conference on Emerging Trends in Physics, where we will continue to explore new frontiers and push the boundaries of scientific knowledge.

Best regards,
Organizing Committee (ICP-2025)
University of Management and Technology (UMT), Lahore

Table of Content

Synthesis of Advanced Nanostructures via PLAL: A Novel Approach for Energy Harvesting, Storage, Green Hydrogen Production, Carbon Management for Sustainable Development

Muhammad Ashraf Gondal
[1]Department of Physics, Center of Research Excellence in Nanotechnology (CENT),
[2]K.A.CARE Energy Research and Innovation Center,
King Fahd University of Petroleum & Minerals, Dhahran 31261, Saudi Arabia
email: magondal@kfupm.edu.sa

Abstract

Nanomaterials possess unique properties that make them highly attractive for various applications due to their size- and shape-dependent physio-chemical, optical, and electronic properties. These properties enable them to serve as novel structural building blocks for the preparation of advanced functional materials for energy harvesting, energy storage, photodetectors, photonics, and other devices. Recently, our research group has focused on the synthesis and characterization of high-purity semiconductor nano-composite materials using a green and clean method called pulsed laser ablation in liquids (PLAL). By fusing these materials to form proper heterogeneous structures using the PLAL technique, we have observed immense improvements in their optical and chemical properties.

We have developed a rapid, clean, and one-step PLAL method for synthesizing high-purity nanocrystals of metal oxides, semiconductors, and their nanocomposites using different aqueous media. This method employs the second harmonic of a Nd:YAG nanosecond pulsed laser as an irradiation source. In addition to pure and composite metal oxides, we have also synthesized quantum dots of various cadmium and other compounds using this setup. The morphological and optical characterizations of the synthesized nanocomposites and quantum dots reveal that they possess better characteristics in terms of optical and chemical properties compared to those prepared via complicated wet chemical methods.

The nano-engineered functional materials synthesized using our laser-based synthesis method have been applied in various areas, including renewable energy harvesting devices (third-generation dye-sensitized and perovskite solar cells), thermoelectric devices, energy storage devices (supercapacitors, light-sensitive supercapacitors, perovskite-based supercapacitors), perovskite-based photo-detectors, CO_2 conversion into value added hydrocarbons and green H_2 production. In the field of clean water, we have applied these nano-materials for photocatalytic removal of organic pollutants and harmful microbes, as well as oil-water separation using hydrophilic and oleophobic surfaces. Depending on the duration of the talk, some of these important applications conducted by our research group will be discussed and presented. The author is thankful to KFUPM for supporting this work under project # H_2FC 2305.

Emerging Neuromorphic Vision Sensor Technologies

Ali Imran
National Nanotech Innovation Center, Guangzhou, China.
email: aliimran@pku.edu.cn

Abstract

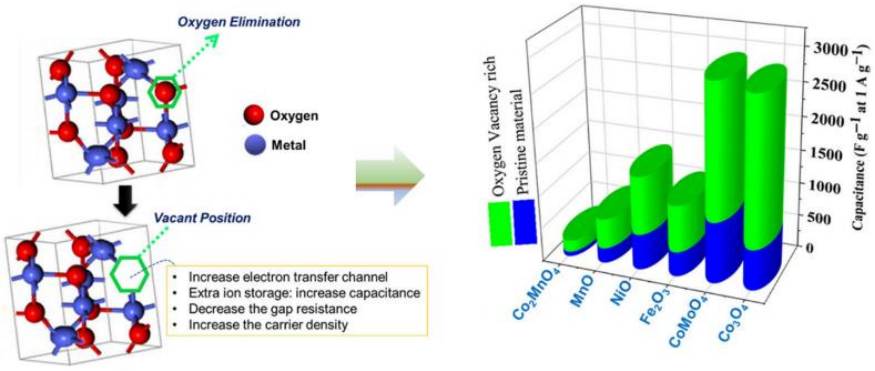
In recent years, the Integration of advanced materials in machine vision systems has opened the new horizons of innovation for next-generation vision sensors. The current work will present the emerging neuromorphic vision sensor (NVS) technologies, demonstrating the development of high-performance systems capable of mimicking the human eye and neural functions. We will Focus on distinct sensors architectures achieved by the complex integration of two-dimensional materials, high-k dielectrics and ferroelectric. Furthermore, their performance across a broadband optical spectrum, capability to emulate synaptic plasticity, and potential applications, especially in artificial intelligence will be highlighted. The powerful capability of sensing, analyzing, and remembering of the NVS will also be discussed. We warmly welcome researchers to explore the interesting journey towards the future NVS systems through cutting-edge research, which is expanding the boundaries of existing machine vision, neuromorphic computing, and intelligent systems.

Hydroxyl-Deficient or Partially Reduced Metal Oxides for Achieving High-Performance Energy Storage Devices

Nadeem Hussain Solangi
Beijing University of Chemical Technology, Beijing, China
email: solanginadeemhussain@gmail.com

Abstract

Metal oxides (MOs) are promising materials for supercapacitor (SC) electrodes due to their exceptional electrochemical properties. However, optimizing their conductivity and electrochemical activity remains a challenge for achieving high-performance SCs. Hydroxyl-deficient or partially reduced MOs have recently gained attention for their ability to enhance capacitance through the introduction of oxygen/hydroxyl vacancies. These vacancies provide additional active sites for electron storage, thereby improving the material's electrochemical performance. This talk explores the synthesis and characterization of hydroxyl-deficient metal oxides, layered double hydroxides (LDHs), and their nanocomposites for advanced supercapacitor applications. A comparative analysis with recent literature underscores the superior performance of these materials, highlighting the potential of hydroxyl vacancies in SC applications. Looking ahead, the incorporation of MXene, graphene, and carbon frameworks into such composites is proposed to further enhance the electrochemical properties of SC electrodes. This talk lays the groundwork for the systematic development of oxygen vacancy-rich metal oxide-based materials, offering a promising path for future advancements in energy storage technologies.



Quarkonium spectral functions and thermal static quark-antiquark potential from Lattice QCD

Sajid Ali
Faculty of Physics, University of Bielefeld, Germany
email: Sali@physic.uni-bielefeld.de

Abstract

Quarkonia, the bound states of heavy quark-antiquark airs, have proven to be crucial probes for studying quark-gluon plasma. The color screening properties of the QGP weaken the interaction between quark- antiquark pairs, leading to the suppression of quarkonia yields within the QGP. We present some preliminary results on the fate of quarkonia bound states in the QGP by performing spectral reconstruction from lattice cor- relators. The spectral function is reconstructed by combining the vacuum part, which is valid at large energy, with the one obtained from the thermal potential near the threshold. We observe that this spectral function effectively describes the lattice data. Our findings indicate that the thermal interaction shifts the bound state mass and results in a significantly larger thermal width. In the charmonium system, the width is much larger than in the bottomonium system.

Emerging Trends in Electrochemical Energy Storage: Innovations for Sustainable Solutions

Syed Shaheen Shah

Socio-Environmental Energy Science Department, Graduate School of Energy Science, Kyoto University, Yoshida Honmachi, Sakyo-ku, Kyoto 606-8501, Japan

Email:syedshaheenshah3@gmail.com

Abstract

Electrochemical energy storage systems are vital to address the growing global demand for sustainable and efficient energy solutions. Among these, supercapacitors have emerged as a promising class of energy-storage devices, bridging the gap between conventional batteries and capacitors. This talk delves into recent advancements and emerging trends in the field of supercapacitors, with a focus on the utilization of biomass-derived carbon as a sustainable and cost-effective material. The unique properties of biomass-derived carbon, including its high surface area, tunable porosity, and environmental friendliness, make it an attractive choice for supercapacitor applications. In addition, their integration with redox-active materials, such as conductive polymers and layered double hydroxides, opens new avenues for achieving superior energy and power densities. This presentation explores the synthesis strategies, material properties, and electrochemical performance of innovative composites for next-generation supercapacitors, addressing challenges and opportunities through green technologies and advanced fabrication techniques, while highlighting future trends and the potential of hybrid energy storage systems to foster sustainable energy solutions.

Magnetohydrodynamical Model for Stellar and Galactic Winds

Bilal Ramzan
Department of Physics, University of Agriculture Faisalabad
Email. bilal@gm.astro.ncu.edu.tw

Abstract

Cosmic rays are the energetic charged particles and their transport plays an important role in the feedback processes in the intergalactic as well as interstellar enviorments. One of the reasons for launching the stellar/galactic winds throughout the galaxy is also driven by the significant pressure cosmic rays. Cosmic rays effectively coupled to the ejected plasma via streaming instabilities (scattering of hydro-magnetic waves). We are interested to find the stellar wind solutions by including the effects of cosmic rays under the influence of forward/backward propagating self-excited Alfven wave. Cosmic rays can modify the flow via their pressure gradient with diffusive flux. We consider our system as a Four-fluid (MHD) system in which we have thermal plasma, cosmic rays and forward/backward propagating Alfven wave. We want to investigate and analyze the one-dimensional steady flow with the dynamical effects of the cosmic rays.

Doped Layered Cathodes Materials and Their Reaction Mechanism Investigation for Sodium-Ion Batteries

Aneeqa Liaqat [a], Ghulam Alia,*
aUSPCAS-E, National University of Sciences and Technology (NUST), H-12, 44000, Islamabad, Pakistan.
Email- ali@uspcase.nust.edu.pk

Abstract:

Lithium-ion batteries (LIBs) are being used into a growing number of electronic products, including electric vehicles and stationary storage. However, the barriers to large-scale stationary storage include the high cost and limited availability of lithium resource supplies. Because sodium materials are abundant and inexpensive, sodium-ion batteries (SIBs), are becoming a viable replacement for LIBs. High performance anode and cathode materials are necessary for SIBs to be successfully commercialized. In this study, layered cathode materials have been prepared using the facile and scalable solid state method. The prepared cathodes have shown better rate capability and capacity retention when tested in SIBs. The reaction mechanism of the prepared cathodes was investigated using in-situ XRD, X-ray absorption spectroscopy, and high resolution ex-situ transmission electron microscopy. The obtained results indicate that the dopant material has played a vital role in the stabilization of crystal structure of the cathodes.

First Principle study of Mxene M_2XT_2 (M = Hf, Zr; X = C; T = O, F) for photovoltaic applications

Hassan Ali
Department of Physics, University of Narowal, PO 51600, Narowal, Pakistan
Email. Hassan.ali@uon.edu.pk

Abstract

This study employs density functional theory (DFT) computation utilizing the PBE-GGA approximation within the WIEN2k code to investigate the characteristics of MXene M_2XT_2 (where M = Hf, Zr; X = C; T = O, F). These understudied materials are non-magnetic and exhibit a hexagonal crystal structure with space group 164-P-3m1. A comparative analysis of the properties of understudied material was conducted. Our calculated density of states and electronic band structure are consistent with prior results. Hf_2CO_2 and Zr_2CO_2 exhibited indirect bandgaps of 1.16eV and 1.15eV, respectively, classifying them as semiconductors. Conversely, Hf_2CF_2 and Zr_2CF_2 are semimetals because of small energy overlapping between the minimum and maximum of conduction and valence bands. The optical properties of the understudied materials were explained by optical conductivity, loss parameter, extinction coefficient, refractive index, reflectivity, absorption coefficient, and dielectric function. Our findings indicate that these understudied materials are suitable for sustainable energy devices, including photovoltaic cells and optoelectronics. Electronic and optical characteristics support their suitability for optoelectronic devices, photocatalysis, and optics.

Hybrid Energy Storage Devices for Sustainable Development

Muhammad Zahir Iqbal

GIK Institute of Engineering Sciences and Technology

Email: zahir@giki.edu.pk, zahir.upc@gmail.com

Abstract

Climate change is a pressing global challenge with profound implications for sustainable development. Rising temperatures, melting polar ice, and increasing frequency of extreme weather events threaten ecosystems, human livelihoods, and economic stability. These impacts exacerbate existing inequalities, disproportionately affecting vulnerable populations and regions, particularly in developing countries. Sustainable development offers a framework to address these challenges by integrating environmental, social, and economic goals. Strategies such as transitioning to renewable energy, enhancing energy efficiency, promoting sustainable agriculture, and protecting biodiversity are essential to mitigating climate change while fostering development. Advances in technology and innovative financing mechanisms, such as green bonds and carbon markets, are enabling scalable solutions to combat climate change while driving economic growth. However, achieving these goals requires a paradigm shift in consumption patterns, governance structures, and stakeholder engagement. Empowering communities through education and participatory decision-making enhances resilience and fosters ownership of sustainable initiatives. In conclusion, aligning climate action with sustainable development is not only an ethical imperative nonetheless also a pathway to initiating a resilient, equitable, and thriving global society. Collaborative, inclusive efforts are key to this transformative journey.

Unveiling Radiation Effects in Metallic and Semiconductor Materials: From Fundamental Insights to Cutting-Edge Applications

Naveed Afzal

Centre for Advanced Studies in Physics, Government College University, Lahore, Pakistan

Email: naveedafzal@gcu.edu.pk

Abstract

Radiation effects in metallic and semiconductor materials have profound implications across a range of advanced technological applications, from aerospace and nuclear industries to microelectronics and photovoltaics. When exposed to radiation, these materials undergo structural, electrical, and mechanical modifications that can be harnessed to improve performance, longevity, and functionality under extreme conditions. Understanding the fundamental mechanisms of radiation-induced changes in these materials is essential for developing resilient components and devices that can withstand high-radiation environments. This presentation is focused on providing radiation induced changes in metallic and semiconducting materials. In metallic materials, Ti6Al4V was implanted with 50 keV Ar ions at 1×10^{15} ions/cm^2 using an ion implanter. The results showed a significant improvement in the corrosion resistance of the alloy due to ion implantation with a marginal decrease in its hardness. Similarly, the semiconductor materials such as ZnS and NiO were exposed to 25 keV nitrogen and 300 keV carbon ions at different doses. Surface roughness of the films were increased after the ion implantation along with a small decrease in its crsytallinity. The ion-implanted samples showed better photodetection performance under the UV illumination.

Utilization of a Smart TiCo Alloy for Pressure-Induced Hydrogen Storage

A.A.Mubarak[a] and Saad Tariq [b]
[a]Physics Department, Rabigh College of Science and Arts, King Abdulaziz University, Jeddah, Saudi Arabia.
[b]Department of Physics, Faculty of Science and Technology, University of Central Punjab, Lahore 53400, Pakistan
Email:saad.tariq01@ucp.edu.pk

Abstract

One of the most important challenges facing countries is providing cheap energy and renewable sources. Therefore, a smart alloy will be proposed for hydrogen storage due to its ability to expand and contract without breaking and being little affected by heat. In this investigation, the first performance principle is applied to examine the effect and utility of hydrogen absorption in smart TiCo alloy. The hydrogen atoms absorbed at the bridge (TiCoH3-B), face-centered cubic (TiCoH3) and tetrahedral interstitial (TiCoH8) sites in TiCo alloy were studied. The elastic constants, enthalpy of formation energy, and tolerance factors show that TiCoH3 and TiCoH8 are stable alloys and can be formed, while TiCoH3-B is not elastically stable. Cohesive energy shows that increasing induced pressure and hydrogen absorption reduces the stiffness of TiCoH3 and TiCoH8, without alloy collapse. The gravimetric storage capacity of CoTiH3 and TiCoH8 is found to be large enough to be suitable as alloys for hydrogen storage. Pugh's B/G ratio, and anisotropy factor assume that TiCo with or without hydrogen atoms is classified as a ductile and anisotropic alloy, with except for TiCoH8 has brittle behavior up to 40 GPa. The bonding nature of $TiCoH_3$ alloy has a mixture of covalent (Co – H) and ionic bond (CoH6 – Ti). In contrast, TiCoH8 exhibits a covalent bond in the form of Ti – H – Co. Hydrogen absorption and induced pressure encourage electrons to rearrange into the spin up and down channels resulting in a decrease in the overall magnetic moment of the alloy. The mechanical, electronic, and magnetic properties show promise for industrial applications of these alloys, such as piezoelectric and hydrogen storage, and spin and magnetoelectronic manufacturing.

Keywords: Hydrogen storage; absorption energy; Mechanical properties; Charge contours; Magnetization.

Tuning the Multiferroicity of BFO with Potential Dopants

Muhammad Amin
The University of Lahore.
Email.muhammad.amin@physics.uol.edu.pk

Abstract

Energy storage devices play a vital role in modern technology. A single device can perform multifunction if fabricated using a multifunctional material like BiFeO3. For this purpose, a series of La and Cr doped BiFeO3 was synthesized using a cheap and popular technique named sol-gel auto combustion. Urea and glycine were used as chelating agents to ignite and robust the combustion process in order to improve the purification of the residue. A single phase rhombohedral distorted perovskite crystal structure related to bismuth ferrite with space group R3c (161) was confirmed from the X-ray diffraction patterns. Doping of La/Cr at Bi/Fe lattice sites in BiFeO3 did not affect the crystal symmetry of the parent compound. Analysis of surface morphology of all the samples through field emission scanning electron microscope exhibited homogeneous micro structures showing uniform distribution of multi-shaped grains as well as a decreasing trend in porosity and grain sizes with increasing Cr contents. The energy dispersive X-ray spectrum of each composition depicted all the elements in accordance with its stoichiometric formula. Enhanced saturation magnetization was observed with increasing doping concentration in the parent compound. Improved polarization versus electric field loops were observed in Mn and Sr co-doped BiFeO3 nanoparticles. All the properties in the present research work have been explained on the basis of dopants and their concentrations, phase purity, microstructures and grain sizes.

Discrimination of hard dental tissues of diabetic and healthy participants based on variation in elemental compositional analysis via CF-LIBS

Khurram Siraj[1], Muhammad Mustafa Dastageer[1], Amir Israr[2], Shazia Naz[3], Sami ul Haq[2], Muhammad Qasim[1], Rizwan Ahmad[4]

[1]Laser & Optronics Centre, Department of Physics, University of Engineering and Technology (UET), Main Campus, G. T. Road, Lahore, Pakistan
[2]National Institute of Lasers and Optronics - College (NILOP-C), Pakistan Institute of Engineering and Applied Science, Islamabad, Pakistan
[3]Operative Dentistry de'Montmorency College of Dentistry, Lahore, Pakistan
[4]National Centre for Physics (NCP), Islamabad, Pakistan

Abstract

It is significant to measure the effect of systemic disease, diabetes mellitus type II, on dental tissues (enamel, dentine, and cementum) for early detection of diabetes, oral health issues, and preventive care. In this context, Laser-induced breakdown spectroscopy (LIBS) is an elemental analysis technique that has been leveraged to classify dental tissues based on plasma temperature estimated by Boltzmann plot method. One line calibration free (OL-CFLIBS) is employed to quantify elements in dental tissues of diabetic patients and healthy participants, fifteen subjects of each group. The average measured plasma temperature for enamel, dentine, and cementum are (17030 ± 2162) K, (14727 ± 1327) K, and (7371 ± 852) K, respectively. Qualitative and quantitative analysis of detected toxic trace elements (Fe, Pb, Ni, Sn) revealed that their concentration on dental tissues of diabetic patients is higher than the healthier ones irrespective of age and gender. These outcomes are validated by standard elemental techniques, energy dispersive X-ray spectroscopy (EDX) and X-ray fluoroscopy (XRF). The research has applications in the field of laser dentistry regarding special attention to diabetic patients treatment and observing the after-effects of diabetes on dental tissues.

Boosting Lithium-Ion Storage in Ferrites via Hybridization with Carbon Derivatives

Mubasher,
[1]Department of Computing and Technology, IQRA University, H-9 Islamabad, Pakistan
Email : mubasher.rajpoot@iqraisb.edu.pk

Abstract

Developing high-performance electrode materials for lithium-ion batteries (LIBs) requires high electrical conductivity, rapid ion transport, and a large surface area. Ferrite nanoparticles and carbon derivatives i.e.; multi-walled carbon nanotubes (MWCNTs) and reduced graphene oxides (rGOs) nanosheets are synthesized into ferrite-MWCNTs or ferrite-rGOs nanohybrids using a two-step approach. Ferrite nanoparticles are first prepared via chemical methods (co-precipitation or solgel), followed by an ultrasonic-assisted assembly of ferrite-MWCNTs or ferrite-rGOs nanohybrids in a dispersive medium. Structural and morphological characterizations confirmed the formation of FCC crystal structure and the uniform dispersion of ferrite nanoparticles on MWCNTs and rGOs. Ferrite nanoparticles embedded onto MWCNTs and rGOs established an interconnected network, enhancing electron transport pathways crucial for superior LIBs performance. Electrochemical evaluations revealed a high specific capacity of 1342 mAh/g and an excellent reversible capacity of 775 mAh/g at 100 mA/g. Notably, after 100 cycles, the specificcapacity retained its initial value for optimized composition with Coulombic efficiency above 97% making these nanohybrids a promising candidate for advanced energy storage applications. This facile, cost-effective synthesis strategy offers a promising avenue for developing high-performance anode materials for next-generation lithium-ion batteries.

Keywords: Toluene, Lithium-ion battery, Cyclic stability, Rate capability, Specific capacity.

Plasma Parameters in a Multicascade Liner Staged Pinch Device with Finite-β Effect

Arshad M. Mirza, F. Deeba, Z. Ahmed, and G. Murtaza
Dr. Arshad Majid Mirza (S.I.)
School of Science (SSC)
University of Management and Technology

Abstract

The multi-cascade system is effective in achieving thermonuclear fusion conditions, and with an optimal choice of puff thickness and mass ratio, a pinch plasma close to fusion conditions can be obtained. The magnetohydrodynamic (MHD) model provides a more consistent plasma description, predicting a pinch plasma density approximately 1000 times the initial density within a nanosecond timescale, satisfying the Lawson criterion. Additionally, the ion temperature can reach around 80 keV, which is sufficient to sustain fusion reactions.

Solution processed organic photodiodes: Design, Fabrication and Characterization

Qayyum Zafar
Department of Physics, University of Management and Technology, Lahore 54000, Pakistan.
qayyum.zafar@umt.edu.pk

Abstract

Herein we encompass an examination of photodiodes constructed from organic semiconductor materials (OPDs) exhibiting sensitivity to visible light spectrum. The investigation is systematically divided into five distinct sections. Initially, a comprehensive bibliographic analysis is conducted, elucidating the fundamental principles of organic materials and the operational mechanisms underlying organic photodiodes. Subsequently, an extensive exploration of the methodologies and metrology is articulated, which was meticulously executed to design and fabricate novel optoelectronic devices capable of accurately characterizing organic devices. The intricacies of the fabrication process and optimization phases of organic photodiodes are thoroughly delineated. The experimental segment is dedicated to an analysis of the origins of dark current in organic devices predicated on electron donor/acceptor configurations. A selection of materials is critically assessed, and an exhaustive characterization of cutting-edge organic photodiodes is presented in a detailed manner. The performance metrics obtained were comparable to those exhibited by inorganic sensors utilizing silicon technology.

Real-Time Physics-Based AI and HPC Integration for Green Technology Innovations

Antonis Papadakis[1,2]
[1]KYAMOS Ltd., 37 Polyneikis Street, Strovolos, Nicosia 2047, Cyprus.
[2]Department of Electrical, computer Engineering and Infrmatics, Frderick University, Nicosia 1036, Cyprus.
apapadakis@kyamosmultiphysics.com, a.papadakis@frederick.ac.cy

Abstract

Kyamos Multiphysics Ltd. develops advanced multiphysics simulation software that integrates scientific accuracy with broad user accessibility. Our platform supports real-time simulations optimized for high-performance computing environments, utilizing cloud systems, InfiniBand, GPUs, and CUDA-aware MPI. Designed with a user-friendly graphical interface, the software caters to both technical and non-technical users. At its core, Kyamos's simulation engine combines powerful numerical solvers, including the Lattice Boltzmann Method with Multiple Relaxation Time (LB-MRT) for fluid dynamics, Finite Volume (FV) methods, and time-integrated UNET architectures for machine learning-enhanced physics modeling. These approaches enable precise simulation of fluid flow, heat transfer, and coupled phenomena, supporting innovation in sustainable technologies. Currently, Kyamos is applying this framework to a hybrid renewable energy project focused on optimizing smart grid systems integrating wind and solar energy. We are developing an interactive GUI to design, visualize, and manage these grids. Features include climate-aware visualizations, load and generation data integration, and tools built with wxWidgets, OpenGL, OpenCascade, plPlot, and Paraview. To inform grid optimization, we perform high-fidelity CFD simulations using a custom LB-MRT-LES solver to model wind and solar behavior under real weather conditions. This data is fed into an Asynchronous Deep Reinforcement Learning (ADRL) model trained in Python using techniques such as Q-learning, DQN, and PPO. The ADRL system dynamically adjusts power flow across the smart grid to maximize energy efficiency. Our simulations are supported by Kyamos's high-performance computing infrastructure, featuring InfiniBand GPU clusters and MPI tools like OpenMPI. This integrated approach exemplifies the convergence of computational physics, AI, and renewable energy technologies, offering scalable solutions for next-generation energy systems.

Density Functional Theory Investigation of Physical Properties and Hydrogen Storage Potential in CaXH3 (X: Na, Al and Y)

Muhammad Yasir, Muhammad Tahir
Department of Physics, University of Management and Technology, Lahore 54000, Pakistan.
email: muhammad.tahir@umt.edu.pk

Abstract

Density Functional Theory Investigation of Physical Properties and Hydrogen Storage Potential in $CaXH_3$ (X: Na, Al, and Y)" explores the potential of calcium-based hydrides—$CaNaH_3$, $CaAlH_3$, and $CaYH_3$—as hydrogen storage materials for sustainable energy systems using Density Functional Theory (DFT). This research analyzes their structural (e.g., lattice parameters, unit cell volumes), mechanical (e.g., bulk modulus), thermodynamic (e.g., formation energies), electronic (e.g., band structures), and optical properties, focusing on how the substitution of X (Na, Al, or Y) affects their hydrogen storage capabilities, including gravimetric and volumetric capacities and decomposition temperatures. Structurally, $CaYH_3$ has the largest unit cell volume, while $CaAlH_3$ is the most compact; mechanically, all are stable, with $CaYH_3$ showing the highest bulk modulus for greater deformation resistance. Thermodynamically, negative formation energies confirm stability, with $CaNaH_3$ being the most stable, and all compounds exhibit metallic behavior to enhance hydrogen kinetics. For storage, $CaNaH_3$ offers the highest gravimetric capacity at 4.38 wt%, ideal for mobile applications, while $CaAlH_3$ leads with a volumetric capacity of 84.52 g H_2/L, suited for stationary uses—though neither meets the U.S. Department of Energy's 5.5 wt% target. This study underscores $CaNaH_3$ and $CaAlH_3$ as promising candidates and suggests future enhancements like doping or catalyst integration to boost performance, advancing hydrogen storage solutions for clean energy.

Fabrication and Characterization of Polyaniline (PANI) Thin Films for Solid State Devices

Sohail Ahmad, Muhammad Tahir
Department of Physics, University of Management and Technology, Lahore 54000, Pakistan.
email: muhammad.tahir@umt.edu.pk

Abstract

In the world of miniature advancements in technology, a current champion has emerged the micro supercapacitor. The development of portable devices such as sensors, flexible and wearable electronics and energy efficient devices, etc. The emerging focus of the researcher depends on one of the affordable, environmentally friendly electronic devices. Polyaniline is a conductive polymer, and the cellulose material is a biodegradable substrate. Different concentrations of polyaniline ink in 10ml of DMF were prepared. The concentrations used were 0.5%,1%,1.5%,2%,2.5%, and 3%. After preparing these solutions, the cellulose papers were dip-coated for different times ranging from 1 to 5 minutes. After dip coating, the cellulose papers were dried at 80°C. The dip-coated cellulose papers were used with devices having a sandwich structure of Ag/Coated Cellulose paper/Ag. Performance evaluation was done through current analysis with time for the investigation of the piezo-electric effect of dip coating on cellulose paper. Afterwards, different forces were applied to each sample, the force ranging from 4.5N to 13.5N, and their impact on piezoelectric behavior was analyzed. The result shows that piezoelectric behavior improved with increasing PANI Concentration when analyzed at the force 12.74 N. With a constant concentration of PANI, the piezoelectric electric behavior shows linearly enhanced /improved /increase with increased value of the applied force.

`

Photoelectrochemical Water Splitting by SnO2/CuO Thin Film Heterostructure Based Photocatalysts for Hydrogen Generation

Joun Ali Faraz
Department of Physics, University of Management and Technology, Lahore 54000, Pakistan.
email : joun.faraz@umt.edu.pk

Abstract

The emission of greenhouse gases from fossil fuels creates devastating effects on Earth& atmosphere. Therefore, a clean energy source is required to fulfill the energy demand. Hydrogen is a renewable energy source but unfortunately, on earth & surface, it exists in compound form. The best source of hydrogen is water and it is an uphill reaction. The dissociation of water using photoelectrochemical cells is considered as the best way to generate hydrogen. To produce hydrogen by splitting water, semiconductor Photocatalysts have received an enormous amount of academic research in recent years. A new class of co-catalysts based on transition metals has evolved as a powerful tool for lowering charge transfer barriers and increasing PEC efficiency. The efficiency of photocatalytic hydrogen generation remains challenging. To solve that challenge, appropriate and efficient Photocatalysts must be developed. One interesting strategy is to align the metal oxide band gaps like to lower them and improve the photocatalytic process. In this investigation, we used a physical vapor deposition approach to put these metal oxides onto an ITO substrate used a physical vapor deposition approach to put these metal oxides into an ITO substrate in this investigation. The SnO 2 and CuO thin films were prepared by thermal evaporation. In this research, SnO 2 /CuO heterostructure based Photocatalysts were prepared at 400 ºC, 500 ºC, and 600 o C. Spectrophotometry was used to determine the optical properties of the produced samples. Optical properties depict that heterostructure thin films showed less transmittance compared to pristine SnO 2 and CuO thin films. XRD patterns of the samples showed that SnO 2 /CuO heterostructure thin film annealed at 600 o C is polycrystalline and peaks are well matched with JCPDS cards of SnO 2 and CuO. It was noticed that heterostructure thin films showed better photocurrent response than compared to pristine SnO_2 and CuO films. The solar light to hydrogen conversion efficiency (STH%) of SnO 2 /CuO-600 o C thin film is tenfold the pristine CuO thin film. The solar to light hydrogen conversion efficiencies can be enhanced by Nano structuring of the prepared samples and making a better smooth film by employing a better deposition technique.

Facile synthesis of Zirconium metal organic framework for supercapacitor application

Muhammad Anas Toheed , Rabia Nasar , Tehreem Fakhar , Mareena
Department of Physics, University of Management and Technology, Lahore 54000, Pakistan.
email : anas.toheed@umt.edu.pk

Abstract

The rising demand for energy has put a lot of pressure on existing forms of energy and non-renewable resources. Such concern has urged the scientific community to look for environmentally friendly renewable energy sources. The use of renewable sources is challenging because their supply is stumpy and unpredictable, and that is why there is also a need for energy storage systems. Comparing supercapacitors with other storage technologies, the former is becoming popular because of its higher power density, appropriate charge discharge capability, and better cyclic performance. Supercapacitor performance depends evidently on their electrodes. Supercapacitor materials based on MOFs have been explored as prospective electrode materials attributable to their high porosity, density of active sites, structural pliability and facile synthesis. This work aims at the improvement of the electrochemical stability and capacity of the electrode material through doping of the MOF with transition metal oxides. In particular, MnO 2 @UiO-66 was prepared using the solvothermal process. Moreover, characterization analysis by XRD, FTIR, and SEM was performed to determine structure, morphology and composition of the attained material. As for the electrochemical characterization, cyclic voltammetry (CV), galvanostatic charge–discharge (GCD) and electrochemical impedance spectroscopy (EIS) were used. For the MnO 2 @UiO-66 electrode, the specific capacitance value of 1235 Fg –1 was obtained at current density of 1 Ag −1 , while at current density of 4 Ag −1 , after 5000 cycles, the specific capacitance was remained 87.5% of its initial value. All of these results highlight the possibilities of MnO 2 @UiO-66 as a promising electrode material for the supercapacitor.

Synthesis and Characterization of Lignocellulose Fiber/Copper doped Nickel Oxide (LC/Cu:NiO) Nanostructure Based Paper Electrode for Perovskite Solar Cells Applications

Rabia Nasar, Muhammad Anas Toheed , Tehreem Fakhar , Mareena
Department of Physics, University of Management and Technology, Lahore 54000, Pakistan.
email : rabia.nasar@umt.edu.pk

Abstract

Perovskite-based solar cells are involved in solar cell production as they enhance power conversion efficiency. The stability and performance of cells are mainly reliant on the materials used as hole transportation materials. One of the vital constituents of the perovskite solar cells are hole transporting layer. The supreme hole transporting material is the one that retains high hole mobility, durable air and mechanical stability and should have energy levels that are a suitable match with the perovskite layer. Lignocellulose (LC) fiber is reflected as a very abundant, eco-friendly, lightweight natural fiber and a biocompatible polymer. In this work Lignocellulose (LC) fiber is used as a substrate. As hole transporting materials (ETM) for perovskite solar cells, many kinds of semiconductor materials can be employed. In this research work, NiO is used as hole transporting material (HTM) due to its superior electrical properties, long-term mechanical and air stability, high hole mobility, and high conductivity. To enhance the properties of NiO thin films and also increase the power conversion efficiency of perovskite solar cells, Cu was added into it as a dopant. Cu-doped NiO (Cu:NiO) has a high conductivity compared to pure NiO. X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Ultraviolet-Visible Spectroscopy (UV-Vis), were carried out to characterize the synthesized material. It was indicated that Cu:NiO has better efficiency as a pure NiO when used as hole transporting material (HTM) in the Perovskite solar cells (PSC).

Dosimetric Comparison of Anisotropic Analytical and Acuros Algorithms in Head and Neck Cancer Patients with Denture Implants

Musafra Shan, Zaheer Hussain Shah
Department of Physics, University of Management and Technology, Lahore 54000, Pakistan.
email : zaheer.hussain@umt.edu.pk

Abstract

This study investigates the dosimetrist performance of the Anisotropic Analytical Algorithm (AAA) and the Acuros XB (AXB) algorithm in the treatment of head and neck cancer patients with denture implants. Accurate dose calculation in radiotherapy is crucial, especially in the presence of high-density materials such as dental implants, which can cause significant dose perturbations. The study includes a cohort of head and neck cancer patients with metallic denture implants who underwent radiotherapy planning using both AAA and AXB algorithms. The data was collected from cancer hospital and was analyzed by using some statistical software. Key metrics such as dose-volume histograms (DVHs), conformity indices, and dose heterogeneity were evaluated to compare the two algorithms. The findings highlight discrepancies in dose distribution, particularly in regions near the implants, emphasizing the limitations of the AAA in accounting for complex tissue heterogeneities and the superior accuracy of the AXB in such scenarios. The study concludes that the Acuros algorithm provides a more reliable dosimetric evaluation in the presence of dental implants, potentially leading to more effective and safer treatment outcomes. These results advocate for the adoption of advanced dose calculation algorithms like AXB in clinical settings for betterment of head and neck cancer patients with prosthetic dental appliances.

Comparative Evaluation of Butterfly Rapid Arc and Tangential Rapid Arc Techniques in Radiation Therapy for Breast Cancer Patients with Nodal Involvement

Sahar Mehmood, Zaheer Hussain Shah
Department of Physics, University of Management and Technology, Lahore 54000, Pakistan.
email : zaheer.hussain@umt.edu.pk

Abstract

To introduce the comparison of tangent bases rapid arc and butterfly rapid Arc Technique in Radiation therapy for advanced left breast cancer needing nodal involvement. Fifteen patients with advanced left breast cancer who had received modified radical mastectomy (MRM) and needed adjuvant radiotherapy including nodal irradiation were assessed. Among 30 radiotherapy treatment plans, 15 plans were designed by using tangent rapid arc technique and 15 plans were designed by using butterfly rapid arc technique of the same fifteen patients. The main difference of tangent rapid arc from butterfly rapid arc was that the area of avoidance sector within specific degrees of angle that had no monitor unit (MU) delivery was used in the arc planning, including a total of 5 sectors in 5 partial arcs. The dosimetry of planning target volume (PTV), right breast, bilateral lungs, and heart between tangent rapid arc and butterfly rapid arc were compared. The conformity index (CI) and homogeneity index (HI) of PTV between two groups were statistically equivalent which indicated that the treatment efficacy of the plans regarding tangent rapid arc was compatible with butterfly rapid arc. However, all neighboring organs at risk (OAR) showed a great percentage of reduction in mean doses and low dose parameters by using Eclipse ARIA Version 18. It is highly recommended for treating breast cancer, especially for difficult cases with left side disease needing nodal irradiation.

Synthesis and Characterizations of Carbon-Based Materials for Supercapacitor Applications

Iqra Nisar, Zaheer Hussain Shah
Department of Physics, University of Management and Technology, Lahore 54000, Pakistan.
email : zaheer.hussain@umt.edu.pk

Abstract

The development of efficient carbon-based electrode materials is crucial for advancing supercapacitor technology. In this study, graphene oxide (GO) was synthesized using the modified Hummers method and subsequently reduced at high temperature to obtain reduced graphene oxide (rGO). Multi-walled carbon nanotubes (MWCNTs) were purchased and functionalized to enhance their surface properties. Sulfur-doped graphitic carbon nitride (S-doped g-C_3N_4) was synthesized and further combined with GO, rGO, and functionalized MWCNTs to form binary composites. The optical properties of the synthesized materials were investigated using UV-Vis spectroscopy, while electrochemical characterizations, including cyclic voltammetry (CV), galvanostatic charge-discharge (GCD), and electrochemical impedance spectroscopy (EIS), were performed. The results demonstrated significant improvements in electrochemical performance, making these composites promising candidates for next-generation supercapacitor applications.

Rare-earth metal oxide nanocomposites with carbon as electrode for supercapacitors

Sidra Khalid, Sidra Ashraf
Department of Physics, School of Science, University of Management and Technology, Lahore 54782, Pakistan
email : sidra.ahsraf@umt.edu.pk

Abstract:

In this study, Oxides of rare earth metals Holmium and Cerium have been prepared for the purpose of their use in supercapacitors. This study shows the successful synthesis of Cerium oxide/Carbon (CeO2/C), and Holmium oxide (Ho2O3/C) nanocomposites by using the hydrothermal method. It not only contributes to advancing the fundamental understanding of electrode materials but also addresses the practical challenges in developing high performance energy storage devices. Through systematic characterization and electrochemical evaluation, we aim to demonstrate the superior performance and potential scalability of these nanocomposites, paving the way for their application in next-generation supercapacitor technologies. X-ray Diffraction, Field Emission Scanning Electron Microscopy and electrochemical characterizations are employed to explore the properties of all prepared samples. X-ray diffraction results exhibit the polycrystalline nature and pure phase of synthesized materials. N2-sorption study shows the type II characteristic isotherm and H3 hysteresis loop which indicates type IV isotherms which confirms that the materials are of macro porous plus mesoporous nature. From Cyclic Voltammetry analysis exhibited the nanocomposites Pseudo capacitive storage mechanism. The Galvanostatic charge–discharge test indicated that CeO2/C nanocomposite have shown maximum specific capacitance of 100 F/g. Electrochemical Impedance Spectroscopy plot gives the good agreement of solution resistance of electrodes about 1 X. CeO2/C nanocomposites have shown best specific capacitance Cs among the two prepared nanocomposites and have the capacity to be used as an electrode material for supercapacitors.

Tuning Electrochemical Properties of Mixed Metal Zr-Ni-Co@ZIF-67 Nanocomposites for Supercapacitors

Sidra Khalid, Hassan Shahzad
Department of Physics, School of Science, University of Management and Technology
Lahore, Pakistan
email : sidra.khalid@umt.edu.pk

Abstract

The growing demand for sustainable and efficient energy storage systems continues to challenge the development of electrode materials that combine high energy density and specific capacitance. Supercapacitors often suffer from low energy densities, limiting their broader applicability in advanced technologies. To address these challenges, this study explores the synthesis and characterization of Zr-Ni-Co@ZIF-67 nanocomposites using a controlled co-precipitation and pyrolysis approach with varying molar ratios of ZIF-67 to metal precursors (1:1), (1:2), and (2:1) respectively. XRD analysis revealed the successful integration of Zr, Ni, and Co into the ZIF-67 framework, resulting in well-defined crystalline phases. Morphological investigations via FESEM demonstrated interconnected, porous architectures that facilitate efficient ion transport and maximize electroactive surface area. Complementary Raman spectroscopy confirmed the formation of robust metal-oxygen (M-O) and metal-nitrogen (M-N) bonds, while FTIR analysis validated the retention of functional groups critical for electrochemical performance. Electrochemical studies highlighted the superior performance of the Z-3 nanocomposite (2:1 metal ratio), which achieved a of 391 Fg -1 at 1 Ag -1 and an energy density of 28 W h/kg. This study underscores the potential of Zr-Ni-Co@ZIF-67 nanocomposites as next-generation SC electrode materials, providing a promising pathway to address the energy density limitations of traditional supercapacitors.

Study of cosmic ray propagation with ionization effects by the hydrodynamic approach

Aqeel Afzal, Syed Nasrullah Ali Qazi
Department of Physics, School of Science, University of Management and Technology
Lahore, Pakistan
email : nasarullah.qazi@umt.edu.pk

Abstract

Cosmic rays are high-energy particles (mostly protons, electrons, and atomic nuclei) originating from astrophysical sources such as supernova remnants and active galactic nuclei, with energies spanning from MeV to beyond 10 20 eV. This study explores cosmic ray propagation in the interstellar medium (ISM) using a hydrodynamic model that incorporates ionization effects. Key propagation mechanisms are examined, including diffusion through magnetic irregularities, convection by galactic winds, magnetic interactions (scattering/deflection), and energy losses via ionization and synchrotron radiation. Ionization by cosmic rays is highlighted as a critical process that alters ISM chemistry, contributes to gas heating, and influences molecular cloud evolution. The hydrodynamic framework treats cosmic rays as a fluid coupled with the ISM's plasma and gas, and includes derived ionization source terms to represent energy and momentum deposition. Coupled nonlinear ordinary differential equations governing cosmic ray and shock dynamics are solved using MATLAB's adaptive ode45 solver (Runge–Kutta 45). Currently, the investigation of the ionization effects in the cosmic-ray plasma with the analysis of the hydrodynamic approach is underway. It is speculated that cosmic ray driven ionization significantly affects ISM composition, modulates magnetic turbulence, and may trigger star formation. Ionization is thus pivotal for ISM evolution, and future work will explore hybrid modelling approaches with improved observational data.

Radial/Halo Acceleration for the Rotated Supported Galaxies

Tausiq Haider Khan, Syed Nasrullah Ali Qazi
Department of Physics, School of Science, University of Management and Technology
Lahore, Pakistan
email : nasarullah.qazi@umt.edu.pk

Abstract

Rotationally supported galaxies serve as an important testing ground for theories that aim to explain the observed discrepancies between baryonic matter and galactic dynamics—commonly known as the missing mass problem. In this research-based study, we explore the empirical relationship between baryonic acceleration and observed acceleration, known as the Radial Acceleration Relation (RAR), using high-resolution rotation curve data. Building on this, we introduce the concept of the Halo Acceleration Relation (HAR), which isolates the acceleration that can be attributed specifically to the dark matter halo or modified gravity effects. By employing a binned statistical analysis across different radial zones, we compare the behavior of HAR against the predictions of both Modified Newtonian Dynamics (MOND) and standard ΛCDM-based dark matter models. Our analysis confirms the tight correlation in RAR, but also reveals noticeable deviations in HAR raising important questions about the validity of current models, the impact of binning, or the need for more refined interpolating functions in MOND. These results offer deeper insights into the distribution of mass in galaxies and contribute to the broader understanding of the gravitational landscape on galactic scales

Theoretical Investigation of Structural, Mechanical, Electronic and Magnetic properties of Ir-Based Full Heusler Alloys

Shamsa Kanwal
Department of Physics, School of Science, University of Management and Technology
Lahore, Pakistan
email : shamsa.kanwal@umt.edu.pk

Abstract

The structural, electronic, and magnetic characteristics of Ir 2 VY (where Y= Al, Si) alloys, where Y represents Al and Si were investigated through first-principles calculations. The calculations were performed using the full potential linear augmented plane wave (FPLAPW) method as implemented in the Wein2k code employing the generalized gradient approximation (GGA) within the Perdew–Burke–Ernzerhof (PBE) scheme (GGA-PBE). From the total energy calculations, it has been observed that all these alloys are stable in structure than Xa structure and also it is found that the alloys (Z =Al and Si) are ferromagnetically stable. It is observed that the electronic band curves corresponding to the spin-up state exhibit metallic characteristics, with a consistent energy level aligning with the Fermi level. Consequently, in the spin-down state of the the electronic band structure exhibits a band gap of 0.667 eV and 0.701 eV for alloy which is very close to the already predicted value as 0.756 eV in the study by Prakash. Similarly, it is also depicted within TDOS in the majority spin band showcases characteristics commonly associated with metals, whereas the minority spins band exhibits semiconducting behavior. This distinctly highlights a 100% spin polarization at the Fermi level predicting both alloys as half-metallic ferromagnetic. For the specific Heusler Alloy, which encompasses 26 valence electrons, the projected total magnetic moment, as per the Slater-Pauling rule, amounts to 2μB and for which has 27 valence electrons measures a magnetic moment of 3μB. In this study, the computed total spin magnetic moment for the both alloys aligns precisely with the anticipated total value of the integral magnetic moment. This implies that the alloy functions as a half-metallic ferromagnetic, rendering it highly suitable for applications in spintronics.

Hydrothermal Synthesis and Electrochemical Characterization of ZnO Nanoparticles for Glucose Sensing Applications

Saira Shaheen, Shamsa Kanwal, Sanam
Department of Physics, School of Science, University of Management and Technology
Lahore, Pakistan
email : saira.shaheen@umt.edu.pk

Abstract

Zinc oxide (ZnO) is widely recognized as a multifunctional nanomaterial owing to its remarkable physical and chemical properties. In this study, ZnO nanoparticles were synthesized using a hydrothermal method under elevated temperature and pressure conditions, which are essential to ensure complete reaction and phase formation, as the precursors do not dissolve effectively at atmospheric pressure and temperatures below 100 °C. The synthesized ZnO nanoparticles were characterized using Powder X-ray Diffraction (XRD), confirming their crystalline structure and phase purity. UV–Visible spectroscopy revealed a distinct absorption peak at 255 nm, indicating the optical band gap of the ZnO nanoparticles. Furthermore, cyclic voltammetry (CV) was employed to investigate the redox behavior of glucose at various scan rates. The results demonstrate that the highly crystalline ZnO nanoparticles possess excellent electron mobility and biocompatibility, making them promising candidates for non-enzymatic glucose sensing applications.

Keywords: Zinc oxide nanoparticles, hydrothermal synthesis, glucose sensing, cyclic voltammetry, XRD, UV-Vis spectroscopy.

Shaping Future Leaders: The Role of STEM Education in Climate Change Mitigation

Zubair Ahmad
Section Head of Module Development and publication, Qatar University Young Scientists center (QUYSC), 2713 Doha, Qatar.
Email: zubairtarar@qu.edu.qa

Abstract

In an era where climate change poses one of the greatest challenges to humanity, the need for forward-thinking, innovative leaders has never been more critical. STEM (Science, Technology, Engineering, and Mathematics) education plays a pivotal role in shaping the next generation of problem solvers, equipping them with the technical expertise, analytical mindset, and creativity needed to develop sustainable solutions. This plenary session explores how STEM education can serve as a driving force in climate change mitigation, empowering students and professionals alike to tackle environmental challenges through scientific research, engineering innovations, and policy-driven strategies. By examining real-world case studies and successful STEM-driven climate initiatives, this session will highlight the importance of interdisciplinary learning, hands-on engagement, and the integration of emerging technologies such as artificial intelligence, renewable energy, and climate modeling. It will also address the need for inclusive and diverse participation in STEM fields to ensure a broader range of perspectives in climate solutions. Through a forward-looking approach, this session is to inspire educators, policymakers, and industry leaders to reimagine STEM curricula, ensuring that future leaders are not only scientifically literate but also socially responsible and action-oriented. By fostering a new generation of climate-conscious innovators, STEM education serves as a powerful catalyst in the fight against climate change, bridging the gap between knowledge and impactful action.

Magnetic Systems, Quantum Field Theory, and the emergence.

Bilal Masud

Abstract

In statistical mechanics, partition functions are sums over discretized states. When the correlation length of a spin system diverges near a critical point, discretization of the parts is traced out in Wilson-replacing-by-average, etc. The resulting continuity is an emergent property of the whole. The partition function becomes a path integral over all values at each position of a continuous, say, spin or magnetization field. A path integral can be obtained as a product of Green functions, or by using a numerical discretization called a lattice gauge theory. Also, many features of any specific system are noticed to be left out in a universality that can also be used as a downward constraint on parts by symmetries and purely empirical properties of the whole. Any LHS=RHS, as a constraint or as a fundamental physics, does not give both sides anyway; so, a theory of everything is not guaranteed at any level.

Keywords: Partition function, magnetic systems, quantum field theory, continuum limit, emergence, universality.

Y(1S) - Y(1s) scattering cross sections: Analysing interaction using potential model

Ahmad Awan, Muhammad Imran Jamil
Department of Physics, School of Science, University of Management and Technology
Lahore, Pakistan
email : imran.jamil@umt.edu.pk

Abstract

In this study, we calculated the scattering cross sections of two Y(1S) mesons using a potential model combined with the Resonating Group Method (RGM), employing the adiabatic approximation to characterize meson interactions. We investigated two scenarios: one with a point-like form factor (f = 1) and another with a Gaussian form factor, to explore how the internal structure of the meson affects the interaction. At a center-of-mass kinetic energy of 0.01 GeV, the maximum value of total spin-averaged cross section was 0.3 mb for the point-like form and 0.19 mb for the Gaussian form with quadratic potential. For the Cornell potential, the values were 0.18 and 0.11 mb, respectively, with the same COM K.E. This shows a reduction in the cross section when the internal structure of the mesons is taken into account. The small variation between these values indicates that the form factor has a limited effect on Y(1S) scattering, likely due to the larger mass of the mesons and smaller rms radii. In contrast, lighter mesons exhibit a more pronounced reduction in cross sections when the Gaussian form factor is applied, highlighting their greater sensitivity to the form factor's detailed shape. This contrast could suggest a potential role of Y(1S) as probes of the Quark-Gluon Plasma (QGP).

Keywords: Quadratic potential, Cornell potential, Y scattering, quark potential model.

Electrochromic Energy Storage Materials: A Pathway to Carbon Mitigation and Net-Zero Buildings

M. Norhaffis Bin Mustafa

Sunway Centre for Electrochemical Energy and Sustainable Technology
Sunway University, Malaysia.

Abstract

The transition to net-zero buildings requires innovative multifunctional materials that enhance energy efficiency while reducing carbon emissions. Electrochromic supercapacitor technology (EST) represents a groundbreaking advancement in sustainable energy storage and smart building integration, offering a dual-function approach to carbon mitigation and energy conservation. By incorporating electrochromic, thermochromic, photochromic, and supercapacitor technologies into a single device, multifunctional smart windows can dynamically regulate light transmission and store energy, significantly reducing the demand for artificial lighting and climate control in urban infrastructures. This talk explores the latest advancements in EST materials, with a focus on emerging composites such as MXene-bimetallic phosphate hybrids, which exhibit enhanced electrochromic response and superior energy storage performance due to their synergistic effects. The integration of such materials into smart windows and green building technologies aligns with Sustainable Development Goals (SDGs 7, 11, and 13) by fostering affordable and clean energy, sustainable urban development, and climate action. Furthermore, ability to undergo reversible coloration with minimal voltage input enables energy-efficient control over solar irradiation, directly contributing to carbon footprint reduction. By optimizing material design and device architecture, EST has the potential to transform modern buildings into self-regulating, energy-efficient systems, playing a pivotal role in the decarbonization of the built environment. This presentation will discuss recent breakthroughs, challenges, and future perspectives in electrochromic supercapacitors, emphasizing their role in sustainable cities and climate mitigation strategies.

Investigation Of X-Ray Emission from Laser Produced Aluminium Antimonide Plasma

Sidra Ashraf
Department of Physics, School of Science, University of Management and Technology, Lahore 54782, Pakistan
email : sidra.ahsraf@umt.edu.pk

Abstract

Lasers are integral to numerous applications in our daily lives, with one of their notable uses being the ablation of materials to generate plasma, which in turn produces X-rays with a variety of applications. This study investigates the generation of hard X-rays from Aluminium Antimonide (AlSb) plasma, induced by a Q-switched Nd: YAG laser operating at 1064 nm with a pulse duration of 9-14 ns and a peak power of 1.1 MW. The AlSb target was selected due to its unique electronic structure and high atomic number, which are advantageous for efficient X-ray generation. At a tight focus, the laser produced a spot size of 11.8 micrometers, achieving an intensity of 10^12 W/cm^2, to study the transmission of hard X-rays both in a vacuum environment with a pressure of 10^-3 torr and in air at atmospheric pressure. A Photo Multiplier Tube (PMT) was employed to detect the transmitted hard X-rays, which were filtered using a 10μm-thick Al filter. The fundamental mechanisms behind the emission of hard X-rays from laser-induced AlSb plasma were explored. Plasma plume expansion and the energy of the emitted radiation were found to depend on the number of laser pulses and the ambient pressure. The intensity of the plasma plume was observed to be inversely proportional to the ambient pressure and directly proportional to the number of laser pulses fired. Plasma confinement under high pressures was also examined. Time-resolved studies of the hard X-ray emission contributed to the analysis. The relationship between different laser shots and the current, voltage, and energy of the hard X-rays, as well as their inverse proportionality to ambient pressure, was quantified. At an ambient pressure of 10^-3 torr, the dynamics of the AlSb plasma plume were observed. The surface morphology of the laser-irradiated AlSb target was also analyzed, revealing unique properties pertinent to X-ray emission.

Laser Induced Breakdown Spectroscopy for the Detection and Quantitative Analysis of Toxic and Non-Toxic Elements in Toys

Hira Yaseen
Department of Physics, School of Science, University of Management and Technology, Lahore 54782, Pakistan
email : hira.yaseen@umt.edu.pk

Abstract

Toys of different brands were analyzed by Laser Induced Breakdown Spectroscopy (LIBS) technique employed for the analysis of toxic and nontoxic elements. All samples were irradiated without sample preparation treated under the ambient environment of argon gas. The analysis of emitted spectra reveals the presence of different elements in the samples which was verified by the National Institute of Standard and Technology (NIST) database. Both toxic and non-toxic elements like lead, tin, mercury, potassium and magnesium are found indifferent concentrations. The concentration of heavy metals like lead, mercury and tin in different toys were in the range of 897.2 ppm-320.5 ppm, 88.2 ppm-140.4 ppm and 8.4 ppm-10.2 ppm respectively which is much higher than the permissible value set by US Environmental Protection Agency (US EPA), US Food and Drug Administration (US FDA) and other regulatory authorities. The concentration of non-toxic elements like magnesium and potassium are within safe permissible limits.

Emphasizing the hybrid structure and magnetism: "Encapsulation of 2D Crts within Multi-Walled Carbon Nanotubes: A One-Dimensional van der Waals Heterostructure

Aqrab ul Ahmad
International Iberian Nanotechnology Laboratory (INL) Braga, Portugal

Abstract

CrI_3 is a layered ferromagnetic insulator that has garnered significant attention as the first experimentally demonstrated stand-alone monolayer ferromagnet, marking a milestone in the field of two-dimensional (2D) magnetic materials. This discovery has opened new avenues for integrating magnetism into van der Waals heterostructures. In this study, we explore an even lower dimensional regime by synthesizing and characterizing a one-dimensional (1D) van der Waals heterostructure, wherein CrI_3 nanotubes are encapsulated within multi-walled carbon nanotubes (MWCNTs), forming a hybrid system that combines a magnetic insulator with a conductive host. Through a capillary-driven filling process, we successfully obtained single-walled CrI_3 nanoparticle nanotubes ranging from 2 to 10 nm, with an average diameter of approximately 5.3 nm. These nanotubes' structural and compositional integrity was thoroughly validated using aberration-corrected scanning transmission electron microscopy (STEM) and complementary spectroscopic techniques. Magnetic characterization via SQUID magnetometry, in conjunction with element-specific X-ray magnetic circular dichroism (XMCD), provides compelling evidence that the encapsulated Cr atoms retain their magnetic character. The magnetic response is consistent with a collective magnetic state, exhibiting signatures of a radial magnetization configuration—a phenomenon theoretically predicted by both first-principles calculations and model Hamiltonian approaches. These findings not only demonstrate the feasibility of synthesizing 1D magnetic van der Waals heterostructures but also establish CrI_3 nanotubes as a promising platform for investigating curvature-induced non-collinear magnetism and anisotropic spin textures. This work represents a critical advancement in the exploration of low-dimensional magnetic systems and their potential applications in next-generation spintronic and quantum devices.

Foderated Machine Learning for Energy Load Forecasting: A Case Study of Household Energy Consumption

Sanaullah Manzoor
Glasgow Caledonian University, UK

Abstract

The growing use of consumer electronics has resulted in the production of massive amounts of electrical energy data. Accurate forecasting of future electricity demand is very challenging due to reliability, power quality, data characteristics, and users' privacy and security concerns. Federated learning (FL) has emerged as an efficient method for training these forecasting models while maintaining data privacy and reducing costs. However, FL models remain susceptible to privacy breaches. To address this, differential privacy (DP) is incorporated into local model weights, enhancing security but often compromising prediction accuracy. To address this trade-off, we propose a novel single-layer federated weight aggregation framework for consumer energy load forecasting. This privacy-aware approach aggregates only the single layer of local models, ignoring other layers to minimize privacy risks.

Innovations in Printed Electronics: Emerging Nanomaterials, Sustainable Fabrication, and Semiconductor Applications for a Greener Future

Syed Muhammad Hafiz
Kuala Lumpur, Wilayah Persekutuan Kuala Lumpur, Malaysia

Abstract

Printed electronics, powered by advancements in emerging nanomaterials and novel fabrication techniques, are revolutionizing the semiconductor industry by enabling flexible, lightweight, and cost-effective electronic devices. These innovations also play a crucial role in addressing climate change mitigation and supporting Sustainable Development Goals (SDGs) by promoting energy-efficient manufacturing, reducing electronic waste, and enabling environmentally friendly technologies. This talk explores on the advanced fabrication techniques—Inkjet Printing—that not only enhance device scalability and performance but also minimize material waste and energy consumption. By bridging materials science, semiconductor technology, and sustainability initiatives, printed electronics pave the way for a more energy-efficient and environmentally responsible future.

R-Type Hexagonal Ferrite Nanoparticles and Their Electrochemical Senser for Levofloxacin

Sajjad Hussain
Department of Natural Sciences, The Begum Nusrat Bhutto Women University, Sukkur, Pakistan
email: sajjad.hussain@bnbwu.edu.pk

Abstract

The usage of Levofloxacin (LEV) has increased in recent years for the treatment of bacterial infections in both human and veterinary fields. In this context, there has been a significant demand for the development of a highly sensitive and cost-effective approach to LEV quantification. In this study, R-type hexagonal ferrite nanoparticles (SrSn2Fe4O11-NPs) were prepared by an auto-ignition methodology and various analytical techniques were used for the material characterization, including X-ray diffraction (XRD), Field emission scanning electron microscopy (FE-SEM), X-ray photoelectron spectroscopy (XPS), Brunauer Emmett and Teller (BET) analysis, dynamic light scattering (DLS), and vibrating sample magnetometer (VSM) analysis. The characterization confirmed that the prepared material has a crystalline structure single-phase with a crystalline size of 35.02 nm. The R-type hexagonal ferrite nanoparticles were immobilized on a glassy carbon electrode (GCE) by a simple drop-casting approach to developing an efficient electrochemical sensor (SrSn2Fe4O11-NPs) for sensitive and selective LEV detection through an extended concentration range (0.06 × 10-6 to 170 × 10−6 M) and a low detection limit of (41.5nM). The developed sensor was applied successfully to quantitatively determine LEV in clinical samples and pharmaceutical preparations with excellent recoveries from 95.2 to 102.5 %.

Computational Assessment of the Temperature-Efficiency Inverse Relationship in Next-Generation Solar Technologies

Qurban Ali
Department of Physics, School of Science, University of Management and Technology, Lahore 54782, Pakistan
email : qurban-ali@umt.edu.pk

Abstract

The unique characteristics of thermoelectric materials make them an excellent choice for promoting energy efficiency and advancing technological applications. Within the broad spectrum of photovoltaic (PV) technologies, perovskite solar cells (PSCs) that are free of lead have emerged as a focal point of interest, owing to their non-toxic composition, and superior charge transport efficiency. In this investigation, a 1D simulation is completed via COMSOL Multiphysics to examine the performance of ZnO/$MAGeI_3$/Cu_2Te PSCs. The impact of different oxide-based electron transport layers (ETLs) and hole transport layers (HTLs) on the performance of PSCs was initially examined. Research revealed that PCSs with ZnO as an ETL and Cu_2Te as an HTL revealed the maximum PV performance in context of power conversion efficiency (PCE ~25.6%), and other parameters were short circuit current density (J_{sc} ~57.9 mA/cm^3), open circuit voltage (V_{oc} ~1.03V), and fill factor (FF ~42.76%) at a hole mobility (500 cm^2/Vs). Then, we conducted an in-depth analysis of the impact of varying thicknesses of ZnO, $MAGeI_3$, and Cu_2Te layers in the optimized device. We successfully achieved a remarkable PCE of 31.07% and FF of 46.14%, at an acceptor density of 1×10^{20} 1/cm^3. The results and analysis provide a key basis for selecting $MAGeI_3$ as an optimized absorber material.

Implications of thickness-induced perturbation in charge carrier transport dynamics and acceptor-donor density gradients on BFO-based solar cell: computational paradigm advancing renewable energy frontiers

Muhammad Mubeen

Centre of Excellence in Solid State Physics, University of The Punjab, Lahore.

Abstract

Advancement in photovoltaic (PV) technology have significantly improved solar cell efficiency, making solar energy a promising alternative to conventional energy sources. Among various PV technologies, perovskite solar cells (PSCs) are gaining attention due to their cost-effective fabrication and environmentally benign composition, making them strong candidates for future energy solutions. This study investigates lead-free BiFeO3 (BFO)-based PSCs, incorporating a 2D ZnSe/BFO/spiro-OMeTAD structure to enhance device performance. Device simulation using COMSOL Multiphysics optimizes charge transport by varying thickness and acceptor/donor density gradients, revealing key performance trends. Results indicate that increasing BFO thickness enhances short-circuit current density and power output while reducing open-circuit voltage, where the optimal electron transport layer thickness is ~75 nm, achieving a maximum efficiency of 10.72%. Resistance analysis in Python determines minimum series resistance of ~2.5 (Ωm^2), maximum shunt resistance of ~8505 (Ωm^2), and characteristic resistance of ~32.7 (Ωm^2), demonstrating critical insights for lead-free PSC design and performance enhancement.

Influence of acceptor/donor densities and layer thicknesses on the efficiency of 2D ZnO/BFO/spiro-OMeTAD perovskite solar cells A COMSOL simulation-based optimization

Muhammad Umer Salman

Centre of Excellence in Solid State Physics, University of The Punjab, Lahore.

Abstract

The adverse effects of global warming and the continued reliance on hazardous energy sources, such as coal and petroleum, have intensified the global pursuit of clean and sustainable energy alternatives. Among these, solar energy emerges as the most viable option to meet the growing energy demands of an expanding population. Over the past decades, extensive research has focused on identifying optimal materials for solar cells to enhance their stability, cost-effectiveness, and efficiency. In this context, perovskite materials— particularly BiFeO3— have gained significant attention as absorber materials due to their multifunctional properties, including room-temperature ferroelectricity and strong remanent polarization, which eliminate the need for a conventional p–n junction. This study employs COMSOL Multiphysics software to simulate a ZnO/BiFeO3/spiro-OMeTAD solar cell structure, assuming ohmic front and back contacts. Key parameters, such as the acceptor and donor densities of states, as well as the thicknesses of BiFeO3, ZnO, and spiro-OMeTAD layers, were systematically varied to evaluate their influence on the photovoltaic performance of the cell at room temperature. The results indicate that increasing the thickness of BiFeO3 leads to a progressive enhancement in short-circuit current density, power output, and overall efficiency. In contrast, increasing the thicknesses of the ZnO and spiro-OMeTAD layers results in a decline in these performance metrics. Furthermore, variations in donor and acceptor densities significantly impact the solar cell's efficiency. This study offers valuable insights into optimizing material properties and device parameters for experimental applications, highlighting the potential of BiFeO3-based perovskite materials as promising candidates for next-generation photovoltaic technologies.

Physical attributes of double perovskite oxides Ba2LuNbO6 under the pressure applications

Afreenish Irfan, Quratul Ain
Department of Physics, School of Science, University of Management and Technology, Lahore 54782, Pakistan
email : qurat.ulain@umt.edu.pk

Abstract

The physical characteristics of double perovskite oxides have made them a desirable option due to their effective bandgap tunability. This bandgap tunability is affected by cation engineering, doping and pressure modulation. These strategies enable precise control over the electronic structure, making double perovskite oxides promising candidates for photovoltaic applications. In this manuscript, we have analyzed the physical traits of cubic Ba2LuNbO6 with pressure modulation. The pressure values are selected as 0 GPa, 10 GPa, 20 GP and 30 GPa. The quantum mechanical interactions between ions and electrons in the material are addressed via the mBJ approximation. Ba2LuNbO6is structurally and thermodynamically stable according to the parameters obtained from Birch's equation. Cubic formation is guaranteed from the obtained results of tolerance factor and octahedral tilting. The Hooke's law is used to express the linear relation of stress and strains. The computed elastic traits report a decreasing trend with increase in pressure. As pressure is raised a noticeable decrease in the materials stiffness and rigidity is seen. With pressure increment, the atomic bonding becomes weaker and lattice becomes soft. Higher pressure causes a brittle to ductile transition for Ba2LuNbO6. The electronic bandgap reports a decreasing trend as pressure is enhanced. With increment in pressure, the optical analysis shows a notable shift in the peaks from the high energy region to the low energy region indicating that Ba2LuNbO6 has the potential to be used in pressure related photovoltaic devices.

Optimizing the role of $MnSe_2$ as an efficient electron transport layer to enhance the performance of perovskite solar cells

Quratul Ain
Department of Physics, School of Science, University of Management and Technology, Lahore 54782, Pakistan
email : qurat.ulain@umt.edu.pk

Abstract

This study highlights the significant enhancement of Mo-doped MnSe2 as an electron transport layer (ETL) for perovskite solar cells (PSCs). X-ray diffraction (XRD) confirms a cubic structure with improved crystallinity and increased crystallite size upon Mo doping. Raman spectroscopy reveals phonon mode shifts and reduced defect-induced disorder, indicating structural integrity. Ultraviolet-visible (UV-vis) spectroscopy shows a redshift in the absorption edge, reducing the optical bandgap from 2.62 eV to 2.56 eV. Photoluminescence (PL) spectra exhibits reduced emission intensity for the Mo-doped film, signifying enhanced charge carrier separation. Current density–voltage (J–V) analysis demonstrates a higher power conversion efficiency (21.51%) for Mo-doped MnSe2-based PSCs due to increased short-circuit current density. Electrochemical impedance spectroscopy (EIS) confirms reduced recombination losses, while external quantum efficiency (EQE) analysis highlights improved charge collection. These findings establish Mo-doped MnSe2 as a superior ETL candidate, enhancing charge transport and stability for high-performance PSCs.

Introducing HHO Gas to Biomass, Coal, and Oil Boilers: Enhancing Efficiency and Reducing Pollution

Tanvir Hussain
Department of Physics, School of Science, University of Management and Technology, Lahore 54782, Pakistan
email : tanvir.hussain@umt.edu.pk

Abstract

The growing global energy demand, coupled with the environmental impacts of fossil fuel combustion, necessitates the adoption of cleaner and more efficient energy technologies. This study investigates the integration of HHO gas—a stoichiometric mixture of hydrogen and oxygen produced via water electrolysis—into biomass, coal, and oil-fired boilers to enhance combustion efficiency and reduce harmful emissions. Case studies demonstrate that blending HHO gas with biomass fuel can significantly reduce nitrogen oxide (NO), carbon monoxide (CO), and smoke emissions by 22.5%, over 90%, and 74.4%, respectively, while improving preheating speed and reducing operating costs by up to 40%. In coal-fired boilers, adding 1 kg/h of HHO gas can save up to 57 tons/year of Indian lignite or 43 tons/year of sub-bituminous coal, while also improving boiler efficiency. For oil-fired systems, although fuel consumption reduction is minimal, steam production increases markedly (4%–27% for heavy oil and 4%–21% for light diesel oil). The development of a 5 Nm^3/h HHO generator and ongoing research on zero-gap alkaline water electrolyzers underscore the potential for scalable, cost-effective green hydrogen production. These findings highlight HHO gas as a promising transitional technology for reducing emissions and improving energy efficiency across diverse industrial boiler applications.

Preparation of efficient Photocatalyst by band gap engineering of CdS thin film through alloying with CdTe for hydrogen generation via water splitting

Fayaz Ahmad, Tanvir Hussain
Department of Physics, School of Science, University of Management and Technology, Lahore 54782, Pakistan
email : tanvir.hussain@umt.edu.pk

Abstract

Solar-driven hydrogen production through water splitting is regarded as one of the most promising and cost-effective pathways for sustainable fuel generation. However, the low efficiency of existing photocatalysts remains a major challenge. This study reports the fabrication of an efficient photocatalyst by tailoring the band gap of cadmium sulfide (CdS) thin films through controlled alloying with cadmium telluride (CdTe). CdS–CdTe alloy thin films were synthesized and systematically analyzed for their photoelectrochemical performance. Band gap engineering via CdTe incorporation enhanced light absorption in the visible range and improved charge carrier separation. Among the tested compositions, the CdS film doped with 15 % CdTe exhibited the highest solar-to-hydrogen conversion efficiency, attributed to its optimized band gap for water splitting and superior photocurrent response. These findings demonstrate that precise band gap tuning through alloying offers a viable route to enhance photocatalytic activity, paving the way for the development of efficient, low-cost photocatalysts for large-scale hydrogen generation.

Meson Meson Scattering through an Improved Many Body Potential

Muhammad Imran Jamil
Department of Physics, School of Science, University of Management and Technology
Lahore, Pakistan
email : imran.jamil@umt.edu.pk

Abstract

The basic building blocks of this universe are quarks, leptons and the gauge bosons. I am giving a brief introduction of these particles and there interactions in the first part of my talk. The quarks do not exist in isolation they always make their bound states which are commonly called as hadrons. Mesons and baryons are the two categories of these hadrons. In the labs during scattering experiments it has been found that there are the possibilities of the particles which are considered to be the bound states of two mesons. In the second part of my talk I will give a theoretical description of the meson meson scattering using an improved many body potential in the reference of bound states of two mesons.

Knowledge is in many things and can have many different garbs and can have many different directions and dimensions but the knowledge that is gained by seeking the truth and knowledge that comes out of the pursuit of truth, unbiased, unprejudiced, based upon crystalline reasoning and logical understanding and rational thinking is the one that we care for and we should value. So knowledge is actually consisting of truth and nothing but truth.

(Dr Hasan Sohaib Murad)