Abstract Book: ANAMI 2025

National Conference on Application of Nanophotonics and Advanced Materials for Instrumentation

About Conference

National Conference on "*Applications of Nanophotonics and Advanced Materials for Instrumentation*" is a platform dedicated to fostering academic and research collaborations in the multidisciplinary fields of photonics and material science. This conference is going to organised by the *Department of Physics, Govt. Dungar College, Bikaner, Rajasthan, India* under joint auspices of *IAPT RC-6* and *CMRS, Bikaner*. The conference aims to bring together researchers, scholars and academicians and industry experts to share recent advances and future prospects in nanophotonics, nano crystalline thin films, non-crystalline materials and advanced materials.

Editors

Prof. Ajay Kumar Nagar
Dr. Bhuvneshwer Suthar
Dr. Manoj Singh Shekhawat
Dr. Sudhir Bhardwaj

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Department of Physics,
Govt. Dungar College, Bikaner 334001 (Rajasthan) INDIA

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Organised Under joint auspices of

Department of Physics, Govt. Dungar College, Bikaner

Indian Association of Physics Teachers, RC-6, Jaipur

Condensed Matter Research Society, Bikaner

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Editors

Ajay Kumar Nagar
Govt. Dungar College,
Bikaner (Rajasthan) India
Email: bhuvneshwer@gmail.com

Bhuvneshwer Suthar
Govt. Dungar College,
Bikaner (Rajasthan) India
Email: bhuvneshwer@gmail.com

Manoj Singh Shekhawat
Engineering College Bikaner
Bikaner (Rajasthan) India
Email: manoj.shekhawat1@gmail.com

Sudhir Bhardwaj
Bikaner Technical University
Bikaner (Rajasthan) India
Email: sudhir.hep@gmail.com

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Secretariat
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Department of Physics,
Govt. Dungar College, Bikaner-334001
Rajasthan
Email: os.ncanami@gamil.com
www.sites.google.com/view/anami2025

Preface: ANAMI-2025

It gives us immense pleasure to present the Abstract Book of the *National Conference on "Applications of Nanophotonics and Advanced Materials for Instrumentation" (ANAMI-2025)*, organized by the **Department of Physics, Government Dungar College, Bikaner**, under the joint auspices of the **Indian Association of Physics Teachers (IAPT), RC-6** and the **Condensed Matter Research Society, Bikaner (CMRS)**.

This conference is being conducted in *hybrid mode*, ensuring broad participation and accessibility for researchers from across the country. We are delighted to share that a total of about 120 abstracts has been accepted for presentation from various institutes of India. Out of these, nearly 20 presentations will be delivered offline at the venue, while the rest will be presented through online sessions.

To encourage focused discussions and knowledge sharing, the abstracts have been organized into the following thematic categories:

A: Nanoscience and Nanotechnology

B: Nanophotonics and Optoelectronics

C: Optics, Laser and Electronics

D: Material Synthesis & Characterization Techniques

E: Computation Techniques & Mathematical Approaches

F: Instrumentation and Device Application

G: Others

These categories reflect the *multidisciplinary* character of ANAMI-2025 and capture the richness of contributions from participants. The accepted works span a wide range of topics, including photonic crystals, plasmonic and metamaterials, nonlinear optics, nanostructured composites, thin films, theoretical modeling, and advanced instrumentation applications.

We firmly believe that the deliberations at **ANAMI-2025** will act as a catalyst for collaborative research, inspire innovative methodologies, and strengthen the scientific community working in the frontiers of nanophotonics and advanced materials.

We extend our heartfelt gratitude to all the contributors for sharing their valuable research, to the reviewers for their constructive evaluation, and to the organizing committee for their dedicated efforts. We also acknowledge with deep appreciation the guidance of our esteemed patrons and the participation of our invited speakers, whose expertise enriches this conference.

We hope that this Abstract Book will serve not only as a record of the proceedings of **ANAMI-2025** but also as a source of inspiration for future research endeavors.

Warm Regards,

26 September 2025

Ajay Kumar Nagar
Bhuvneshwer Suthar
Manoj Singh Shekhawat
Sudhir Bhardwaj
(Editors)

Message from the Principal

I am delighted to convey my warm greetings on the occasion of the **National Conference on "Applications of Nanophotonics and Advanced Materials for Instrumentation" (ANAMI-2025)**, being organized by the *Department of Physics, Government Dungar College, Bikaner*, under the joint auspices of the *Indian Association of Physics Teachers (IAPT), RC-6* and the *Condensed Matter Research Society (CMRS), Bikaner*.

Science today is advancing at a remarkable pace, and the domains of nanophotonics and advanced materials are at the heart of this transformation. These fields not only deepen our fundamental understanding of light–matter interactions but also drive innovations in instrumentation, communication, energy, healthcare, and beyond. By bringing together a wide community of researchers and academicians, ANAMI-2025 creates a space for dialogue, exchange of ideas, and inspiration for future directions.

I am particularly pleased to see the active participation of young researchers and students in this conference. Their curiosity, enthusiasm, and dedication are the true strength of our scientific community. I am confident that the discussions and interactions at this forum will spark new collaborations and help cultivate a spirit of inquiry that extends well beyond this event.

I extend my heartfelt appreciation to the organizing team for their efforts and commitment in hosting ANAMI-2025, and I wish all participants a rewarding and enriching experience. May this conference become a milestone in fostering scientific growth and innovation.

With warm regard,

Prof. Rajendra Kumar Purohit
Principal,
Govt. Dungar College, Bikaner

Message from the Chairman

It is a matter of great pride for me to welcome all participants to the **National Conference on "Applications of Nanophotonics and Advanced Materials for Instrumentation" (ANAMI-2025)**, organized by the *Department of Physics, Government Dungar College, Bikaner*, under the joint auspices of the *Indian Association of Physics Teachers (IAPT), RC-6* and the *Condensed Matter Research Society (CMRS), Bikaner*.

The Department of Physics at Government Dungar College has a rich legacy of academic excellence and research contribution. Over the years, it has continuously strived to nurture scientific curiosity, inspire young minds, and promote research culture in frontier areas of physics. Hosting ANAMI-2025 is another step in this direction, providing a meaningful platform for discussion and collaboration in the rapidly advancing fields of nanophotonics and advanced materials.

This conference brings together researchers, academicians, and students from across the nation to share their work, exchange ideas, and explore the latest developments in optics, nanoscience, and instrumentation. I am confident that the deliberations will foster new collaborations, broaden perspectives, and motivate young scholars to pursue impactful research.

I extend my heartfelt appreciation to the Organizing Committee for their efforts and to all participants for contributing to the success of this conference. I wish ANAMI-2025 a grand success and hope it serves as an inspiration for future endeavors of the Department of Physics, Government Dungar College, Bikaner.

With warm regards,

Prof. M.D. Sharma
Head, Department of Physics,
Govt. Dungar College, Bikaner

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National Conference on
"Applications of Nanophotonics and Advanced Materials for Instrumentation"
(ANAMI-2025)

Program Schedule

Day 1 (26.09.2025)

9:00 AM to 10:00 AM	Registration
10:00 AM to 11:00 AM	Public Lecture in Honour of Prof. Ravindra Mangal
11:15 AM to 11:45 AM	Inaugural Session
12:00 to 1:00 PM	Keynote Lecture
1:00 PM to 2:00 PM	Lunch
2:00 PM to 4:00 PM	Invited Session
4:00 PM to 4:15 PM	High Tea
4:15 PM to 6:15 PM	Oral Session (Offline)

Day 2 (27.09.2025)

9:00 AM to 11:30 AM	Oral Session (Online)
11:30 AM to 11:45 AM	Tea Break
11:45 PM to 2:45 PM	Oral Session (Online)
2:45 PM to 3:15 PM	Lunch Break
3:15 PM to 3:45 PM	Valedictory Ceremony

Table of Content

A-001

Facile synthesis and fluorescence emission of zincoxide quantum dots

Thakur Prasad Yadav
[1]*Department of Physics, Faculty of Science, University of Allahabad, Prayagraj-211002, India*
[2]*Department of Physics, Institute of Science, Banaras Hindu University, Varanasi-221005, India*
[3]*Department of Physics, Tilak Dhari Post Graduate College, Jaunpur-222001, India*

Abstract. Zinc oxide (ZnO) materials have become highly explored oxide-based nanomaterials since its discovery due to several interesting optical/ fluorescence properties. In the present study, ZnO quantum dots (QDs) have been synthesized successfully by adopting a simple approach using high energy ball milling (HEBM) and subsequently liquid phase exfoliation (LPE) through ultrasonication. The analyses confirm ZnO QDs as spherical in shape with size range ~2-6 nm. Furthermore, the optical properties ratify the formation of zinc oxide QDs. Moreover, the fluorescence spectroscopy shows a remarkable shift in the peak position of as-synthesised ZnO QDs than the ball milled product. An illustrious peak at ~ 400 nm in the fluorescence spectroscopy emission spectrum corroborates violet emission. This development associated with the fluorescence properties prompt the expanded usage of ZnO QDs in biomedical imaging applications.
Key words: Zinc oxide, nanotechnology, QDs, high energy ball milling

A-002

Impact of chitosan coated MFe_2O_4 (M=Co, Ni, Zn) nanocomposites prepared by co-precipitation route

Kamlesh V. Chandekar*, Aditi K. Gharat, Shreya S. Walavalkar,
Department of Physics, Rayat Shikshan Sanstha's, Karmaveer Bhaurao Patil College, Vashi, Navi Mumbai-400703, Maharashtra, India
*Corresponding Author: chandekar.kamlex@gmail.com

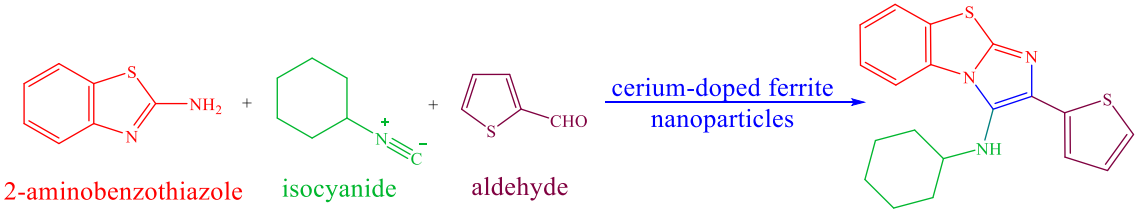
Abstract. The chitosan (Chi) coated MFe_2O_4 (M=Co, Ni, Zn) (Chi@CoF, Chi@NiF, and Chi@ZnF) magnetic nanoparticles (NPs) were synthesized by the co-precipitation route. X-ray diffraction (XRD) patterns of the MFe_2O_4 NPs confirm phase analysis with cubic structure. Increased lattice parameters of the cubic structure of the prepared MFe_2O_4 NPs indicating the expansion of lattice. The average crystallite size of 15.9±0.2, 2.6±0.06, and 3.3±0.08 nm was evaluated for highest intensity peak (311) of the XRD patterns of the MFe_2O_4 NPs. The highest value of lattice strain (139.4), and dislocation density (647.8 nm^{-2}) was estimated from the XRD pattern for Chi@NiF NPs. The average particle size of 15.3±0.3, 3.32 ±0.02, and 3.47±0.06 nm was evaluated for Chi@CoF, Chi@NiF, and Chi@ZnF NPs, respectively with the spherical shape morphology. X-ray photoelectron spectroscopy (XPS) was used to observe the oxidation states of Fe, Ni, Co and O present in the prepared samples. The saturation magnetization (58.80, 6.55, 9.04 emu/g), Coercive field (823,15.5,18.08 Oe), and remanance (18.72, 0.0022, 0.0037 emu/g) was reported for Chi@CoF, Chi@NiF, and Chi@ZnF NPs, respectively. The prepared Chi@MFe_2O_4 NPs can be employed on MCF -7, and MDA-MB-231 cell lines of the Breast cancer (BC).

Effective synthesis of imidazo[2,1-*b*]thiazoles via Groebke–Blackburn–Bienaymé reaction using Cerium lanthenoide dopped ferrite nanopartical

Umesh Chejara and Anamika Prajapati*
* *Govt. Girls College, Taranagar (Churu)- 331304*
E-mail: aonu27@gmail.com

Abstract

Cerium-doped ferrite nanoparticles act as highly efficient heterogeneous catalysts in the Groebke–Blackburn–Bienaymé (GBB) reaction, promoting the annulation of 2-aminobenzothiazole with structurally diverse isocyanides and aldehydes to synthesize imidazo[2,1-b]thiazoles. This methodology exhibits remarkable bond-forming efficiency and procedural simplicity, enabling the rapid and economical construction of complex bioactive and structurally diverse molecular scaffolds. Moreover, cerium lanthanide-doped ferrite nanoparticles demonstrate outstanding recyclability and reusability, retaining their catalytic activity and product yields over multiple reaction cycles, thereby making the process economically viable for large-scale and industrial implementation.



2-aminobenzothiazole isocyanide aldehyde

N-cyclohexyl-2-(thiophen-2-yl)benzo[*d*]imidazo[2,1-*b*]thiazol-3-amine

To the best of our knowledge, this study is the first to demonstrate the use of Cerium-doped ferrite nanoparticles as highly efficient and recyclable catalysts for the Groebke–Blackburn–Bienaymé (GBB) reaction under mild and environmentally benign conditions, enabling the streamlined synthesis of bioactive heterocycles.

Keyword: Cerium dopped ferrite; nanopartical; Groebke–Blackburn–Bienaymé reaction; imidazo[2,1-*b*][1,3,4]thiadiazole; imidazo[2,1-*b*]thiazole

A-004

Fueling Innovation - Impact of Aluminium Oxide-Copper Oxide Nanoparticles blended fuel for Enhanced Efficacy

Chirag S. Trivedi[1#], Anil M. Bisen[2], Balkrishna P. Shah[3]
[1]*Department of Applied Sciences & Humanities, ITM Vocational University, Vadodara -391760, Gujarat, INDIA*
[2]*Department of Mechanical Engineering, ITM Vocational University, Vadodara - 391760, Gujarat, INDIA*
[3]*Department of Physics, The Maharaja Sayajirao University of Baroda, Vadodara - 390002, Gujarat, INDIA*
[#]Corresponding Author's email: ctrivedi16101997@gmail.com

Abstract. Nanotechnology offers novel opportunities for improving fuel performance and reducing environmental impacts through nanoparticle-based additives. This study investigates the effect of aluminium oxide–copper oxide (Al_2O_3–CuO) nanoparticles as diesel fuel additives on the performance, combustion, and emission characteristics of a single-cylinder, four-stroke, CRDI VCR diesel engine. Copper oxide nanoparticles were synthesized via a chemical reduction method and characterized using XRD to confirm crystalline phase formation. Fuel blends were prepared by dispersing 50 ppm of Al_2O_3 and CuO nanoparticles in neat diesel, and comparative engine tests were conducted at varying loads using Enginesoft software. The results show that the nanoparticle-blended fuel (Run 1) exhibited significant improvements in performance parameters compared to neat diesel (Run 0), with higher brake thermal efficiency, increased indicated thermal efficiency, improved mechanical efficiency, and reduced specific fuel consumption. However, emission analysis revealed a trade-off: while performance was enhanced, Run 1 demonstrated consistently higher CO, HC, NO, and smoke levels compared to neat diesel, indicating incomplete combustion and elevated pollutant formation. These findings highlight the dual effect of nanofuel additives—boosting combustion efficiency but potentially aggravating emissions—emphasizing the need for optimization of dosing levels, dispersion stability, and long-term durability studies. This work contributes to the growing body of research on nanofuel additives and underscores their potential in shaping cleaner and more efficient energy systems, provided that associated environmental challenges are addressed.

Synergistic Analysis of α-Al2O3 Nanofluids in Shell-and-Tube Heat Exchangers: Experimental Testing and Numerical Validation

Dhruva Shah[1], Aditya Bais[2], Dattatraya Subhedar[2], and Sanni Kapatel[1]*
[1]*P.D. Patel Institute of Applied Science, Charusat, India*
[2]*Chandubhai S Patel Institute of Technology, Charusat, India*
*Corresponding Author's email: sannikapatel.phys@charusat.ac.in

Abstract. Shell and tube heat exchangers are widely used in industries for efficient thermal energy transfer between hot and cold fluids. Their performance, often evaluated using the Log Mean Temperature Difference (LMTD) and ϵ-NTU methods, is critical for optimizing thermal processes. Recent studies highlight nanofluids suspensions of nanoparticles in base fluids as promising agents for enhancing heat transfer. This work investigates the influence of α-Al_2O_3 nanoparticles on the efficiency of a shell and tube heat exchanger. α-Al_2O_3 and γ-Al_2O_3 nanoparticles were synthesized by calcination and confirmed through X-Ray Diffraction (XRD) analysis. Nanofluids containing 0.1, 0.3, and 0.5 vol% α-Al_2O_3 in a 50:50 ethylene glycol–water mixture was prepared and used as the hot fluid for experimental evaluation of heat exchanger effectiveness and overall heat transfer coefficient. Numerical simulations were also performed with a 1 vol% concentration. Results showed progressive improvements in overall heat transfer coefficients of 6.9%, 8.4%, 10.42%, and 15.9% for 0.1, 0.3, 0.5, and 1 vol%, respectively, while effectiveness increased by 4.4%, 6.36%, 8.5%, and 14.38%. Flow analysis indicated Reynolds numbers above 45,200, Prandtl numbers greater than 21, and Nusselt numbers exceeding 66, confirming turbulent conditions dominated by convective heat transfer. These findings demonstrate that incorporating α-Al_2O_3 nanoparticles into base fluids enhances heat transfer performance, validating nanofluid application as an effective strategy for improving shell and tube heat exchanger efficiency.

Keywords: Shell and Tube heat exchanger, nanoparticle, nanofluid, Thermal conductivity, Effectiveness

Shape Reversibility and Multivariant Characteristics of Martensite in Shape Memory Alloys

O. Adiguzel
Department of Physics, Firat University, Elazig, Turkey
Email: oadiguzel@firat.edu.tr

Abstract. Shape memory alloys take place in a class of advanced smart materials by exhibiting dual memory characteristics, shape memory effect and superelasticity. Shape memory effect is initiated with thermomechanical processes on cooling and deformation and performed thermally on heating and cooling, with which shape of the material cycles between original and deformed shapes in reversible way, and this behavior can be called thermoelasticity. Shape memory effect is governed by crystallographic transformations, thermal and stress induced martensitic transformations. Thermal induced martensitic transformation occurs on cooling with cooperative movement of atoms in <110 > -type directions on {110} - type close packed planes of austenite matrix, along with lattice twinning and ordered parent phase structures turn into the twinned martensite structures, and twinned structures turn into detwinned martensite structures by means of stress induced martensitic transformations with deformation. The {110}-plane family represent six certain planes as follows, (1 1 0), (-1 1 0), (1 0 1), (-1 0 1), (0 1 1), (0 1 -1), and totally 2024 martensite variants occur with the martensitic transformation. Superelasticity is performed with stressing and releasing the material in elasticity limit at a constant temperature in the parent austenite phase region, and shape recovery occurs immediately upon releasing, by exhibiting elastic material behavior. Superelasticity is also result of stress induced martensitic transformation, and the ordered parent phase structures turn into the detwinned martensite structures with stressing. Lattice twinning and detwinning reactions play important role in martensitic transformations, and they are driven by internal and external forces, by means of inhomogeneous lattice invariant shears. These alloys are functional materials and used in many fields in biomedical application to the building industry as the energy absorber against the seismic events. Noble metal copper-based alloys exhibit this property in metastable β-phase region, which has bcc-based structures. Lattice twinning is not uniform in these alloys, and the ordered parent phase structures undergo the layered structures with martensitic transformation. In the present contribution, x-ray and electron diffraction studies were carried out on ternary copper based CuZnAl and CuAlMn alloys. X-ray diffraction profiles and electron diffraction

patterns exhibit super lattice reflections. A series of x-ray diffractogram were taken during aging. X-ray diffractograms taken in a long-time interval show that locations and intensities of diffraction peaks change with the aging time at room temperature, and this result refers to the redistribution of atoms in diffusive manner.

Keywords: Shape memory effect, martensitic transformation, thermoelasticity, superelasticity, twinning, detwinning

A-007

Soft matter ferroelectrics: Physical behaviour and novel applications

Ramneek Kaur[#]
Department of Physics, Mata Gujri College, Fatehgarh Sahib, Punjab, India
E-mail:dhaliwalramneek@gmail.com

Abstract. Soft ferroelectric liquid crystalline (FLC) materials combine the properties of liquid crystals with ferroelectric behaviour, allowing for reconfigurable polarization and easy orientation changes in response to electric fields. While hard ferroelectric materials require stronger fields for polarization, soft materials can be easily polarized with low electric fields. Soft FLC can be easily aligned at minimal energy on air water interface due to amphiphilic character. In contrast hard ferroelectric material cannot align due to their rigid structures, they require higher energy for alignment. FLC possess flexibility which enables easy alignment and rapid response, making them ideal for dynamic applications in displays and sensors. We have prepared Langmuir–Blodgett films of FLCs doped with low concentrations of single-wall carbon nanotubes (SWCNTs) to explore their physical behaviour and potential applications in soft matter ferroelectrics. Surface pressure–area isotherms reveal that these films exhibit remarkable stability and excellent spreading characteristics. The interaction between SWCNTs and FLC molecules within the monolayer was analysed through elasticity profiling, indicating a maximum elasticity in the condensed phase. Atomic force microscopy confirmed a uniform and homogeneous deposition of the monolayer on the substrate. X-ray diffraction analysis confirmed the retention of the smectic C* phase of the FLC, alongside characteristic peaks corresponding to SWCNTs. Photoluminescence emission spectra, excited at 250 nm, displayed multiple peaks attributed to electronic transitions facilitated by the presence of SWCNTs, with emission intensity increasing with SWCNTs concentration in the FLC matrix. The incorporation of SWCNTs notably enhanced the optoelectronic properties of the FLC, highlighting their potential for innovative applications in soft matter ferroelectrics.

Keywords: Ferroelectric Liquid Crystals, Single Wall Carbon Nanotubes, Langmuir Blodgett Technique, Atomic Force Microscopy.

A-008

Synthesis of Stable Solution-Processed $(TEA)_2PbI_4$ 2D halide Perovskite for Photodetectors

Manav Sharma[1], Prasun Kumar[2], Vivek Kumar Shukla[1], Ranbir Singh[2]
[1]*Department of Applied Physics, School of Vocational Studies and Applied Sciences, Gautam Buddha University, Greater Noida, UP 201312, India*
[2]*School of Mechanical and Materials Engineering, Indian Institute of Technology (IIT) Mandi, Mandi, Himachal Pradesh 175005, India*

Abstract. Conventional three-dimensional (3D) perovskite materials are renowned for their exceptional optoelectronic properties, making them highly suitable for photodetector (PD) applications. However, these materials often suffer from stability issues, as their structural and functional integrity deteriorates under environmental stressors such as moisture, thermal fluctuations, and ultraviolet (UV) exposure. Low-dimensional perovskites generally exhibit somewhat lower optoelectronic performance than 3D perovskites but offer significantly enhanced environmental stability. Notably, the fabrication of pure 2D perovskite materials can be synthesised under ambient conditions whereas 3D perovskites typically require controlled environments, such as a nitrogen-filled glovebox, to prevent degradation during formation. In this study, we have fabricated a pure 2D halide perovskite, 2-thiopheneethylammonium lead iodide $(TEA)_2PbI_4$ on glass substrates using a solution-processed method under ambient conditions (RH ≈ 57% ± 4%). we conducted structural, morphological, and optical characterisations to gain a deeper understanding of the influence of the thiophene group in comparison to other 2D perovskite materials

Keywords: photodetector, 2D perovskite, SEM, XRD, Contact angle, I-V characteristic

A-009

Photocatalytic Applications of Cobalt, Zinc, Nickel, and Magnesium Doped Spinel Ferrites in Organic Dye Removal.

Sadanand. R. Sarve[1,#], Shital W. Awaghade[2]
[1,2] *Vidya Vikas College, Samudrapur 442305, Maharashtra, INDIA*
[#]Corresponding Author's email: sarve.sadanand@gmail.com

Abstract. The spinel ferrite nanoparticles doped with transition metals cobalt, zinc, nickel, and magnesium, have been extensively studied for their effectiveness as photocatalysts in the degradation of organic dyes. Cobalt ferrite ($CoFe_2O_4$) due to its narrow band gap and magnetic recovery properties absorbs visible light and have high efficiency in degrading methylene blue dye. Zinc ferrite ($ZnFe_2O_4$) has flexible electronic structure, which provides it with excellent photocatalytic activity for degradation of dyes like methylene blue and methyl orange when exposed to sunlight. Nickel-substituted ferrites increases charge carrier separation, which improves the degradation of both methylene blue and rhodamine B dye. Magnesium doped ferrite have large surface area and stability, which is effective in degradation of methylene blue and other cationic dyes. The co doped spinel ferrites such as Co-Zn, Ni-Zn, and Mg-Zn ferrites have faster degradation rates and greater efficiency compared to ferrites doped with a single metal. These enhancements is due to reduced electron-hole recombination, a broader response to visible light, and an increase in active surface sites. Hence, cobalt, zinc, nickel, and magnesium doped and co-doped spinel ferrites are promising photocatalysts for the sustainable breakdown of methylene blue and other harmful dyes, presenting potential applications in wastewater treatment.

Keywords: Spinel ferrites; Photocatalysis; Dye degradation; Methylene blue; Transition-metal doping; Visible light photocatalyst; Wastewater treatment.

A-010

Nanostructured Polyaniline–Metal Oxide Hybrid Films: Conductive AFM Insights into Electronic Applications

Gurpreet Kaur Bhullar
P.G. Department of Physics, Mata Gujri College, Fatehgarh Sahib, Punjab, India, 140407
Email: preet4bhullar@gmail.com

Abstract. Hybrid nanostructures of conducting polymers and metal oxides are promising candidates for multifunctional devices due to their tunable electrical properties. In this study, Langmuir–Blodgett (LB) films of polyaniline (PANI) incorporated with ZnO nanoparticles were fabricated and systematically characterized. Atomic Force Microscopy (AFM) revealed uniform nanostructured morphologies and topography with very low surface roughness, while Conductive AFM (C-AFM) measurements demonstrated diode-like I–V characteristics. The electrical current response was strongly dependent on ZnO loading, increasing from ~8 nA at 5 wt% to ~20 nA at 20 wt%, confirming enhanced charge transport. Furthermore, the synergistic π–π stacking between PANI backbones and oxygen of ZnO facilitates improved electron mobility and surface interaction sites, imparting diode-like electrical Characteristics. The ability to assemble ordered monolayers via the LB technique not only ensures structural control but also enables their application in flexible electronics, environmental monitoring, and next-generation nanophotonic instrumentation.

Nanoparticles: Unlocking Medical Efficiency through Precise Synthesis and Targeted Therapy

Ranveer Singh
Department of Chemistry, M.L.B. Govt College, Nokha (Bikaner) Rajasthan
Email: chemdrranveersingh2015@gmail.com

Abstract. Nanoparticles, which offer improved therapeutic efficacy and fewer side effects, have become a viable tool in medical research. This research focuses on creating nanoparticles with exact control over their surface characteristics, size, and form. We look into the effectiveness of these nanoparticles in focused treatment, medication administration, and imaging. Our findings show that nanoparticles have the ability to enhance patient care and treatment outcomes. This research highlights the importance of nanoparticle synthesis and functionalization in unlocking their medical efficiency.

Keywords: Nanoparticles, Synthesis, Medical efficiency, Targeted therapy, Drug delivery, Imaging applications.

A-012

Performance Analysis of Nanotransistors with III-V Channel Materials for Thermophysical Effects

[1]Pooja Srivastava, [2]Arvind Kumar Singh, [1]Anshika Tripathi, [1]Anubha Singh, [1]Deepika Sharma, [1]Devika Arya, [1]Sneha Singh
[1]Department of Physical Sciences, Banasthali Vidyapith, Banasthali 304022, India
[2]Department of Mathematics, Institute of Science, Banaras Hindu University, Varanasi 221005, India

Abstract. This work specifically addresses that gap by presenting a comparative analysis of nanotransistors as FinFET, JLFET, and nanosheet FETs with III–V channel materials under different temperature conditions. Using Silvaco TCAD simulations, threshold voltage, carrier mobility, ON/OFF current ratio, and subthreshold swing evolve with temperature have been evaluated, and how these variations affect overall reliability have been performed. The results underline that while nano-transistors provide significant benefits—such as compact size, high switching speed, and low power consumption—they also face practical challenges like fabrication complexity, heat management, and sensitivity to thermal changes. By explicitly linking temperature dependence with both material choice and device architecture, this study offers new insights into identifying the most suitable nanotransistor design for future technologies. These findings are particularly valuable for applications such as AI accelerators, 5G communication systems, and portable electronics, where devices must be not only efficient but also thermally stable.

As CMOS technology continues to scale into the nanometer regime, traditional planar MOSFETs encounter significant challenges, including short-channel effects, increased leakage currents, and reduced reliability. To address these issues, advanced device structures like FinFETs, Junctionless FETs, and Gate-All-Around (GAA) Nanosheet FETs have been introduced, offering stronger electrostatic control and improved efficiency. In parallel, III–V compound semiconductors such as GaAs, InGaAs, and InP have garnered significant attention due to their high electron mobility and excellent transport properties, making them strong candidates for next-generation high-speed, low-power devices. However, most studies have focused either on device scaling or material properties in isolation, while the combined impact of temperature

variation on III–V nanotransistors across different architectures remains less explored.

Keywords: Nanotransistors, III-V compound materials, drain-induced barrier lowering, subthreshold slope, temperature effect

A-013

Localized surface plasmon resonance based colorimetric sensor for detection of Mercury ion

Bijoy Sankar Boruah[#]
Department of Physics, Rangapara College (Autonomous)-784505, Sonitpur, Assam, India
[#]Corresponding Author's email: bijoyboruah09@gmail.com

Abstract. This study reports a localized surface plasmon resonance (LSPR)-based colorimetric method for mercury ion detection using silver nanoparticles as the sensing unit. Mercury, one of the most toxic heavy metal ions, poses severe ecological and health risks even at concentrations as low as 2 ppb. With increasing industrialization, mercury contamination in water has become a critical concern, necessitating the development of sensitive and selective detection approaches. In this work, green-synthesized chitosan-reduced silver nanoparticles were employed for mercury ion sensing. To enhance selectivity, the nanoparticle surface was functionalized with cysteamine, which enabled a distinct color change from yellowish to blue upon interaction with mercury ions, while remaining unresponsive to other metal ions. The selectivity and sensitivity of the system were further confirmed by UV–Vis spectroscopy, which revealed a characteristic LSPR peak shift in mercury-treated solutions. These findings highlight the potential of cysteamine-modified silver nanoparticles as a promising green platform for rapid and selective mercury ion detection in water systems.

Keywords: LSPR; Colorimetric; Mercury

A-014

Study of Photo response of ZnO Nanoparticles for Prepared by Hydrothermal Method

Rajnish Yadav[1], Ramesh Kumar[1]*
P.G Department of Physics, V.K.S.U, Ara, Bihar
*Corresponding Author's Email: rameshphysicsdu@gmail.com

Abstract. Semiconductors with dimensions in the nanometer range are turns out to be the important field of studies due to their long range of applications. Optical properties of ZnO are of great interest for application in optoelectronics, photovoltaics and biological sensing. Various chemical synthetic methods have been developed to prepare such nanoparticles ZnO nanoparticles are synthesized by hydrothermal method. In this method zinc acetate salt is used with surfactant to form the ZnO precipitates. The obtained precipitates are vacuum dried at room temperature. The prepared sample is characterized by XRD techniques and characteristics peaks are obtained. Furthermore, The FT-IR and Raman studies confirm the formation of Zno nanoparticles. The particles obtained are of the orders of 20 nm. Furthermore, the prepared sample tested for photo response measurement and rGO sample have photo response of 5% at 30 Mw/cm^2.

A-015

Robust XRD and SEM Metrics for TiO_2 Nanoparticles: Scherrer, Williamson–Hall, Texture, Lattice & Morphology parameters Across Five Synthesis Variants

Khyati Mody[1], I B Patel[2]
Department of Physics, Veer Narmad South Gujarat University, Surat-395007, Gujarat, India
[1]E-mail ID: kmody1997@gmail.com, [2]ibpatel@vnsgu.ac.in

Abstract. Titanium dioxide (TiO_2) nanoparticles are heavily researched for photocatalysis, gas sensing, and energy applications but for the most part reports are based on a single condition of synthesis with minimal characterization. We report herein a comparative study of five TiO_2 nanoparticle samples (S1–S5) synthesized under varying parameters. Instrumentation-corrected X-ray diffraction (XRD) was used for estimating crystallite size (Scherrer), strain (Williamson–Hall), defect density, specific surface area (SSA), texture coefficients, and cell parameters. Crystallite sizes were 6–12 nm in diameter while Williamson–Hall sizes were up to 20 nm with microstrain up to 3.8×10^{-3}. Defect densities were up to ~10^{16} m^{-2} while SSA was between 116–224 m^2 g^{-1}. Lattice refinements revealed cell volume contraction upon increased strain. SEM confirmed nanoscale particle size, agglomeration, and morphology consistent with XRD. Application mapping suggests S3 with least crystallite size and highest SSA is best for photocatalysis while S2 and S5 for their highest defect densities are best for gas sensing. S1 and S4 are stable controls for coatings as well as for use in electrochemical applications. We introduce a reproducible, comparative model linking synthesis conditions with structural parameters and functional potential in sol–gel TiO_2.
Keywords: TiO_2 nanoparticles, sol–gel synthesis, Scherrer, Williamson–Hall, defect density, SEM, surface area, photocatalysis, gas sensing.

A-016

Reactivity of hydroxyl radical towards the polycyclic aromatic hydrocarbons as finite size model of graphene

Anjali Singh*, Durgesh Yadav, Amarjeet Yadav
Department of Physics, Siddharth University Kapilvastu, Siddharth Nagar
*Email: singhanjali64654@gmail.com

Abstract. Nanomaterials have significant applications in different areas such as the environment, agriculture, food, biotechnology, biomedical, and medicines. Graphene, a carbon based nanomaterial is widely used in medical field such as targeted drug delivery. In theoretical study, polycyclic aromatic hydrocarbons (PAHs) were taken as finite size model of graphene. We have studied the hydroxyl radical (OH) interaction at the different sites of finite size graphene using the density functional theory (DFT). Addition of OH at the different site of nine to sixteen fused benzene rings were performed at B3LYP and M062X along with the 6-31G(d,p) basis set. Binding energies were calculated with and without the basis set superposition error (BSSE) at the mentioned levels of DFT. The calculated binding energies reveal that OH radical bind at edges more strongly than the inner sites.

A-017

Performance Evaluation of Nanotransistors with Organic Materials for Low Power and High-Speed Applications

[1] Pooja Srivastava, [2] Arvind Kumar Singh, [1] Saumya, [1] Pragya Choudhary, [1] Tapasya, [1] Smriti Singh, [1] Kanak Sharma
[1]*Department of Physical Sciences, Banasthali Vidyapith, Banasthali 304022, India*
[2]*Department of Mathematics, Institute of Science, Banaras Hindu University, Varanasi 221005, India*

Abstract. The current advancements in technology have raised the need for continuous need to find better alternatives to the existing silicon-based transistors that can support low power consumption and high-speed performance simultaneously. Silicon transistors pose several fundamentals such as higher power consumption and short channel effects challenges when scaled down to nanometre, furthermore scaling of silicon increases fabrication costs and makes the process all the more difficult.
As such Organic nanotransistors stand to provide promising alternatives to the existing challenges. They lower the overall cost of fabrication, also they provide more compatibility with flexible and large area substrates, their molecular structure can also be chemically engineered, allowing them to be optimized for specific applications. This makes them highly compatible with the emerging technologies including wearable devices, bio compatible and energy efficient electronics.
This study aims to analyse the performance of organic nanotransistors by comparing them with silicon nanotransistors. Key device parameters such as threshold voltage, charge carrier mobility, on/off ratio, subthreshold ratio, transconductance, and switching delay have been analysed for the same. Further, the study examines the performance gap between low power consumption and speed caused due to some properties of organic materials such as environmental instability and low charge carrier mobility.
Overall, this work aims to provide useful perspectives into the design and optimization of organic nanotransistors, reinforcing the advantages of integrating them into sustainable and energy efficient electronic systems
Keywords: Nanotransistors, Organic Materials, Short Channel Effect, Sub Threshold Ratio, Switching Delay, Transconductance

A-018

First principles study of Li adsorption on Co-doped armchair graphene nanoribbon

Nancy[1], Babita Rani[*1]
[1]*Department of Physics, Punjabi University, Patiala, India*
*Email: dr.babita@pbi.ac.in

Abstract. In this study, we investigate the interaction of Li with Co-doped armchair graphene nanoribbon (AGNR) using density functional theory. The calculated formation energy demonstrates the stability of the Co-doped AGNR. Pristine AGNR is unsuitable for adsorption of Li, as its cohesive energy is less than that of bulk Li. In contrast, the adsorption energy of Li on Co-doped AGNR is found to be greater than that of Li on pristine AGNR and the cohesive energy of bulk Li. Furthermore, density of states (DOS) analysis reveals that the semiconducting nature of both pristine and Co-doped AGNRs turns metallic after the adsorption of lithium.

A-019

Spin-Orbit Coupling Effects on Optical Conductivity in Flat-Band 2D Lattices

Shashikant Kumar[*1] and Prakash Parida[1]
[1]*Department of Physics, Indian Institute of Technology Patna, Bihar, India*
[*]E-mail: shashikant_1921ph20@iitp.ac.in

Abstract. Our study explores the optical conductivity of three two-dimensional (2D) lattice systems: kagome, Lieb, and dice lattices. Using a tight-binding model with spin–orbit coupling (SOC), we analyze their electronic band structures and corresponding optical responses. The kagome lattice, characterized by Dirac cones and flat bands, is compared with the Lieb and dice lattices, which also host flat bands intersecting Dirac cones but differ in sublattice geometry and symmetry. We show that the origin of flat bands—arising from electron localization or destructive interference—plays a decisive role in shaping optical conductivity. SOC introduces band gaps near Dirac points, especially in the kagome lattice, suggesting potential for topological insulating phases. In contrast, the flat bands in Lieb and dice lattices remain robust against SOC, indicating stable and predictable optical properties useful for optoelectronic applications. Our comparative analysis highlights key differences in optical transitions. Dirac-to-Dirac transitions yield strong, high-frequency conductivity in the kagome lattice but are negligible in Lieb and dice lattices. Flat-to-Dirac transitions are prominent at high frequencies in kagome and Lieb lattices, while dice lattices exhibit strong responses at lower frequencies. These results provide insight into the physics of flat-band systems and point to opportunities for tunable optical materials via SOC engineering.

Keywords: Kagome, Lieb, Dice, Tight-binding, Optical-conductivity

A-020

Nanotechnology in Energy: Advancements in Solar Cells and Energy Storage Significant

Suraj Prakash
Department of Chemistry, Govt. College, Kolayat, Bikaner
Email: Chemsp2023@gmail.com

Abstract. Improvements in solar cells and energy storage systems have been fueled by nanotechnology, which has become a disruptive force in the energy industry. Using breakthroughs like quantum dots, perovskite nanomaterials, and plasmonic nanostructures, scientists have created high-efficiency solar cells with enhanced light absorption, charge carrier transport, and stability through nanoscale material manipulation. Nanostructured electrodes, improved electrolytes, and new materials like graphene and metal-organic frameworks have made it possible to design high-capacity, fast-charging batteries and supercapacitors for energy storage. These developments tackle important issues like sustainability, scalability, and efficiency in the adoption of renewable energy. This review examines recent developments in solar energy conversion and storage applications of nanotechnology, emphasizing their potential to completely transform the world's energy landscape while overcoming constraints like cost and environmental
Keywords: Nanotechnology, solar cells, energy storage, quantum dots, etc

A-021

Transition from metallic to semiconducting spin polarized state in zigzag graphene nanoribbon

Monika Khetarpal
Department of Physics, Government Maharani Sudarshan College for Women, Bikaner 334001, Rajasthan, India
Email: drmonikaphy7@gmail.com

Abstract. The zigzag graphene nanoribbon (ZGNR) has a very outstanding and unique electronic structure and transport properties such as the edge state and spontaneous magnetization. By applying the nearest neighbour tight-binding model with p_z orbital basis set I report a theoretical study of the electronic structure of a series of hydrogen-terminated ZGNR having different chirality combinations. It is found that all zigzag graphene nanoribbons are metallic and feature a flat band extending over one-third of the one-dimensional Brillouin zone. Further, the variation of flatness ratio with the width of ribbons demonstrated that the nanometer size effect is a key factor to determine the relative importance of the edge states. When Coulomb repulsion is added then apart from the gapped semiconducting property, being incredibly appropriate for electronics, it is observed that ZGNR has astonishing magnetic properties. All quasiparticle systems have a bandgap that decreases as the width of the system increases. Moreover, the calculations illustrated that zigzag graphene nanoribbons have spatial spin-polarized ground states with spin moments coupled ferromagnetically on the same edge and antiferromagnetically between different edges. This makes ZGNR a promising candidate to be used in spintronic devices avoiding heavy magnetic atoms and further, due to unusal magnetic and electronic property they are ideal material in nanophotonic devices.

Keywords: ZGNR, Band structure, Tight binding, Flat bands, Spin polarization

A-022

Structural, Optical Properties of ZnO-50%CNT and Photocatalytic MB Dye Degradation

Ramanand Sharma [a], Nathu Lal[b], Chhagan Lal[c], Amanpal Singh[c]
[a]*Govt KMG College, Neemkathana*
[b]*Govt. Girls College, Jhunjhunu*
[c]*Department of Physics, University of Rajasthan, Jaipur*
Email: rnsharmanmr@gmail.com

Abstract. The present work investigates the structural and optical properties of a green synthesized ZnO–50% CNT nanocomposite and evaluates its photocatalytic performance in the degradation of methylene blue (MB) dye. X-ray diffraction analysis confirmed the wurtzite hexagonal phase of ZnO with no secondary phases, indicating successful incorporation of carbon nanotubes into the ZnO matrix. The introduction of 50% CNTs resulted in reduced crystallite size and enhanced surface interaction between ZnO nanoparticles and CNTs. Morphological observations made by SEM-EDX revealed a well-dispersed network of CNTs, which facilitated effective charge transport and minimized electron–hole recombination which is favourable for dye degration. Optical studies using UV-Vis Spectrometer demonstrated a noticeable red-shift in the absorption edge, leading to a reduced band gap and improved visible-light response. Photocatalytic experiments showed that the ZnO–50% CNT nanocomposite exhibited superior MB dye degradation efficiency compared to pure ZnO and pure CNT, owing to the synergistic effect of ZnO photocatalytic activity and CNTs' electron mobility. These findings highlight the potential of ZnO–CNT nanocomposites as efficient photocatalysts for wastewater treatment applications.
Keywords: Nanocomposite, CNT

A-023

Nanoscience and Nanotechnology: A Frontier for Transformative Research

Nirmala Bansal
Department of Chemistry, SRP Govt. PG College, Bandikui 303313, India

Abstract. Nanoscience and nanotechnology are emerging as the science and technology of the future, promising to reshape our understanding of nature at the most fundamental scale. By enabling control at the level of atoms and molecules, these fields are expected to bring revolutionary changes in medicine, energy, environment, materials, and information technology.

Though still in its early stages, nanotechnology holds immense potential. It demands a comprehensive understanding of nanoscale systems, where novel phenomena often diverge from conventional physics and chemistry. At its core, nanotechnology involves the design, characterization, and fabrication of structures, devices, and systems at the nanoscale, where precise control of size and shape leads to unique properties and unprecedented applications.

By bridging fundamental science with technological innovation, nanoscience and nanotechnology are poised to drive the next wave of human progress, opening doors to smarter, smaller, and more efficient solutions for global challenges.

Keywords: Nanoscience, Nanotechnology, Nanoscale Systems, Innovation, Applications

A-024

Casson Hybrid Nanofluid Flow over a Wedge within a Porous Medium

Shubham Bansal[1,#],
[1]*Department of Mathematics, S.B.D. Government College, Sardarshahar, Churu,331403, Rajasthan, INDIA*
[#] Email: bansals306@gmail.com

Abstract. This work investigates Casson hybrid nanofluid flow and heat transfer over a wedge embedded in a porous medium, where blood is considered as the base fluid and Ag and ZnO nanoparticles are dispersed to form the hybrid nanofluid. The formulation accounts for the effects of magnetic field, slip velocity, variable thermal conductivity, heat source/sink, and viscous dissipation. Using similarity transformations, the governing boundary layer equations are reduced to nonlinear ordinary differential equations, which are then solved numerically with the MATLAB solver bvp4c. The influence of Casson fluid parameter, nanoparticle volume fraction, and wedge angle parameter on velocity and temperature profiles, skin-friction coefficient, and Nusselt number is systematically analyzed. The findings show that hybrid nanoparticles significantly improve thermal performance compared to single nanoparticles, while the Casson parameter reduces wall shear stress. The outcomes provide insights into optimizing hybrid nanofluids for advanced thermal management applications involving wedge-shaped geometries.
Keywords: hybrid nanofluid, Casson fluid, nanoparticle volume fraction, variable thermal conductivity.

A-025

Study of $Ag_x(CdS)_{1-x}$ composite thin films

Mahesh Chander Mishra
Departments of Physics, Government College, Tonk, 304001 India

Abstract. This paper presents Ag /CdS Composite thin films fabricated on glass substrate via Spin Coating Method. Ag doping in CdS with x= 0.1, 0.3, 0.5 different concentration by sonication method. The undoped and Ag doped CdS were characterized by X-ray Diffractometer (XRD) and Scanning electron microscope (SEM) used for structural and morphological study. XRD confirmed that CdS shift Cubic to hexagonal phase due to silver concentration. UV-Visible spectrometer used for calculated band gap by Tauc's plot method. The optical direct band gap values reduced from 2.41 to 2.02 eV from undoped to x= 0.3 Ag doped and slightly increase at x=0.5 Ag. Fourier transforms infrared spectrometer (FTIR) used for bond formation and identification of functional group. The photoluminescence (PL) spectrum emitted a strong peak near band edge emission at approximately 630nm, meaning better optical quality.
Keywords: CdS powder. Silver powder. Ultra-Sonication. Spin Coating. Magnetic Stirrer. Vacuum Oven.

Advanced Microwave Absorbing Material System for Next-Generation Invisible Defence Applications

Vijayeta Pal[1, 2]*
[1]*School of Materials Science and Technology, Indian Institute of Technology, Banaras Hindu University, Varanasi, India*
[2]*I-DAPT Hub Foundation, Indian Institute of Technology, Banaras Hindu University, Varanasi, India*
*Email: vijayeta.idapt@itbhu.ac.in ; vijayetapal@gmail.com

Abstract. Recently, low-detectability technology supports defence strikes by reducing the chances of detection, allowing forces to approach or engage targets with greater precision and safety. It has become a key priority in defence and military, where advanced absorber materials are playing a crucial role for reducing radar cross-sections and thereby enhancing low detectability. In this study, we synthesized a multi-layered composite structure via high-energy ball milling, confirmed by Raman analysis, showing a stable cubic phase at room temperature. The composite demonstrates excellent microwave absorption by minimizing reflection and scattering, while also being lightweight, flexible, thermally stable, and environmentally durable. The micrographs reveal spherical nanoparticles with smooth surfaces, and uniform size. In this study, the hybrid nanocomposites prepared exhibit particle size less than 85 nm. The developed absorber systems exhibit a minimum reflection loss of -27dB, wide bandwidth with EAB occurring within 6 GHz bandwidth from 12 to 18 GHz, thin profile, and low filler content, making them strong candidates for next-generation invisible defence applications.

B-001

Uses of Optoelectronics in Society

Ramesh Chand Meena
Department of Physics, SCRS Govt. College Sawai Madhopur
Mail: meena1991ramesh@gmail.com

Abstract. Optoelectronics is a field that combines optics and electronics, focusing on devices and systems that detect, emit or control light using semiconductors has a wide range of uses in modern society. These devices convert electric energy into light. Here's an overview of its main applications and uses in society are in fiber optic communication like as high-speed internet, cable TV and telephone services. Infrared remote control used in TV remotes, AC controllers. Laser Communication used in free space optical communication. In Medicine and Healthcare optical tomography and endoscopes use light for non-invasive imaging, treats conditions like neonatal jaundice or skin disorders using controlled light exposure. In Consumer Electronics LED display and screens, optical storage devices like CD, DVD and Blu ray players, Camera Sensors and some use infrared light grids to detect touch. In security and surveillance use as Night Vision Devices, Optical Sensors and Facial Recognition Systems. In Industrial applications used in automation, robotics and quality control and Bar Code scanners. In Transportation used in autonomous vehicles for object detection and mapping, traffic monitoring and Head Up Displays. In Energy and Environment Sensors detect pollutants or monitor light levels in ecosystems. In Military and aerospace used in missiles, drone and aircraft and uses optoelectronics sensors for Earth observation and reconnaissance.

B-002

Quantum Dots Sensitize Solar Cell

Saurav Kumar Jha[a*] and Anita Kumari Maliyan[b]
[a]*Uttarakhand Open University*
[b]*S.G.R.R. (P.G.) College, Dehradun, Uttarakhand 248001*
*Corresponding Author E-mail: ms.saurav1997@gmail.com

Abstract. The urgent demand for clean and sustainable energy has accelerated research into third-generation photovoltaics. Quantum Dot Sensitized Solar Cells (QDSSCs) are emerging as promising alternatives to conventional crystalline silicon and dye-sensitized solar cells owing to their tunable bandgaps, high absorption coefficients, and potential to exceed the Shockley–Queisser efficiency limit via multiple exciton generation (MEG). This study explores the theoretical basis of QDSSCs, including quantum confinement, bandgap engineering, and charge transport mechanisms. Optical and electrochemical characterization revealed size-dependent absorption and distinct efficiency trends, with CdSe-based QDSSCs achieving ~5% power conversion efficiency (PCE), outperforming InP (3.3%) and $CuInS_2$ (2.7%). Electrochemical impedance spectroscopy demonstrated reduced charge-transfer resistance in CdSe devices, while encapsulation and gel electrolytes significantly enhanced stability. Comparative case studies against conventional silicon panels under Delhi irradiance conditions indicated that although QDSSCs currently lag in absolute efficiency, they exhibit superior tunability, lightweight flexibility, and integration potential. The findings highlight QDSSCs as a frontier in next-generation photovoltaics, with advances in lead-free quantum dots, solid-state electrolytes, and scalable fabrication techniques offering viable pathways toward commercialization. Also, in this study the comparison has been made for the efficiencies of various traditional solar plants at different locations.

Keywords: Quantum Dot Sensitized Solar Cells (QDSSCs), multiple exciton generation (MEG), renewable energy, quantum confinement, bandgap engineering, photovoltaic efficiency.

One Dimensional Ternary Photonic crystals-based biosensor for blood hemoglobin detection

Sanjeev Sharma*[1], Kuldeep Singh[2], Vipin Kumar[3], Sri Krishana Singh[2]
[1*]*Department of Applied Science & Humanities, IMS Engineering College, Ghaziabad, India-201009*
[2]*Janta Vedic College Baraut, Uttar Pradesh 250611, India*
[3]*Department of Physics, Janta Vedic College Baraut, Uttar Pradesh 250611, India.*
[4]*Department of Physics, Government College Lamta, Balaghat, Madhya Pradesh, India- 481551*
*E-mail: sanjeevsharma145@gmail.com

Abstract. A one-dimensional ternary photonic crystals-based biosensor has been used for blood hemoglobin detection. In the proposed structure a blood sample is inserted between three alternate layers of different materials in a periodic manner. In the proposed work, a biosensor aims to detect hemoglobin in blood sample by utilizing a refractive index measurement. The sensing performance of a one-dimensional ternary photonic crystal is based on slightly change in the hemoglobin refractive index/ concentrations in blood sample. A theoretical analysis like transmittance, quality factor, sensitivity and detection limit are based on transfer matrix method. The main aim of this device is to provide a tool for medical diagnoses.
Keywords: Biosensor, Blood sample, Sensitivity, TMM, Refractive index.

B-004

Effect of Damping Factor of a Metallic Layer in a Quaternary Photonic Crystal for Multichannel Filter Application

Shreya Sharma[1], Bhuvneshwer Suthar[2], Narendra Kumar[1#], S. P. Ojha[3]
[1]*Department of Physics, SLAS, Mody University of Science and Technology, Lakshmangarh 332311, Sikar, Rajasthan, India*
[2]*Department of Physics, Govt Dungar College, Bikaner 334001, Rajasthan, India*
[3]*Department of Applied Physics, Indian Institute of Technology (BHU), Varanasi 221005, India*
[#]Corresponding author: nkumar.cash@gmail.com

Abstract. In this work, we investigate a quaternary photonic crystal (QPC) consisting of a unit cell made up of three semiconductor layers and one metallic layer. Using the transfer matrix method, the transmission spectra of the proposed QPC are analyzed in the terahertz frequency range while varying the damping factor. The results show that while the damping factor changes, the peak position remains almost unchanged. However, the quality factor decreases as the damping frequency increases, and the overall transmittance is reduced because of absorption effects. These tunable characteristics suggest that the proposed QPC structure could be highly useful in the development of optical filters and advanced photonic devices.
Keywords: transfer matrix method (TMM), quaternary, semiconductor, optical filters, optical devices.

B-005

Photonic Bandgap Analysis in One-Dimensional Photonic Crystals for Optical Biosensing

Sumitra Dewal
Department of Physics, M.L.B. Govt. College, Nokha (Bikaner) 334803, Rajasthan, INDIA
Email: sumitradewal786@gmail.com

Abstract. Photonic crystals (PhCs) have emerged as promising structures for manipulating light at the nanoscale, offering unique opportunities for optical sensing applications. In this study, we investigate the photonic bandgap (PBG) characteristics of one-dimensional (1D) photonic crystals and evaluate their potential in the design of highly sensitive optical biosensors. By employing the transfer matrix method (TMM), we simulate and analyze the transmission spectra of multilayered dielectric structures with periodic refractive index contrasts. The influence of key parameters such as refractive index contrast, layer thickness, and number of periods on the position and width of the PBG is systematically studied. Results indicate that slight variations in the refractive index — simulating biomolecular interactions — lead to measurable shifts in the bandgap, highlighting the sensitivity of the structure to environmental changes. This sensitivity makes 1D PhCs suitable candidates for label-free biosensing. The findings provide a theoretical foundation for designing low-cost, compact, and highly sensitive photonic biosensors based on 1D photonic crystal architectures.

B-006

Optical and Functional Properties of Double Perovskite Oxides for Nanophotonic Device Engineering

Charu Agarwal[1,2,#]
[1]*Department of Physics, S.R.K.P. Govt. P.G. College, Kishangarh, Ajmer 305801, INDIA*
[2]*Department of Physics, University of Rajasthan, Jaipur 302004, INDIA*
charuagarwal2310@gmail.com

Abstract. Double perovskite oxides ($A_2B'B''O_6$) represent a promising class of functional materials for nanophotonic device applications, owing to their unique combination of structural flexibility, optical tunability, and multifunctional electronic properties. Unlike conventional semiconductor platforms, these oxides offer high refractive indices, wide bandgap variability, and strong excitonic features, which are essential for tailoring light-matter interactions at the nanoscale. Their inherent thermal and chemical stability further ensures device reliability under harsh operating conditions, a critical advantage for integrated photonic systems. When incorporated into resonant dielectric nanostructures, photonic crystals, and waveguide architectures, double perovskite oxides can facilitate enhanced light confinement, low-loss propagation, and tunable spectral responses. Their ability to couple ferroelectric and magnetic ordering with optical functionality also opens pathways toward active photonic modulation, polarization control, and multifunctional nanophotonic devices. Recent advances in thin-film growth and epitaxial engineering of these oxides enable precise control of cation ordering and defect landscapes, thereby optimizing optical constants and nonlinear responses. This work highlights the potential of double perovskite oxides as a robust platform for next-generation nanophotonic materials and devices, with applications spanning ultrafast photonic switches, tunable resonators, and quantum photonic components. Their multifunctionality positions them at the forefront of efforts to design energy-efficient, miniaturized, and resilient photonic technologies.

Keywords: Double Perovskite, Nanophotonic Devices, Ferroelectric, Magnetic Ordering

B-007

Design of a Photonic Crystal Sensor for Fat Level Detection in Adulterated Milk

Aditi Lamba[#], Amit Kumar, Narendra Kumar*
Department of Physics, SLAS, Mody University of Science and Technology, Lakshmangarh-332311, Sikar, Rajasthan
[#] Email: addy315666@gmail.com, *nkumar.cash@gmail.com

Abstract: In this paper, we focus on the optical measurement of fat level in adulterated milk using a one-dimensional photonic crystal (1-D PC) structure with a symmetrically introduced defect layer. In this configuration, the defect layer is filled with milk samples of varying fat concentrations. The transmission characteristics of the PC are analyzed, and a defect mode appears within the photonic band gap (PBG) region. It is observed that as the fat concentration in milk increases, the defect mode frequency shifts linearly. This behavior highlights the potential of the structure as an optical sensor for determining fat concentration in milk, since variations in fat content directly alter the refractive index of the medium. The resulting refractive index changes lead to a corresponding shift in the defect mode wavelength, as well as modifications in the full width at half maximum (FWHM) and quality factor (QF).
Keywords: Photonic crystal, Milk adulteration, Fat concentration

B-008

Tunable Hyperbolic Metamaterials for Enhanced Light-Matter Interaction and Broadband Absorber Design

Amit Kumar[#], Aditi Lamba, Narendra Kumar
Department of Physics, SLAS, Mody University of Science and Technology, Lakshmangarh-332311, Sikar, Rajasthan
*akumar.cash@gmail.com, addy315666@gmail.com, nkumar.cash@gmail.com

Abstract. In this review paper, we make an exhaustive analysis of a design and numerical study of tunable hyperbolic metamaterial (HMM) based geometry like a periodic metal-dielectric multilayer stack optimized to provide a broadband hyperbolic regime in the visible and near-infrared ranges. We study the active control over the effective permittivity tensor and Type I to Type II hyperbolic dispersion transition. External tuning mechanisms, such as refractive index modulation of the dielectric layer, are also reviewed for the sake of dynamic control over the hyperbolic bandwidth. Comparing the results reported by the researchers in more recent years, it is found that tunable HMMs provide a reconfigurable platform for nanophotonic devices. Promising applications include ultra-sensitive plasmonic sensors, ultracompact waveguides, improved nonlinear optical devices, and near-field super-resolution imaging systems. The study suggests the design and guidelines for practical applications of HMMs in future optical communication, quantum photonics, and broadband absorber.
Keywords: Hyperbolic metamaterials, Dispersion, Absorber

B-009

Study of defect-induced localized modes in 1-D Ternary Chalcogenide Photonic Crystals

Rajpal Singh
Department of Physics, Govt. M. S. Girls College, Bikaner
Email: rajubkn@gmail.com

Abstract. In this work, we investigate defect-induced optical characteristics of symmetrical one-dimensional (1-D) ternary chalcogenide photonic crystals using the transfer matrix method (TMM). Numerical results reveal the emergence of sharp resonant transmission peaks within the Photonic Band Gap (PBG). The wavelength, number of modes and quality factor of the defect-induced localized modes can be precisely controlled by varying the thickness of the defect layer. The resonance wavelength shifts towards higher wavelength with an increase in the thickness of the defect layers and shows the red shift. The study highlights the role of defect engineering in designing compact optical filters, wavelength-selective resonators, and refractive index sensors for infrared photonic applications.
Keywords: Photonic crystal, chalcogenide, defect-induced localized mode etc

B-010

Design and Analysis of a 1D Photonic Crystal-Based Optical Reflector Incorporating Superconductor–Semiconductor Layers

Isha Chaudhary, Vipin Kumar*, R. Kumar
Department of Physics, Janta Vedic College, Baraut (Uttar Pradesh), India-250611
*Email: vipinphys@gmail.com

Abstract. In this work, we propose and theoretically investigate an omnidirectional optical reflector and polarization-selective filter based on a one-dimensional photonic crystal (1D-PC) composed of alternating $YBa_2Cu_3O_7$ (YBCO) and Si layers. The refractive indices of YBCO and Si are modeled as functions of temperature and wavelength for realistic analysis. Using the transfer matrix method (TMM), reflectance and transmittance spectra are obtained. Results show that no omnidirectional reflection (ODR) band appears near the critical temperature, but ODR emerges below it. At 85 K, the YBCO/Si structure exhibits an ODR band from 1394–1621 nm (bandwidth 227 nm) for both TE and TM modes. Additionally, at higher incident angles, the structure functions as a polarization-selective filter without introducing defects.
Key Words: Photonic band gap, Reflectance/transmittance spectra, Omnidirectional reflection, Polarization filter

B-011

Effect of nanophotonic on solar cell materials and on its applications

Neerul Deogan
Department of Physics, Ramgarhia Girls College, Ludhiana 141003, Punjab INDIA
Email: deogann@gmail.com

Abstract. Nanophotonic is the study and manipulation of light at the nanoscale. It has emerged as a transformative field in photovoltaics. By exploiting this phenomenon, it can be used for enhancement in light absorption, charge generation and overall efficiency of solar cell materials. The transition to renewable energy is crucial for sustainable development in India particularly as energy demands continues to rise. Solar energy, a key component of India's renewable energy strategy offers immense potential due to its abundance, environmental benefits and technological advancements. The development of environmental friendly nanomaterials can play pivotal role for sustainable energy solutions. New solar cells have been devised using nanotechnology which are significantly cheaper than conventional solar cells. Researchers have developed a Honeycomb like structure of graphene which will replace the platinum in a dye sensitized solar cells for conversion of sunlight into electricity. This paper examines the application of nanomaterials and nanophotonic in solar cells, emphasizing the urgent need for renewable energy due to fossil fuel depletion and rising energy demands and show how different strategies influence the optical and electronic properties of solar cell materials. It categorizes solar cells into three generations -silicon based, semiconductor compounds and novel nanomaterials. The 3rd generation including perovskite, Nano wires, dye sensitized and quantum dot solar cells, shows significant potential for enhanced efficiency and reduced costs. The widespread potential of these advanced solar cells promises significant advancements in renewable energy technology. This will help in designing flexible, Lightweight or low-cost technologies suitable for diverse applications.
Keywords: Nanophotonic; Nanotechnology; Solar Cell; Nano Materials; Perovskite

B-012

Nanophotonics and Optoelectronics: Fundamentals, Devices, and Emerging Applications

Shaminder Singh Sandhu
Department of Physics, DAV College, Chandigarh 160011, INDIA
E. Mail: shaminderssandhu@gmail.com

Abstract. Nanophotonics and optoelectronics exploit light–matter interactions at nanometer length scales to enable optical functionality beyond the diffraction limit, resulting in ultracompact light sources, detectors, modulators, and energy harvesters. This review synthesizes the fundamental physical mechanisms—surface plasmon resonances, photonic crystals, metamaterials, and quantum confinement—and examines how they are engineered within optoelectronic architectures. Advances in nanoscale LEDs and lasers, plasmonic and dielectric photodetectors, and nanophotonic strategies for light trapping in solar cells are discussed with emphasis on recent experimental milestones and performance metrics. Key applications in optical communication, quantum photonics and neuromorphic photonic computing are analyzed. We identify the central technical challenges—material losses, fabrication scalability, and heterogeneous integration with CMOS—and evaluate mitigation routes, including hybrid plasmonic–dielectric architectures, low-loss alternative plasmonic materials, two-dimensional materials, and AI-driven inverse design. The review concludes with an outlook highlighting realistic device trajectories, industrially relevant roadmaps for commercialization, and promising research directions for realizing energy- and cost-efficient nanophotonic optoelectronics.

Keywords: Nanophotonics; Optoelectronics; Surface plasmons; Photonic crystals; Perovskite photovoltaics; Quantum photonics

B-013

Advantages of Organic Solar Cells in comparison with traditional solar cells

Poora ram
Department of Physics, MBC Govt. Girls College, Barmer, Rajasthan

Abstract. Organic solar cells (OSCs) are a rather new alternative to the traditional photo-voltaic cells. Being a new technology, OSCs are made up of organic substances which render them of higher degree of flexibility as well as a lightweight design which improves their overall utility. Additionally, they are not silicon based and therefore incur lower manufacturing costs which in turn make them economical alternatives for power production using solar energy. Their properties can be tuned with specific solar as well as climatic conditions. OSCs are easy to manufacture and are ecologically friendly since they have recyclability, lower carbon footprint and lower energy demands during their manufacturing. Although they are a technology of the future, they come with a few limitations which include lower power generating efficiency and a comparatively shorter lifespan than traditional PV cells. Despite these challenges, OSCs are proving to pave way for cleaner and easily accessible solar energy.

C-001

Study of One Dimensional Quasi Photonic Crystals for Optical devices

Sapna Dinodiya
Govt. Women Polytechnic College, Bikaner, Rajasthan
Abstract. In this work, we are going to study the optical characteristics of 1 D quasi photonic crystal structure with a defect sequence using the transfer matrix method (TMM). The effects of the defect on photonic band gap and transmission spectra are examined. The defect creates the localization of light within the band gap, which exhibits a significant change when the refractive indices and thickness of materials are changed. The structure can be used in different types of optical devices such as optical cavities, filters and sensors, including sensing and imaging for biomedical applications.
Keywords: Quasi photonic crystal, Defect layer, Transmission spectra, Photonic band gap

C-002

Investigation of structural, optical and luminescence properties of $BaBPO_5$ (BaBP):Dy^{3+} phosphor for solid-state lighting applications

T. Chandra Mohan[a*], P. Sai Dinesh[a], B. Surya Narayana Devara[b], T. Raghu Raman[c], Y.C. Ratnakaram[a].
a. Department of physics, Sri Venkateswara University, Tirupati, Andhra Pradesh, India.
b. A.S.D GDC Kakinada, Adikavi Nannaya University, Kakinada, Andhra Pradesh, India.
c. GDC Puttur, Sri Venkateswara University, Tirupati, Andhra Pradesh, India.

Abstract. A novel white light emitting BaBP:xDy^{3+} (x = 0.06, 0.08, 0.10, 0.12, and 0.14 mol%) phosphors were synthesized using a high-temperature solid-state reaction technique. The phase purity, structural, optical, and photoluminescence characteristics of the synthesized phosphor were studied using powder X-ray diffraction (PXRD), high-resolution scanning electron microscopy (HRSEM), Fourier-transform infrared (FTIR)spectroscopy, Fourier-transform Raman (FT-RAMAN) spectroscopy, UV-Vis DRS, and photoluminescence spectroscopy. The excitation spectra were obtained at a wavelength of 575 nm, and several sharp peaks were observed in the 300–400 nm region, with a high-intensity peak at 348 nm, indicating potential excitation by the NUV chip. The photoluminescence spectra of all concentrations of Dy^{3+} ions were analyzed under an excitation wavelength of 348 nm. The emission spectra showed four prominent peaks at 472, 484, 574, and 664 nm, corresponding to the $^4I_{9/2} \rightarrow {}^6H_{15/2}$, $^4F_{9/2} \rightarrow {}^6H_{15/2}$, $^4F_{9/2} \rightarrow {}^6H_{13/2,}$ and $^4F_{9/2} \rightarrow {}^6H_{11/2}$ transitions of Dy^{3+} ions. The Y/B ratio, concentration quenching, energy transfer mechanism, and cross-relaxation mechanisms were also studied. The CIE color coordinates, CCT, and color purity values were calculated for all concentrations of the Dy^{3+} ions. The CCT values were in the range of 4000 – 4600 K. The CCT values fall within the neutral white to cool neutral white light range. The photoluminescence spectra and CIE chromaticity coordinates suggest that the prepared phosphor is a potential candidate for the manufacture of NUV-based WLEDs and solid-state lighting.
Keywords: XRD, FTRAMAN, CCT, neutral white light, solid-state lighting

C-003

An Advanced Enhancement in Lasing Gain of $In_{0.671}Al_{0.009}Ga_{0.320}As/InP$ under Altering Quantum Width

Pyare Lal
Department of Physics, Banasthali Vidyapith 304022, Rajasthan, INDIA
Corresponding Author's email: drpyarephysics@gmail.com

Abstract. The present work's key focus has been endured on study of an advanced enhancement in lasing gain of $In_{0.671}Al_{0.009}Ga_{0.320}As/InP$ heterostructure under altering width of central quantum layer in fibre optic communication technology. In this research, the simulative and innovative model of 5 quantum layers compressive strained heterostructure of net size 260nm has been governed schematically. For the present work, an integrated theory of Luttinger model of 4x4 matrix and k.p model of effective masses has been worked out to display mathematically salient lasing coefficient such as upper energy levels, lasing gain coefficient, coefficient of signal loss, fibred signal loss, coefficient of bandwidth etc. under altering quantum widths. The various lasing quantum effects of width has been displayed by graphs at constant temperature 298K and constant concentration 0.223×10^{18} /cm^3, although internal compressive strain of 0.00117 has been existed in this work. Further, quantum width varying effect on upper levels and quasi fermi level have been presented by simulation. In addition, in the simulating results, at minimal loss (0.05dB/km) data signal, the achieved 1550nm shortwave infrared signal has been demonstrated graphically at very high intensity 4300/cm under 6nm quantum width. Moreover, this 1550nm signal has very high speed and larger bandwidth coefficient at minute value of latency coefficient. So, this 1550nm $In_{0.671}Al_{0.009}Ga_{0.320}As/InP$ provides key role in the fibred optical communication technology as in the form of 1550nm amplifying heterostructure, 1550nm detecting heterostructure and 1550nm lasing quantum heterostructure etc.

Keywords: Luttinger model, k.p model, lasing gain coefficient, loss coefficient, bandwidth coefficient.

C-004

Study on Renewable Energy Resources and Energy Storage Devices

Bhuvneshwari[1], Avinash vyas[1#], Sunil kumar meena[2#]
[1] *Department of Physics, Shri Baldev Ram Mirdha Govt. College Nagaur (Raj).*
[2] *Department of Physics, Govt. College Jayal, Nagaur (Raj).*
[#]Email : vyasavinash2050@gmail.com, nimeshsamay6sec@gmail.com

Abstract. The present work focuses on renewable energy resources and the importance of energy storage devices. Nowadays, humans live in the chain of supply and demand; every product's manufacturing and production depend on the supply of energy. To fulfill energy demand, fossil fuels are burned for transportation, industry, heat, electricity, and other uses. Poisonous gases released into the environment and climate is affected. To clean Earth's environment, green energy resources should be appreciated. After producing energy from renewable sources, storage is required. Recently, using electrochemical materials, many storage devices have been developed. Electrochemical materials are the backbone of energy storage devices such as rechargeable batteries, fuel cells, and supercapacitors, which are crucial for storing and converting energy efficiently. The project highlights how these materials contribute to integrated renewable energy, reduce dependence on fossil fuels, and support applications such as electric vehicles, portable electronics, and large-scale energy storage systems. These devices fulfill the requirements of energy and resolve environmental challenges. We are discussing these roles in minimizing greenhouse gas emissions by promoting clean and sustainable energy solutions. Through this study, the project emphasizes not only the scientific principles of electrochemical materials but also their real-world applications. It is one step towards the potential for shaping a greener and more sustainable future.

Keywords: Renewable energy resource, electrochemical materials, Storing devices, Li-Ion and Na-Ion battery.

C-005

Nonlinear Dynamics of Soliton Collisions and Internal Modes in Discrete Optical Waveguides

Ramesh Kumar[1,2,#)], U. Singh[2,3)], O. P. Swami[2)], G. Suthar[4)] and A. K. Nagar[2)]
[1]*Department of Physics, SNDB Govt PG College, Nohar, Hanumangarh, 335523, Rajasthan, India*
[2] *Department of Physics, Govt Dungar college, Bikaner, 334001,Rajasthan, India*
[3] *Department of Physics ,SRRM Govt College, Jhujhunu, 333001, Rajasthan, India*
[4]*Department of Mathematics, Manda College, Bikaner, 334022, Rajasthan, India*
[#)]Corresponding author: rphysics52@gmail.com

Abstract. Discrete optical waveguides offer a versatile platform for exploring nonlinear dynamics of solitons. In such systems, collisions are shaped not only by lattice discreteness but also by the excitation of internal modes, which influence stability and energy redistribution. Using the discrete nonlinear Schrödinger model, we investigate soliton collisions and show regimes of elastic and inelastic interaction, trapping, and long-lived oscillatory states. Internal resonances play a key role in asymmetric outcomes and energy exchange. These results provide insights into controlled soliton interactions in photonic lattices, with implications for optical switching, routing, and all-optical information processing.
Keywords: Discrete solitons, Soliton collisions, Internal modes, Nonlinear optical waveguides, Photonic lattices.

C-006

Bifurcation Analysis of Plasmon-Soliton at the Interface of a Planar Waveguide

U. Singh[1,2)], Ramesh Kumar[2,3)] and A. K. Nagar[2)]
[1] *Department of Physics, SRRM Govt College, Jhunjhunu, 333001, Rajasthan, India*
[2] *Department of Physics, Govt Dungar College, Bikaner, 334001, Rajasthan, India*
[3]*Department of Physics, SNDB Govt PG College, Nohar, Hanumangarh, 335523, Rajasthan, India*
[a)]Corresponding author: usnlphy@gmail.com

Abstract. We study plasmon-soliton interaction at the interface of planar waveguide consisting of a metal and nonlinear Kerr dielectric. Using nonlinear dynamics, the dependence of spatial soliton on low, medium and large power in the presence of losses in the metal is discussed. The results are helpful for explaining the observed beam propagation behaviour in earlier work.
Keywords: plasmon, soliton, planar waveguide, Kerr dielectric, bifurcation analysis

C-007

Synthesis, Structural and Spectral Studies of Er^{3+} doped $LiSrVO_4$ Synthesized by Combustion Method

Meniak Khajuria[1,*], Pankaj Biswas[1]
[1]*School of Physics, Shri Mata Vaishno Devi University, Katra 182320, J&K, INDIA*
[#]Corresponding Author's email: meniakkhajuria@gmail.com

Abstract. This study presents the combustion synthesis and explores the structural and optical properties of $LiSrVO_4$ nanophosphor doped with 2 mol% Er^{3+}. The material was characterized using X-ray powder diffraction, Photoluminescence, and UV-VIS spectrometry. The XRD analysis indicated that the sample crystallized into a monoclinic structure with the space group Cmcm, with lattice constants a = 5.865 Å, b = 9.291 Å and c = 7.140 Å with volume (V) = 389.07 Å^3. The crystallite size was calculated as 67 nm approximately using the Williamson-Hall analysis. Upon 980 nm excitation, $LiSrVO_4$:Er^{3+} at 2 mol % emitted visible light, predominantly in green and red bands with peak emissions observed at 528 nm, 546 nm and 660 nm with transitions $^2H_{11/2}\rightarrow{}^4I_J$, $^4S_{3/2}\rightarrow{}^4I_J$ and $^4F_{9/2}\rightarrow{}^4I_J$ (J=15/2), respectively. Diffuse Reflectance (DR) studies revealed an optical bandgap of 3.53 eV for the $LiSrVO_4$ doped with Er^{3+}. These findings suggest that the synthesized phosphors have potential applications in photovoltaic solar cells, bio-imaging, and fingerprint detection.
Keywords: Nanophosphors, Upconversion, UV, PL

C-008

Optical Biophysics of Insect Vision

Kamlesh Rawat
Department of Zoology, SPC Government College Ajmer
Email: rawat_kamlesh@hotmail.com

Abstract. Insects exhibit a remarkable diversity of visual systems, optimized through evolution to meet the ecological demands of their environments. The study explored the optical biophysics underlying insect vision, focusing on the structural, functional, and photophysical mechanisms of compound eyes. The effect of microstructural adaptations—such as ommatidial arrangement, interommatidial angle, and cuticular lens properties—enable high-speed motion detection, polarization sensitivity, and spectral discrimination were the key factors of the study. Integrating principles from optics, neurobiology, and quantum photo-physics the inference was made as pioneer in the field. The findings highlight the interplay between physical constraints and biological innovation, offering insights relevant to both fundamental vision science and the design of bioinspired optical technologies.

C-008

One-Dimensional Photonic Crystal Based Diatom Sensor for Optical Sensing Applications

Ankita[1,#]
[1]*Department of Physics, Government Girls College, Taranagar, 331304, Rajasthan, INDIA*
[#]Email: ankita13895@gmail.com

Abstract. One-dimensional (1D) photonic crystals (PCs) have attracted significant attention in the field of optical sensing due to their simple fabrication, strong photonic bandgap (PBG) properties, and high sensitivity to environmental changes. In this work, the application of a 1D photonic crystal structure as a diatom sensor is explored. Diatoms, being microalgae with periodic silica nanostructures, exhibit unique optical responses that can be effectively detected using photonic crystals. By engineering a defect layer within the 1D PC, resonance modes can be tuned to interact with diatom samples, leading to measurable shifts in transmission spectra. These shifts serve as indicators for the presence and concentration of diatoms in a medium, enabling real-time and label-free optical sensing. The study highlights the advantages of 1D photonic crystal-based diatom sensors, including compact design, low-cost implementation, and enhanced detection sensitivity, making them promising candidates for environmental monitoring, water quality analysis, and biosensing applications.
Keywords: Diatom sensor, Optical sensing, One-dimensional photonic crystal.

D-001

Exchange bias phenomenon in bulk and thin films of Double perovskite compound

Amit Kumar Singh*
Department of Physics, Marwari College, Lalit Narayan Mithila University, Darbhanga - 846004, Bihar, India
*Corresponding author: amitphy1991@gmail.com

Abstract. Double perovskite Nd_2NiMnO_6 (NNMO) compound has attracted significant attention owing to their fascinating magnetic properties, including exchange bias (EB), which plays a vital role in spintronic and magnetic storage applications. This study presents a comparative analysis of exchange bias phenomena in bulk and thin-film forms of NNMO compound, highlighting the similarities and differences in their origin, magnitude, and tunability. The discussion encompasses structural factors, magnetic anisotropy, interface effects, and synthesis routes that influence EB behavior. In bulk NNMO system, EB is primarily governed by intrinsic structural disorder, grain boundaries, and competing magnetic phases, whereas in thin films, substrate-induced strain, interfacial coupling, and layer thickness play dominant roles. The review also addresses temperature dependence, training effects, and the role of antisite disorder in both morphologies. By systematically correlating experimental findings with theoretical models, this work aims to provide insights into the optimization of EB in Nd_2NiMnO_6 for device-oriented applications.
Keywords: Double perovskite, Exchange Bias, Thin film, Antisite disorder, Spintronic,

D-002

Structural and Optical Perspectives of Halide Perovskites: $MAPbBr_3$ and $MA_3Bi_2Br_9$

Rahul Palsaniya, Sarita Kumari
Department of Physics, University of Rajasthan, Jaipur, Rajasthan
Email: rahulchoudhary0804@gmail.com

Abstract. Halide perovskites have attracted significant attention in recent years owing to their exceptional potential in photovoltaic and optoelectronic devices. Among them, lead-based perovskites such as $MAPbBr_3$ (methylammonium lead bromide) exhibit superior structural uniformity and excellent optical absorption, making them efficient candidates for light-harvesting applications. Nevertheless, the inherent toxicity and instability of lead-based systems necessitate the exploration of eco-friendly alternatives. In this regard, $MA_3Bi_2Br_9$ (methylammonium bismuth bromide), a lead-free halide perovskite derivative, emerges as a sustainable substitute with promising stability and suitable optical features. This study emphasizes a comparative analysis of the structural framework, band gap characteristics, and optical responses of $MAPbBr_3$ and $MA_3Bi_2Br_9$. The insights gained highlight the interplay between material structure and optoelectronic behavior, thereby contributing to the design of stable, efficient, and environmentally benign perovskite-based devices.

Keywords: Halide Perovskites, $MAPbBr_3$, $MA_3Bi_2Br_9$, Structural Properties, Optical Characteristics

D-003

Evaluation of Photon Shielding Parameters in $NiCuFe_2O_4$ and $NiMgFe_2O_4$ Nanoparticles

Kalidas B. Gaikwad [a*], Pravina P. Pawar [a]
[a*] *Department of Physics, Deogiri College, Chhatrapati Sambhajinagar. (MS), 431004, India.*
[a*] *Department of Physics, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar. (MS), 431004, India.*
[a] *Department of Physics, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar. (MS), 431004, India.*
*Corresponding Author's E-mail: kalidasgaikwad7@gmail.com

Abstract. This work employed the Sol-gel auto-combustion process to produce ferrite samples of $NiCuFe_2O_4$ and $NiMgFe_2O_4$. In order to examine the synthetic materials' structural, optical, and functional groups, a variety of analytical methods were employed, including XRD, UV-Vis, and FTIR. Furthermore, we examined the gamma-ray shielding characteristics for the produced materials using a NaI (Tl) scintillation detector and a variety of gamma-ray sources. The theoretical values and the experimental results exhibited a strong connection. The synthesized ferrite nanoparticles' capability to shield against gamma radiation was evaluated using this software program. By adjusting the radiation dose's strength, ferrites have been exposed to gamma radiation from an array of sources. An investigation of the mass and linear attenuation coefficients, mean free path, half value layer, tenth value layer, effective atomic number, and effective electron density for synthesized spinel ferrites at 122–1330 keV is conducted using Phy-X/PSD software. The gamma-ray energy absorption build-up factor (EABF) for selected ferrites is investigated at incident photon energy levels ranging from 0.015 to 15 MeV using the geometric progression (G-P) fitting technique. It is widely recognized that the recommended nanoparticles can aid in improving shielding against γ-radiation.

Keywords: Ferrite Nanoparticles; X-ray diffraction; UV-Vis spectro-photometer; FTIR; Radiation Shielding Parameters.

D-004

Highly Efficient Near-Infrared Emission from Er^{3+}-Doped $Na_2BiMg_2(VO_4)_3$ Phosphors: Synthesis, Characterisation, and Potential Applications

Rashmi V. Pandey[1#], Halim S. Ahamad[1], Supriya Kshetrapal[2], and Nilesh Ugemuge[3]

[1] *Department of Physics Saint Francis De Sales College Seminary Hills, Nagpur 440006, Maharashtra, INDIA*

[2] *Department of Physics Saint Francis De Sales College, Nagpur 440001, Maharashtra, INDIA*

[3] *Department of Physics Anand Niketan College of Science, Arts and Commerce, Warora Chandrapur 442914, Maharashtra, INDIA.*

[#]Corresponding Author's email: rashmipandey2021@gmail.com,

Abstract. Er^{3+}-doped $Na_2BiMg_2(VO_4)_3$ phosphor materials were synthesized and investigated for near-infrared (NIR) luminescence properties. Samples with varying Er^{3+} concentrations 1, 2, 5, and 7 mol% were characterized using structural and optical techniques. Under 524 nm excitation, all compositions exhibited strong and stable emission around 1536 nm, corresponding to the $^4I_{13/2} \rightarrow {}^4I_{15/2}$ transition of Er^{3+} ions. The results confirmed efficient NIR emission with good structural stability and photoluminescence reliability across different doping levels. These features make the synthesized phosphors promising candidates for applications in optical communication, biomedical imaging, and advanced photonic devices.

Keywords: Er^{3+}-doped phosphors, Near-infrared emission, $Na_2BiMg_2(VO_4)_3$, Photoluminescence, Optical communication, Biomedical imaging.

Investigating the influence of Erbium doping on structural, morphological, compositional and magnetic properties of $Zn_{0.6}Mg_{0.4}Er_xFe_{(2-x)}O_4$ Ferrites

Ummed Singh
Department of Physics, JNVU, Jodhpur, Rajasthan, INDIA
Email: ustanwar411@gmail.com

Abstract. Ferrites, a class of materials known for their exceptional electrical, magnetic, and mechanical properties, have found diverse applications, ranging from high-density data storage to biomedical technologies. Among these, magnesium ferrites have been employed as catalysts and humidity sensors, while super paramagnetic ferrites are promising candidates for cancer treatment through hyperthermia therapy. In this context, we present a study on a series of Er3+ substituted $Zn_{0.6}Mg_{0.4}Er_xFe_{2-x}O_4$ (x=0.0, 0.05, 0.10, and 0.15) ferrites, with a focus on their structural, morphological, compositional and magnetic characteristics. The synthesis of these ferrites was carried out by using co-precipitation method, and their structural properties were analyzed through XRD analysis. The results confirmed the presence of both cubic and tetragonal spinal structures, with variations in lattice constants and crystallite sizes attributed to Er^{3+} substitution. SEM analysis provided insights into the morphological information about the nanoparticles, revealing spherical grains with some degree of agglomeration. FT-IR analysis further corroborated the presence of essential metal-oxygen bonds in the samples at different wavenumbers. The VSM analysis demonstrated that maximum saturation magnetization of 48.44 emu/g is observed for x=0.15 content of Er in synthesized ferrites. This research sheds light on the structural, morphological, compositional and magnetic properties of Er-doped $Zn_{0.6}Mg_{0.4}Er_xFe_{2-x}O_4$ ferrites, underscoring the significance of fine-tuning composition to tailor specific properties. The findings contribute to the understanding of $Zn_{0.6}Mg_{0.4}Er_xFe_{2-x}O_4$ nanomaterials and their applications in fields such as catalysis, sensors, memory storage, switching devices etc.
Keywords: $Zn_{0.6}Mg_{0.4}Er_xFe_{2-x}O_4$ ferrites, Er-doping, structural analysis, magnetic analysis.

Structural and Optical Characterization of $CsPbBr_3$ Nanowires and Nanocrystals for Optoelectronic Applications

Nidhi Kumari Meena
[1]*Department of Physics, University of Rajasthan, Jaipur 302004, Rajasthan, INDIA*
Email: nidhi.meena.2986@gmail.com

Abstract. $CsPbBr_3$ nanowires (NWs) and nanocrystals (NCs) were synthesized via a hot injection method and comprehensively analysed for their structural and optical characteristics. Field emission scanning electron microscopy (FESEM) and high-resolution transmission electron microscopy (HRTEM) revealed the coexistence of mixed-dimensional nanostructures, comprising NWs up to ~15 µm in length and NCs with different morphology. X-ray diffraction (XRD) confirmed the orthorhombic phase with sharp reflections and characteristic peak splitting, indicating high phase purity. Lattice fringes with ~0.30 nm spacing were observed in HRTEM, and selected area electron diffraction (SAED) confirmed the single-crystalline nature of the NCs. UV–Vis absorption showed multiple transitions, and a sharp photoluminescence (PL) peak at 526 nm with a FWHM of ~23 nm was observed. The small Stokes shift minimal trap assisted recombination, highlighting the potential of these nanostructures high-performance optoelectronic applications.
Keywords: $CsPbBr_3$, nanowires, optoelectronic materials

D-007

Optical Characterization of Yb doped Cesium Copper Chloride ($CsCuCl_3$) Perovskite Powder

Harsha Sonawane[1#], Ashok Sunatkari[2], Shital Sonawane[3], D. Swarnalata Sunatkari[4]
[1]*Department of Physics, Siddharth College of Arts, Science & Commerce, Mumbai, Maharashtra, INDIA*
[2]*Department of Physics, Siddharth College of Arts, Science & Commerce, Mumbai, Maharashtra, INDIA*
[3]*Department of Physics, Siddharth College of Arts, Science & Commerce, Mumbai, Maharashtra, INDIA*
[4]*Department of Physics, N.G. Acharya & D. K. Marathe College, Mumbai, Maharashtra, INDIA*
[#]Corresponding Author's email: harshasonawane24@gmail.com

Abstract. Inorganic halide perovskites are novel materials that exhibit a small as well as large energy gap and tunable exciton luminescence, which is obtained by exchanging the halide ion in the structure. This paper presents powdered CsCuCl3 perovskite doped with different concentration of Yb3+ ions prepared using the hydro-solvo thermal reaction method. In order to investigate the spectroscopic features of CsCuCl3:Yb3+ perovskite detailed analysis including UV absorption, Photoluminescence spectroscopy and SEM with EDAX were characterized. It was observed that dopant content strongly influences the obtained results. The introduction of different concentration of Yb^{3+} ions into the host lattice leads to a deterioration of optical properties and it shows blue shift. Particle size decreases as concentration of ions increases useful application in optoelectronic devices.
Keywords: CsCuCl3:Yb3+, perovskite, Optical properties, Optoelectronic applications.

D-008

The Structural And Optical Properties Of $InAs_xSb_{1-x}$

Rajkumar Jhakal[1,#], M.D. Sharma[2]
[1]*Department of Physics, S.B.D. Government College, Sardar Shahr 331403, Rajasthan, INDIA*
[2]*Department of Physics, Government Dungar College, Bikaner 334001, Rajasthan, INDIA*
[#]Corresponding Author's email: jhakalraj@gmail.com

Abstract. We present a theoretical study of the optical and structural characteristics of $InAs_xSb_{1-x}$ Semiconducting alloys in zinc blende structure using the Harrison bond orbital model in conjunction with the empirical pseudopotential approach in the virtual crystal approximation. Calculations are made for $InAs_xSb_{1-x}$'s elastic constant, bulk modulus, refractive index, high frequency dielectric constant, and static dielectric constants. For $InAs_xSb_{1-x}$ ($0<x<1$) Our results are predictions.
Keywords: Structural Properties, Optical Properties, $InAs_xSb_{1-x.}$

D-009

Effect on Surface and Functional Modifications in Silicone Rubber Composites under High- Energy Ion Irradiation

Bhawna[1], Kusum rani[2] , Kulvinder Singh[3] and Alka Garg[4]*
[1]*Baba Mastnath University, Asthal Bohr, Rohtak-124021, Haryana, India*
[2]*Baba Mastnath University, Asthal Bohr, Rohtak-124021, Haryana, India*
[3]*Deen Dayal Upadhaya College, University of Delhi. India*
[4]*Gargi College, University Of Delhi, India*
*Corresponding author Email: alka.garg@gargi.du.ac.in

Abstract. Study investigates about the alterations in surfaces and optical characteristics of silicon rubber composites induced by high – energy nickel and lithium ion irradiations. Ion irradiation was discovered to introduce microstructural flaws such as cracks, voids, and surface roughness, which are directly linked to changes in crosslinking density and the production of new chemical connections. These changes show the possibility for functional customization of silicone-based composites by influencing hydrophobicity, mechanical stability, and optical absorption. Defect sensitivity is further increased by the addition of dopants like bismuth iodide, suggesting potential uses in radiation detection.

The present study expands on our previous research on silicone rubber composites cured with peroxide, which found a direct correlation between X-ray detector performance and structural and morphological changes. This study illustrates how controlled irradiation can be utilized to alter polymer properties for improved durability and multifunctionality by contrasting silicone rubber's reactions to light (Li) and heavy (Ni) ion beams. The findings offer information pertinent to cutting-edge uses in radiation detecting technology, biomedical devices, high-voltage insulation, and aircraft.

Keywords: Silicone rubber composites, High-energy ion irradiation, Nickel and lithium ions, Surface modification.

D-010

Structural, Optical and Spectroscopic characterization of Magnesium Substituted nanocrystalline Cobalt Ferrite for technological uses

Chandra Prakash Barupal[1, #], Arvind Kumar[1], Shyam Prakash Pareek[2]
[1]*Department of Physics, University of Rajasthan, Jaipur, Rajasthan, INDIA*
[2]*Department of Physics, S S Jain Subodh PG College, Jaipur, Rajasthan, INDIA*
[#]Corresponding Author's email: cpbarupal1984@gmail.com

Abstract. Magnesium-substituted nanocrystalline cobalt spinel ferrite compounds, represented by $Mg_xCo_{1-x}Fe_2O_4$ (with x values ranging from 0.2 to 1.0 in increments of 0.2), were synthesized using the sol-gel method in this study. The impact of increasing magnesium content on the properties of these nanocrystals was systematically assessed. X-ray diffraction (XRD) established the formation of spinel phases, confirmed the single-phase purity, and revealed changes in crystallite size associated with varying magnesium concentrations. Both the crystallite size and the lattice parameter 'a' exhibited dependencies on the magnesium content. Rietveld refinement further confirmed that the $Mg_xCo_{1-x}Fe_2O_4$ nanoparticles possess a single-phase cubic spinel structure. Additional phase purity verification was provided by Fourier Transform Infrared (FTIR) spectroscopy, which showed that the stretching vibrations of (Fe-O) bonds at tetrahedral sites shifted within the 536 to 543 cm^{-1} range as the magnesium concentration increased. Optical characterization using UV-visible spectroscopy indicated that the band gap energy changes with higher levels of magnesium, making these materials highly suitable for microwave absorption and visible light activation applications. The study emphasizes the structural, optical, and spectroscopic features that are pertinent for technological advances such as biosensors. Magnesium-substituted cobalt ferrites thus present significant potential for a variety of biomedical and engineering applications.
Keywords: XRD, Rietveld refinement, FTIR, UV-visible

D-011

Sustainable Synthesis of Bioactive Hydroxyapatite from Tilapia Fish Scales

V. Prasad[1], A. Paul, Ullas[1], S. Koujalagi[1], Pradeep H N[1], Madhu A[2]
[1]*Department of Biotechnology, Dayananda Sagar College of Engineering, Bengaluru, India-560078*
[2]*Department of Physics, Dayananda Sagar College of Engineering, Bengaluru, India-560078*
[#]Corresponding Author's email: mmathi.33@gmail.com

Abstract. Bioactive ceramics are very desirable for uses in regenerative medicine because they create strong connections with soft tissue and bone provide an economical and environmentally friendly way to create bioactive hydroxyapatite (HAp) from tilapia fish scales, a commonly available biowaste. The scales are cleaned and then calcined at two distinct temperatures—650°C and 950°C—to create HAp powders. Fourier transform infrared (FTIR) spectroscopy, X-ray diffraction (XRD), energy-dispersive X-ray (EDX) analysis, and scanning electron microscopy (SEM) were then used to characterise the resultant materials. Improved crystallinity at the higher calcination temperature was demonstrated by XRD analysis, which validated the synthesised HAp's crystalline nature. While EDX confirmed the existence of calcium (Ca), phosphorus (P), and oxygen (O) as the major elements, FTIR spectra showed distinctive phosphate and hydroxyl group vibrations. The synthesised HAp's Ca/P ratio was determined to be near the optimal stoichiometric value of approximately 1.62. According to SEM pictures, the HAp powders created porous agglomerates, a structure that is advantageous for tissue ingrowth and cellular adhesion in biomedical applications. This study identifies a viable and sustainable biomaterials production route. The process uses an economical raw material, produces a product that closely resembles the mineral makeup of real bone, and lessens its impact on the environment by using waste. High osteoconductivity and biocompatibility are ensured, indicating a viable approach for creating sustainable biomaterials for bone and tissue regeneration. However, challenges like scaling manufacturing and addressing variations in raw material quality and mechanical strength remain.
Keywords: Bioactive ceramics, Tilapai, HAp, Morphology, Structure –XRD and FTIR

D-012

Post-Annealing effect on the structural, morphological and optical properties of MoO_3 thin films deposited by Thermal Evaporation method

Khushbu Dhaked [1, #], Rimpy Shukla[1], Ramphal Sharma[1], Sunil Kumar Goyal[2]
[1]*Department of Physics, IIS (Deemed to be University), Jaipur 302020, Rajasthan, INDIA*
[2]*Department of Electrical Engineering, Manipal University Jaipur, Jaipur 303007, Rajasthan, INDIA*
[#]Corresponding Author's email: drkhushbudhaked@gmail.com

Abstract. This study investigates the effect of annealing temperature on the structural, morphological, and optical properties of Molybdenum oxide (MoO_3) thin films prepared via thermal vacuum evaporation onto glass substrates. The characterization of the films was performed using X-ray diffraction (XRD), Field emission scanning electron Microscopy (FESEM) equipped with EDAX, and UV-VIS spectrophotometer. XRD revealed that the as-deposited films were amorphous, while annealing at 200 °C, 300 °C, and 400 °C improved crystallinity, increased crystallite size, and confirmed the formation of the orthorhombic α-MoO_3 phase. FESEM images showed a transition from fine granular structures in the as-deposited state to well-developed, rod-like, and densely packed grains at higher temperatures, indicating significant crystallite growth. UV–VIS analysis showed a reduction in optical bandgap to approximately 2.93 eV after annealing, enhancing light absorption. These results demonstrate that controlled annealing improves the structural and optical properties of MoO_3 thin films, making them promising for sensors, photocatalytic systems, smart windows, and optoelectronic applications.
Keywords: MoO_3 thin films, Thermal Vacuum Evaporation, Annealing effect, Structure; Morphology, Optical properties.

D-013

Biogenic Synthesis of Silver Nanoparticles from Aloe vera: Antimicrobial Activity Evaluation

Abhilasha Choudhary
Dept of Botany, SBRM Govt College, Nagaur, 341001, Rajasthan, India
Mail ID-abhishiv25@gmail.com

Abstract. Green synthesis of nanoparticles provides an eco-friendly and cost-effective alternative to conventional chemical methods by utilizing plant extracts as reducing and stabilizing agents. This study reports the synthesis of silver nanoparticles (AgNPs) using *Aloe vera* leaf extract and evaluates their antimicrobial potential against pathogenic bacteria. The synthesis process was optimized using a central composite design, and the AgNPs were characterized through UV-Vis spectroscopy, Fourier Transform Infrared (FTIR) spectroscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), X-ray Diffraction (XRD), and Dynamic Light Scattering (DLS). Antimicrobial activity was tested against Gram-positive (*Staphylococcus aureus*, *Bacillus subtilis*) and Gram-negative (*Escherichia coli*, *Pseudomonas aeruginosa*) bacteria using disc diffusion, minimum inhibitory concentration (MIC), and minimum bactericidal concentration (MBC) assays. The synthesized AgNPs exhibited a predominantly spherical morphology with an average size of 15–40 nm and demonstrated notable antimicrobial activity, particularly against Gram-negative strains. Bioactive compounds in *Aloe vera*, such as acemannan and polyphenols, contributed to nanoparticle stability and enhanced antibacterial efficacy. These findings suggest that *Aloe vera*-mediated AgNPs hold significant promise for biomedical and pharmaceutical applications.

Keywords: Green synthesis, silver nanoparticles, Aloe vera, antimicrobial activity, pharmacological analysis

D-014

Impedance Spectroscopy Study of Solid Redox Mediators Prepared with Poly(Ethylene Oxide), Succinonitrile, Lithium Perchlorate, and Cobalt Salts for Dye-Sensitized Solar Cells

Ravindra Kumar Gupta[#]
King Abdullah Institute for Nanotechnology, King Saud University, Riyadh 11451, SAUDI ARABIA
[#]Corresponding Author's email: rgupta@ksu.edu.sa

Abstract. Most regions in Saudi Arabia endure hot weather throughout the year, marked by significant sunshine and an irradiance of about 2 MWh m^{-2}, which is useful for electricity generation using solar cell modules. A dye-sensitized solar cell (DSSC) possesses a simple cell architecture, employs non-toxic and readily available materials, and allows for light to enter from various angles. In a DSSC, a fast ion-conducting redox mediator helps to regenerate dye molecules. This study reports the impedance spectroscopy analysis of novel solid redox mediators (SRMs) for the first time. These mediators were composed of cobalt salts to facilitate the Co(II/III) redox couple and lithium perchlorate to enable Li^+ ion intercalation at the dye-TiO_2-electrolyte interface. The matrix was poly(ethylene oxide), [poly(ethylene oxide)-succinonitrile] blend, and succinonitrile, leading to mediators SRM1, SRM2, and SRM3, respectively. The log impedance-log frequency plots exhibited two linear regions for all SRMs, except for SRM with succinonitrile after its melting temperature. The pattern of the Bode plot with the phase angle was crucial for controlling the Nyquist curve. The Nyquist curve resulted in electrical conductivity of 3×10^{-5}, 3.9×10^{-4}, and 2×10^{-3} S cm^{-1} S cm-1 for SRM1, SRM2, and SRM3, respectively, at 25°C. Both SRM1 and SRM3 exhibited Arrhenius-type behavior with activation energy more than 0.73 eV in region-I and less than 0.19 eV in region-II. In contrast, SRM2 exhibited VTF-type behavior, with a pseudo- activation energy of 0.042 eV. The results are explained in light of XRD, FT-IR spectroscopy, DSC, and TGA studies.
Keywords: Dye-sensitized solar cells; Electrical conductivity; Co(II/III) redox mediators

D-015

A Study about Metamaterials and Metasurfaces

Rafiq Khan, Ajay Kumar Nagar
Department of physics, Govt. Dungar College, Bikaner, Rajasthan 334001 INDIA.
Email: rafiq022049@gmail.com

Abstract. In this study the Metamaterials and Meta surfaces are studied. In the advancement of material science, we explore some new materials like metamaterials. Metamaterials are made with meta-atoms or artificial atoms. These materials perform at nano-meter scale and are useful to develop nanoscale devices. The classification, concepts, properties and some important applications like optical clock, thermal diode, terahertz absorber of metamaterials are discussed. Meta surfaces are 2D views of metamaterials. In this study we explore the overview, dimensions and applications of meta surfaces. Many types of metamaterials like electromagnetic metamaterials, acoustic metamaterials, thermal metamaterials and mechanical metamaterials are discussed.
Keywords- Metamaterials, Material science, Artificial atoms, thermal diodes, nanoscale devices.

D-016

Influence of PEDOT:PSS on the Electrochemical behavior of Vanadium-based Ternary Metal Oxide Nanocomposite Supercapacitors

Rekha Kumari[1], Manav Sharma[1], Vivek Kumar Shukla[*1]
[1]*Department of Applied Physics, Gautam Buddha University, greater Noida - 201312.*
[*]Corresponding Author: vivek@gbu.ac.in.

Abstract. A supercapacitor is an advanced energy storage device that combines the rapid charge–discharge capability of conventional capacitors with the enhanced energy density typically associated with batteries. Based on their charge storage mechanism, supercapacitors are generally categorized into two types: electrochemical double-layer capacitors (EDLCs) and pseudo capacitors. EDLCs offer significant advantages over pseudo capacitors, as their energy storage relies solely on electrostatic processes without involving faradaic reactions, thereby minimizing structural degradation. Moreover, EDLCs are characterized by high power density, fast charge–discharge response, low internal resistance, and excellent coulombic efficiency. In the present study, ternary metal oxides (TMOs) were employed as electrode materials for the fabrication of a liquid-electrolyte-based supercapacitor device. To further enhance electrical conductivity and improve electrode stability, PEDOT:PSS was incorporated into the electrode slurry during preparation. The fabricated device delivered specific capacitances of 125, 93, and 41F g^{-1} at current densities of 2, 3, and 4 mA cm^{-2}, respectively, as evaluated from galvanostatic charge–discharge (GCD) measurements. Furthermore, the device achieved an energy density of 11 Wh kg^{-1} with a corresponding power density of 1142 W kg^{-1}, underscoring its potential for high-performance energy storage applications.

Keywords: Supercapacitors, Ternary Metal Oxide, Hydrothermal synthesis, CV, GCD and EIS.

D-017

Size dependent magnetic behavior and effect of SHI irradiation on magnetic properties of nanocrystalline ferrites

Shyam Prakash Pareek
Department of Physics, S. S. Jain Subodh PG College, Jaipur, 302 004 (India)
Email: shyamsubodh2006@yahoo.co.in

Abstract. The overall magnetic properties of nanoparticles of $Ni_{0.8}Cu_{0.2}Fe_2O_4$ ferrite with average particle sizes of 3, 4, 5, 6 and 9 nm prepared by chemical co-precipitation method have been studied. The dc magnetization measurements show that the samples are superparamagnetic above the blocking temperatures and the blocking temperature of the nanoparticles clearly correlates with the size of the nanoparticles and increases as the function of the size. The effects of 200 MeV Ag ion irradiation on magnetic behaviour of nano particles of $Co_{0.6}Zn_{0.4}Fe_2O_4$ with average particle size of 4.5 nm, synthesized by chemical co-precipitation method also discussed. After irradiation by 200 MeV Ag ions, magnetization enhancement took place and can be attributed to slight increase in particle size and SHI irradiation induced modifications in surface states of the nanoparticles. Mössbauer studies on these pre and post samples revealed that changes in isomer shift, increased quadrupole splitting on SHI irradiation.
Keywords: Magnetizations, Spinal Ferrites, Nanoparticles, Superparamagnetic.

Material Characterization Techniques

Manisha Meena
Department of Physics, Government College Tonk, 304001, Rajasthan, India
Email: manishamina963@gmail.com

Abstract. Material characterization techniques are fundamental tools in materials science and engineering, providing essential insights into the structural, chemical, mechanical, and functional properties of materials. These methods enable researchers to establish correlations between microstructure and performance, thereby guiding the design and development of advanced materials for diverse applications. Broadly, characterization techniques can be classified into structural, spectroscopic, thermal, and mechanical methods.
Structural characterization techniques such as X-ray diffraction (XRD), electron microscopy (SEM, TEM), and atomic force microscopy (AFM) reveal crystallography, morphology, and nanoscale features. Spectroscopic methods including Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, and X-ray photoelectron spectroscopy (XPS) provide information about molecular vibrations, chemical bonding, and surface composition. Thermal analysis techniques like thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) assess thermal stability, phase transitions, and degradation behavior. Mechanical testing methods, ranging from nanoindentation to tensile and hardness testing, evaluate strength, elasticity, and durability.
Recent advancements have enabled in-situ and real-time characterization, integrating multiple techniques to study material behavior under operating conditions. The emergence of high-resolution imaging, synchrotron-based methods, and machine learning-assisted data analysis has further expanded the scope and precision of material characterization.
Despite the progress, challenges remain in scaling characterization for complex, multi-component, and nanostructured materials. Future directions emphasize hybrid techniques, sustainable approaches, and automation for accelerating material discovery and optimization.
Keywords: Material Characterization; Microscopy; Spectroscopy; Thermal Analysis; Mechanical Testing.

D-019

Attenuation behavior of Ionizing Radiation for Epoxy-Based Composites Reinforced with Iron and SiC particles

Jeev Raj Bhati[#], Umesh Kumar Dwivedi
Department of Physics, Amity University Rajasthan, Jaipur 303002, INDIA
[#]Corresponding Author's email: umeshkudwivedi@gmail.com, bhatijeevraj@gmail.com

Abstract. This study presents the fabrication and evaluation of radiation shielding properties of epoxy-based polymer composites reinforced with iron and silicon carbide (SiC). Composites of varying composition of Fe/SiC ratios were fabricated and experimentally tested using a clinical linear accelerator. Photon attenuation was studied at 6 MV, while electron attenuation was analyzed in the 6–15 MeV range. Attenuation characteristics e.g. linear attenuation coefficient (μ), mass attenuation coefficient (μ/ρ), mean free path (MFP), half-value layer (HVL), tenth-value layer (TVL), and radiation shielding efficiency (RSE) were evaluated using a Farmer ionization chamber. Results confirm the role of density and high-Z fraction in improving shielding. For electron beams, attenuation coefficients decreased with increasing energy but consistently improved with higher Fe loading. Overall, the study demonstrates that epoxy composites reinforced with iron, SiC, or iron ore powders exhibit promising photon and electron shielding efficiency. Their tunable composition and thickness make them potential lead-free alternatives for radiation protection in medical and industrial applications.

Keywords: Radiation shielding; Epoxy composites; Iron ore; SiC; Attenuation coefficient; Linear accelerator

D-020

Dependencies of Poisson's Ratio in Ce-Based Bulk Metallic Glasses: The Role of thermal expansion (α), thermal conductivity (W), and the covalent radius (R)

Patel Ram Suthar
Department of Physics, Dr. Bhimrao Ambedkar Govt. College, Sriganganagar, Rajasthan, India-335001
Email: prsuthara@gmail.com

Abstract. In materials science and engineering, Poisson's ratio (ν), shear modulus, and ductility are critical parameters for predicting the mechanical response of materials under diverse loading conditions. Whereas Poisson's ratio and shear modulus predominantly describe elastic deformation, ductility represents a material's capacity to accommodate plastic strain before failure. Bulk metallic glasses (BMGs), distinguished by their exceptional physical and chemical attributes, frequently exhibit measurable plastic strain under compressive loading prior to fracture. A well-established correlation links higher Poisson's ratios with improved ductility, with the brittle-to-ductile transition typically occurring within the critical range of ν = 0.32 to 0.33. Beyond this threshold, a progressive increase in ν consistently corresponds to enhanced plasticity.

The Poisson's ratio of BMG alloys exhibits considerable variation, governed by compositional design, processing conditions, cooling rate, alloying additions, and underlying atomic structure. For instance, in cerium-based BMGs (Ce–Al–Cu–X, where X = Ni, Co, Fe, or Ni–Nb), ν has been shown to depend strongly on the coefficient of thermal expansion (α), thermal conductivity (W), and the covalent radius (R) of the constituent elements. The influence of α, W, and R is particularly applicable when compositional variations of constituent elements of BMG arise through partial elemental substitution, provided the underlying crystal structure remains unaltered.
Key Words: BMG, Poisson's ratio, thermal conductivity, ductility.

D-021

Study of structural and optical properties of $Co_{0.6}Mg_{0.4}Fe_{2-x}Zn_xO_4$ Spinel ferrites synthesized via the sol-gel method

V. K. Mukhiya, R. K. Kushwaha, and H. S. Mund
Department of Physics, Jai Prakash University, Chapra, Bihar-841301, India
Corresponding Authors Email: vikashjpu2021@gmail.com

Abstract. Nano-crystalline $Co_{0.6}Mg_{0.4}Fe_{2-x}Zn_xO_4$ Spinel ferrites were synthesized and systematically investigated to evaluate the influence of compositional variation on their structural and optical characteristics. X-ray diffraction (XRD) analysis confirmed the formation of a single-phase cubic spinel structure with space group *Fd-3m*. The lattice parameter exhibited a gradual increase from 8.3939 Å to 8.4188 Å with compositional modifications, suggesting successful ionic incorporation and lattice expansion. Crystallite size, estimated using the Debye–Scherrer equation, increased from 21.89 nm to 25.26 nm, indicating improved crystallinity at higher substitution levels. The calculated dislocation density (2.09 to 1.57 × 10^{15} lines/m^2) and microstrain (1.65 to 1.43 × 10^{-3}) showed a decreasing trend, revealing reduced lattice imperfections and internal strain. Rietveld refinement provided reliable fitting parameters with acceptable values of R_p, R_{wp}, R_{exp}, and χ^2, confirming the structural stability of the synthesized ferrites. The observed results show that controlled doping effectively tailors crystallite growth and defect concentration, which directly influence the functional properties of ferrites. These findings provide valuable insights into optimizing spinel ferrites for applications in magnetic, electronic, and optical devices.
Keywords: Spinel-ferrites, X-ray diffraction, Crystalline size, Microstrain.

D-022

Role of samarium and aluminum co-doping on the structural and magnetic properties of cobalt ferrite nanoparticles

Sudarshan Gawali[1,#], Sagar Bhagde[2], Rahul Pandit[2], Harish Kulkarni[3], K. M. Jadhav[1,4]

[1]*Department of Physics, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar– 431004, Maharashtra INDIA*

[2]*Department of Physics, Deogiri College, Chhatrapati Sambhajinagar-431005, Maharashtra,*

[3]*Department of Physics, SBES College of Science, Chhatrapati Sambhajinagar-431001, Maharashtra, INDIA*

[4]*Physics Department, School of Basic and Applied Sciences, MGM University, Chhatrapati Sambhajinagar-431003, Maharashtra, INDIA*

[#]Corresponding Author's email: ssgawali@gmail.com

Abstract. Cobalt ferrite in pure ($CoFe_2O_4$) and co-doped with samarium and aluminum ($CoFe_{2-2x}Al_xSm_xO_4$, x = 0.00, 0.04, 0.08) were synthesized by sol-gel auto-combustion method and investigated for structural, morphological and magnetic characterizations to understand the role of samarium and aluminum co-doping. The structural characterizations were carried out by X-ray diffraction technique, which suggest the formation of pure phase structure. The X-ray diffraction pattern reveals the Bragg's reflection belonging to cubic spinel structure. The crystallite size obtained from Scherrer's equation fall in the range 18 nm to 24 nm. The lattice constant slightly increases. Surface morphology viewed through scanning electron microscope (SEM) reveals the agglomeration of the particles. The room temperature magnetization measurement suggest decrease in saturation magnetization, contributed to weakening of A-B super-exchange interaction.

Keywords: Cobalt Ferrite; Sm-Al doping; XRD; SEM; VSM.

D-023

Hot-injection synthesis and characterization of two-dimensional Sb_2Te_3 and (Mn,Se) doped Sb_2Te_3 nanostructures

Ganga A R[1], Rakesh Ramachandran[1], K J Thomas[1]
[1]*Department of Physics, Central University of Kerala*
Email: kj_thomas@cukerala.ac.in

Abstract. This work reports the synthesis and basic characterisation of Sb_2Te_3 and Mn/Se-doped Sb_2Te_3 nanostructures. We used a solution based hot-injection approach for the synthesis of the nanostructures, that resulted in a few-layers thick (3 to 20 nm), and comparatively larger (~9 μm) hexagonal nanoflakes. The XRD analysis of the undoped sample reveals the presence of crystalline rhombohedral Sb_2Te_3 coexisting with hexagonal Te, and a near stoichiometric nanoflake composition. The morphology was identified as a perfect hexagonal structure of Sb_2Te_3 by FESEM. Elemental analysis by EDS and XPS revealed the reduced Te in the stoichiometry of doped samples, which was also due to the absence of Te nanorods. We measured direct optical inter-band and sub-band transitions characteristic to Sb_2Te_3 nanoflakes around 0.3 eV and 0.5eV, by UV-Vis absorption spectroscopy. The HRTEM SAED patterns show highly crystalline nanoflakes, which are promising for exploring 2D transport properties. The FTIR highlights the characteristic lattice vibrations and phonon absorption due to defect induced sub-gap transitions, while complementary Raman analysis confirms the structural impact of Mn, Se incorporation in the nanoflakes through a distinct broadening and blue-shifting of phonon modes, attributed to lattice strain and confinement effects. Controlled magnetic doping of the Sb_2Te_3 nanoflakes is promising for the realization and tuning of topological surface states in Sb_2Te_3 2D flakes. Overall these are promising initial results to study defect states induced by magnetic and non-magnetic dopant impurities in a topological insulator, and how synergistically tune the carrier dynamics—paving the way for next-generation topological insulator spintronic and optoelectronic device applications.
Keywords: Topological insulator, spintronics, hot-injection synthesis, 2D nanoflakes

D-024

Study of structural, thermal, and optical properties of Zn-doped $Co_{0.8}Ni_{0.2}Fe_2O_4$ spinel ferrites

Saroj Dhaka[1,*] and H. S. Mund[2]
[1]*Department of Chemistry, Gramin Mahila Mahavidyalaya, Sikar, Rajasthan-332024, India.*
[2]*Department of Physics, Jai Prakash University, Chapra, Bihar-841301, India.*
Corresponding Author Email: lsmsc09151@gmail.com,

Abstract. In this study, $Co_{0.8}Ni_{0.2}Fe_{2-x}Zn_xO_4$ (x = 0.0, 0.05, and 0.10) ferrites were synthesized by sol-gel auto-combustion method and studied for structural, vibrational, elastic, and optical properties. TGA confirmed spinel phase formation below 800 °C with activation energy increasing from 20.77 to 20.90 $J.mol^{-1}K^{-1}$ showing improved thermal stability. XRD and Rietveld refinement showed cubic spinel structure with lattice constant 8.390-8.382 Å and crystallite size 28.51-38.07 nm. Electron density maps showed stronger Zn-O covalency and charge delocalization. FTIR spectra reveled tetrahedral band υ_1 shifting from 560 to 557 cm^{-1} and octahedral band υ_2 shifting from 560 to 557 cm^{-1} with octahedral force constant increasing from $1.65x10^2$ to $1.79x10^2$ $N.m^{-1}$. Elastic constant C_{11} increased to 0.19 GPa with higher Debye temperature indicating lattice stiffening. UV-Vis analysis showed band gap widening from 1.60 to 1.71 eV with Urbach energy 0.11-0.13 eV. This study shows that Zn substitution improves thermal stability lattice rigidity and optical tunability suitable for high frequency and spintronics devices.
Keywords: Spinel ferrites, Sol-gel method, Vibrational properties, Optical band gap.

D-025

Physical and Optical Parameters of Nd^{3+} Doped Tellurium Bismuth Borate Glasses

Pawan Kumar[1*], Samay Singh Meena[2], Menka Meena[3], Nitiksha Sharma[4], Beena Bhatia[5].
[1,2,3,4,5]*Department of Physics, Jai Narain Vyas University, Jodhpur, India.*
*Email: pawankumar26174@gmail.com

Abstract. A series of Nd^{3+}-doped glasses with the composition $20TeO_2$–$(30–x)Bi_2O_3$–$50B_2O_3$–xNd_2O_3 (where x = 0, 0.5, 1.0, 1.5, and 2 mol%) were synthesized using the conventional the melt-quenching technique. The amorphous nature of the prepared glasses was confirmed through X-ray diffraction (XRD) analysis. Various physical and optical parameters—including dielectric constant, refractive index, ionic concentration, oxygen packing density, interionic distance, polaron radius, reflection loss, energy gap, molar refractivity, molar and electronic polarizability, optical basicity, and field strength—were systematically evaluated. Based on the experimentally measured density and refractive index, the concentration of Nd^{3+} ions, oxide ion polarizability, and theoretical optical basicity were determined. The average electronic polarizability and oxide ion polarizability were calculated using the Lorentz–Lorenz relation. Theoretical optical basicity values were estimated using the Duffy–Ingram approach. Furthermore, the metallization criterion was computed from the refractive index and optical band gap data, with higher values indicating the insulating nature of the glass samples.
Keywords: Melt-quenching technique, optical parameters, Duffy–Ingram.

D-026

Influence of Nd^{3+} Incorporation on the Structural Compactness and Optical Features of Phosphate Glasses

Menka Meena[1*], Samay Singh Meena[2], Pawan Kumar[3], Nitiksha Sharma[4], Beena Bhatia[5]
[1,2,3,4,5]*Department of Physics, Jai Narain Vyas University, Jodhpur, India.*
*Email: menkameena1996@gmail.com

Abstract. A series of Nd^{3+} doped phosphate glass with composition (5-x)P_2O_3.40Li_2O.55B_2O_3.xNd_2O_3(x=0, 0.3, 0.5, 0.7) was prepared by the melt quenching technique. X-ray diffraction analysis was carried out to investigate the structure of the prepared samples, and the results confirmed that all the samples are amorphous in nature. The physical and optical parameters like density, interatomic separation, molar volume, molar refraction, and refractive index are also studied. The density of the phosphate glasses increases with the increase of Nd^{3+} concentration. The refractive index and dielectric constant of the prepared glass increase with the increase in the doping concentration of Nd^{3+} rare earth ions in the glass samples.
Keywords: Glass density, Molar volume, Refractive index, XRD analysis

D-027

Hydrothermal Synthesis and Structural Evaluation of Co doped $MoSe_2$ Nanosheet for improving supercapacitor performance

Monika[1#], Mamraj Singh[2]
[1,2]*Department of Physics, University of Rajasthan, Jaipur 302004, INDIA*
[#]Corresponding Author Email: monikayadav13197@gmail.com

Abstract. The advancement of high-performance energy storage systems has intensified the exploration of novel electrode materials, particularly for supercapacitor technologies. Among the various classes of materials, transition metal chalcogenides (TMCs) have attracted considerable attention due to their unique physicochemical properties, including high surface area, structural tunability, and multiple electrochemically active sites. In this study, cobalt-doped molybdenum diselenide ($MoSe_2$) nanostructures were synthesized via a hydrothermal route to investigate their suitability for supercapacitor applications. Cobalt incorporation was varied systematically (1- 4 at. %) to assess its impact on the structural and electrochemical properties of $MoSe_2$. The synthesis employed sodium molybdate dihydrate ($Na_2MoO_4 \cdot 2H_2O$), selenium metal powder, and cobalt chloride hexahydrate ($CoCl_2 \cdot 6H_2O$) as precursors, while hydrazine hydrate served as the reducing agent. The crystalline structure and phase purity of the synthesized materials were characterized using X-ray diffraction (XRD). Preliminary findings suggest that cobalt doping significantly influences the materials crystallinity and could potentially enhance key supercapacitor performance metrics such as power density, specific capacitance, and cyclic stability.
Keywords: Supercapacitors; TMCs; $MoSe_2$; Hydrothermal Synthesis; Energy Storage.

D-028

Synthesis and Characterization of Nanoparticles of Aluminum Doped Cobalt Ferrite

Sarita Kumari[1], Kajal Gupta[2], Subhash Chander[3*], Deeksha singhal[4]
[1]*Department of Physics, University of Rajasthan, Jaipur, Rajasthan 302004, INDIA*
[2]*Department of Physics, University of Rajasthan, Jaipur, Rajasthan 302004, INDIA*
[3]*Department of Physics, S.S. Jain Subodh PG College, Jaipur, Rajasthan 302004, INDIA*
[4]*Department of physics, University of Rajasthan, Jaipur, Rajasthan 302004, INDIA*
* -Corresponding Author Mail id: - subhash_ca@yahoo.com

Abstract. Aluminum-doped cobalt ferrite $CoFe_{2-x}Al_xO_4$ (where X = 0.2, 0.4, 0.6, 0.8) nanoparticles were successfully synthesized using the sol-gel auto-combustion method with nitrate of Co, Al, Fe and citric acid. The structural and optical properties of the samples were investigated using X-ray diffraction (XRD), UV–Visible spectroscopy (UV–Vis), and Fourier-transform infrared spectroscopy (FTIR). XRD analysis confirmed the formation of a single-phase spinel structure, with a slight reduction in lattice parameters upon Al^{3+} substitution, indicating successful incorporation of Al ions into the ferrite lattice. Crystallite sizes were found to decrease with increasing Al content due to lattice distortion and cation redistribution.
Keywords: XRD, UV-Vis, FTIR.

D-029

Advanced Material Synthesis, Characterization Techniques, and Theoretical Insights for N-Heterocyclic Compounds in Nanophotonics and Instrumentation

Abhishek Singh[1,#]
[1]*Department of Physics, Shri Govind Guru Government College, Banswara, 327001, Rajasthan, INDIA*
[#]Corresponding Author's email: abhisheksingh6466@gmail.com

Abstract. The rapid advancement of science and technology relies on the discovery and engineering of materials with precise and tunable properties. Material synthesis and characterization techniques serve as a critical bridge between fundamental research and practical applications, particularly in nanophotonics and advanced instrumentation. Modern synthesis routes not only include traditional methods such as sol–gel, hydrothermal, chemical vapor deposition, and solid-state reactions, but also emphasize sustainable and green approaches to achieve high-quality functional materials. Of special interest are N-heterocyclic compounds, including pyrazole derivatives, which exhibit remarkable electronic, optical, and coordination properties, making them promising candidates for optoelectronic devices, sensors, and photonic systems. To evaluate such systems comprehensively, experimental characterization is coupled with theoretical modeling. Characterization tools such as X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), and UV–Vis spectroscopy provide insights into crystallinity, surface morphology, bonding interactions, and optical responses. Complementarily, Density Functional Theory (DFT) simulations enable prediction of molecular geometries, electronic structures, band gaps, and optical transitions, thereby validating and complementing experimental observations. This synergistic approach of synthesis, characterization, and computational modeling establishes a strong foundation for tailoring advanced materials with superior performance. With the continuous trend toward miniaturization and high-precision instrumentation, the integration of experimental and computational techniques is essential for advancing nanophotonic devices and functional materials. This work highlights the importance of combining synthesis–characterization methodologies with

theoretical frameworks to accelerate innovation in next-generation instrumentation and nanophotonic applications.

Keywords: Material synthesis; Characterization; Nanophotonics; Advanced materials; Instrumentation

D-030

Synthesis, Structural Characterization, and Superconducting Properties of $ErBa_2Cu_3O_{7-\delta}$ High-Temperature Superconductors

Vikram Singh Rawat
Department of Physics, Regional College For Education Research and Technology, Rajasthan
Email: vikram8vn@gmail.com

Abstract. In this work, high-purity Er_2O_3, $BaCO_3$, and CuO precursors were used to create polycrystalline samples of $ErBa_2Cu_3O_{7-\delta}$ (Er123) high-temperature superconductors through the conventional solid-state ceramic method. The stoichiometric mixture was thoroughly ground to ensure homogeneity and then calcined at 900 °C for 24 hours. After intermediate grindings, the resulting powder was pressed into pellets, sintered at 950 °C for 48 hours, and subsequently annealed in flowing oxygen at temperatures between 500–600 °C to stabilize the superconducting orthorhombic phase. Structural characterization was performed using X-ray diffraction (XRD), which confirmed the formation of the Er123 phase with orthorhombic symmetry, along with the presence of minor secondary phases. The obtained lattice parameters indicated oxygen-rich compositions, which are consistent with superconducting behavior. The synthesis conditions and structural features were carefully controlled to ensure that the material exhibited the desired superconducting properties. This study forms the foundation for future investigations into the structural and superconducting properties of Er123 superconductors, with a particular focus on the influence of dopant ions. The research will also correlate these properties with microstructural and resistivity analyses, offering valuable insights into enhancing the superconducting performance of Er123 and similar high-temperature superconducting materials.
Keywords: $ErBa_2Cu_3O_{7-\delta}$, high-temperature superconductors, solid-state reaction, X-ray diffraction,

D-031

Preparation and Characterization of Nanoparticles of Fe^{3+} substituted by chromium Doping in Nickel Ferrite

Kajal Gupta[1], Sarita Kumari[2], Deeksha Singhal[3], ShubhashChander[4*]
[1]*Department of Physics, University of Rajasthan, Jaipur, Rajasthan 302004, INDIA*
[2]*Department of Physics, University of Rajasthan, Jaipur, Rajasthan 302004, INDIA*
[3]*Department of Physics, University of Rajasthan, Jaipur, Rajasthan 302004, INDIA*
[4]*Department ofPhysics, S.S. Jain Subodh PG College, Jaipur, Rajasthan 302004, INDIA*
* Corresponding Author Email: subhash_ca@yahoo.com

Abstract. Ferrites are ceramic like material having magnetic properties which are being utilized for several applications. Nano ferrite s Ni CrxFe2-xO4 (x= 0.2,0.4 ,0.6,0.8) were synthesized by Sol Gel Method with nitrates of Ni, Cr, Fe and citric acid. The structural characterization of these samples was done using the X- ray diffraction method (XRD). XRD patterns confirmed a well-defined single-phase cubic spinel structure.It has been found that as the amount of dopant (Ni) increases , size of the nano particles decreased.
Keywords: XRD

D-032

Eco-Friendly Routes to Plasmonic Nanoparticles: A Sustainable Approach to Synthesis and Functional Characterization

Sushma Dube*, Mausumi Pohit, Manmohan Singh Shishodia and Sudhisht Kumar Srivastava
Department of Applied Physics, School of Vocational Studies & Applied Sciences, Gautam Buddha University, Greater Noida, UP, India
E-mail: sdube08@gmail.com

Abstract. The noble metal nanoparticles in interaction with electromagnetic radiation gives plasmonic response which have noticed by researchers. Plasmonic nanomaterials (P-NMs) are extraordinary for their optical, mechanical, and catalytic properties, which makes them highly valued in various applications such as sensing, disease treatment, and energy transfer and conversion. The research of P-NMs has gained popularity in recent decades, with an emphasis on their synthesis, characteristics, and wide range of uses. There are various methods used for synthesizing of Plasmoninc nanoparticles: physical, chemical, biological or synergistic. Conventional methods of synthesis use expensive and hazardous substances. Due to this the eco-friendly synthesized nanoparticles are believe to be sustainable choice for many application like-medical coating, food packaging. The current study proposed a novel simple and environmentally friendly approach for producing silver nanoparticles (AgNPs) using an extract of Moringa Oleifera Leaves (MOL). Here, we have used harmless substances to obtain silver nanoparticles and common characterization methods. The formation of nanoparticles was confirmed by a color change from yellow to reddish-brown with a surface plasmon resonance at 410-420 nm. The UV-Visible spectroscopy, zeta potential and dynamic light scattering were used to characterize the produced silver nanoparticles.
Keywords: Plasmonic Nanoparticles, silver nanoparticles, Moringa -oleifera,

D-033

Insight into the Dielectric and Magnetic Studies of CFO—BTO ME Composites

S. Abdul Khader*[1], Mohammed Shariff[2], Asiya Parveez[3] and Syeda Seema[4]
[1]*Department of Physics, Maharani's Science College for Women (A), Mysuru-05.*
[2]*Department of Physics (VTU-RRC), Guru Nanak Dev Engineering College, Bidar.*
[3]*Department of Physics, Govt. First Grade College, Ajjampura, Chikmanguluru-577547, Karnataka.*
[4]*Department of Physics, Govt. College, Sedam Road, Kalaburagi-585105, Karnataka.*
**Corresponding author: khadersku@gmail.com*

Abstract. In this paper, the dielectric and magnetic properties of $BaTiO_3$ composites that have been substituted with ferrite ($CoFe_2O_4$—CFO) were investigated. Here, the ferrimagnetic $CoFe_2O_4$ (CFO) was synthesized using the auto-combustion method with nitrate-citric acid as a precursor. The ferroelectric component BTO was bought from Sigma-Aldrich. The combination of these two phases constitutes an advanced composite material, known as magnetoelectric (ME) composite materials. The presence of two phases, such as ferrite and ferroelectric in magneto-electric composites, was investigated using X-ray diffraction (XRD). XRD spectra revealed that the $CoFe_2O_4$ ferrite exhibited a spinel cubic structure, while $BaTiO_3$ exhibited a tetragonal perovskite structure. Synthesized composites exhibited both spinel and perovskite structures. A field emission scanning electron microscope (FESEM) has been used to examine the samples' surface morphology. With the HIOKI LCR HI-TESTER, the frequency-dependent dielectric characteristics of synthetic composites were measured at room temperature (RT) between 100 Hz and 1 MHz. For the synthesized composites, dielectric dispersion is observed at lower frequencies. Vibrating Sample Magnetometer were used to study the magnetic properties of synthesized composites. The narrow loops in the composite magnetic hysteresis are seen to be an indication of their magnetic ordering. All measurements were conducted at room temperature.
Ke**ywords:** **S**pinel; Small polarons; Magnetic; Frequency

D-034

Greenly engineered nanoferrites for technological and biomedical applications

Manisha[1,#], S. Kumar[1]
[1]*Magnetism Laboratory, Department of Physics, Mohanlal Sukhadia University, Udaipur -313002, India*
[#]presenting Author's email: manishachalka4499@gmail.com

Abstract. Biocompatible nanoferrites (NFs) remain in limelight owing to their extraordinary chemical and physical properties. In this study, $ZnFe_2O_4$ (ZFN), $Zn_{0.7}Ca_{0.15}Mg_{0.15}Fe_2O_4$ (ZCMFN), $Zn_{0.35}Co_{0.35}Ca_{0.15}Mg_{0.15}Fe_2O_4$ (ZCCMFN), $Co_{0.7}Ca_{0.15}Mg_{0.15}Fe_2O_4$ (CCMFN) and $CoFe_2O_4$ (CFN) NFs were fabricated using a sugarcane + lemon juice mediated auto-combustion route. PXRD, Raman, FTIR, TGA, and Mössbauer analyses confirmed formation of polydisperse surface functionalized magnetic dots (6–11 nm) of NFs in the phase pure fcc lattice. Good fit to M-H data with modified Langevin function affirmed Superparamagnetic (SPM) nature of ZFN, ZCMFN, ZCCMFN, and CCMFN at 300 K, while in CFN both SPM and Ferrimagnetic (FiM) state co-exist. At 5 K, NFs exhibit soft FiM behavior with decent M_s, except CFN, which displayed hard FiM state with quite high H_c = 1.7 kOe. Notably, ZCMFN showed highest M_s = 51.7 emu/g at 300 K and 92.5 emu/g at 5 K. These NFs shown remarkable induction heating response in water, within ~ 600 sec, a swift rise in temperature upto 38, 57, 42, 65 & 60 ^oC (for ZFN, ZCMFN, ZCCMFN, CCMFN & CFN, respectively) is attained upon subjected to a RF field of 29.17 kA/m. Quiet high SAR = 312, 2312, 1904, 2513 & 2284 W/g are noted for ZFN, ZCMFN, ZCCMFN, CCMFN & CFN, respectively. These SNFs exhibited good biocompatibility against normal HEK-293 cell. Remarkably, these NFs showed exceptional response for killing the breast cancer MCF-7 cells at hyperthermia temperature. These findings are suitable for hyperthermia-based cancer therapy. The details of the findings will be presented in the conference.
Keywords: Spinel nanoferrites; Green synthesis; Superparamagnetism; Hyperthermia

D-035

Structural, Morphological, and Optical Properties of MPA-VS_2 Quantum Dot's

Kajal[1,#] and Hafiz A.K.
Centre for Nanoscience and Nanotechnology, Jamia Millia Islamia, New Delhi, India.
[#] *Corresponding Author Email: kajalthagela95@gmail.com*

Abstract. This study explores MPA-capped VS_2 quantum dots (QDs) as novel candidates for energy storage applications, investigated through ultrafast spectroscopy. The QDs were synthesized using a hydrothermal approach and subsequently characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), and optical analysis. XRD confirmed their crystalline structure with distinct reflections at the (001), (100), and (003) planes, while SEM revealed uniform nanoscale morphology. Optical measurements determined a wide band gap of 4.67 eV, indicating strong quantum confinement and suitability for energy-related processes. These results confirm the successful synthesis of highly luminous MPA-VS_2 QDs with well-defined structural and electronic features.

To unravel their dynamic behaviour, ultrafast spectroscopy is employed to probe charge carrier relaxation, exciton dissociation, and electron–phonon interactions on femtosecond timescales. Understanding these ultrafast processes provides crucial insights into the mechanisms governing energy storage in such nanostructures. Building upon prior expertise in carrier dynamics of semiconductor quantum dots, this work advances the knowledge of how MPA-VS_2 QDs can be optimized for energy conversion and storage. The findings suggest that these QDs hold significant promise as efficient, scalable, and sustainable materials for next-generation energy storage technologies.

Keywords: MPA-VS_2QD, UTFS, energy storage, charge carrier dynamics, hydrothermal synthesis

D-036

Synthesis and characterization of Co doped Ni-substituted spinel ferrites

Deeksha Singhal[1], Kajal Gupta[2], Sarita Kumari[3], Shubhash Chander[4]*
[1]*Department of Physics, University of Rajasthan, Jaipur, Rajasthan 302004, INDIA*
[2]*Department of Physics, University of Rajasthan, Jaipur, Rajasthan 302004, INDIA*
[3]*Department of Physics, University of Rajasthan, Jaipur, Rajasthan 302004, INDIA*
[4]*Department of Physics, S.S. Jain Subodh PG College, Jaipur, Rajasthan 302004, INDIA*
*Corresponding Author Email: subhash_ca@yahoo.com

Abstract
Ferrites are chemical compounds that can be found in ceramic or powdered form. Iron oxide (Fe_2O_3, FeO) is their composition, however other transition metal oxides can change their properties. Nano ferrites $Ni_{(1-x)}Co_xFe_2O_4$,(x= 0.2,0.5,0.7) were synthesized by Sol Gel Method with nitrates of Co, Ni, Fe and citric acid. The X-ray diffraction method (XRD) was used to characterize the structural properties of these materials. These XRD patterns were refined by Rietveld, who revealed a distinct single-phase cubic spinel structure. The morphology of the material was analyzed using FESEM.
Keywords: XRD, Rietveld refinement, FESEM.

D-037

GC-MS Analysis of an Ayurvedic medicinal plant: *Saussurea lappa*

Pratibha Payal
Department of Chemistry, Govt. Dungar College, Bikaner
Email: *pratibha.payal111@gmail.com*

Abstract. *Saussurea lappa Clarke*, popularly known as Kuth root and Costus belongs to family Compositae. In Ayurveda, it is used for improving complexion and curing leucoderma, itching, vomiting, scabies and epilepsy. Different pharmacological experiments in a number of *in-vitro* and *in-vivo* models have demonstrated that it possesses anti-inflammatory, antiulcer, anticonvulsant, anticancer, anti-arthritic, antiviral, antimicrobial, antioxidant and hepatoprotective activities. In view of its medicinal importance we have analyzed this plant using Gas Chromatography–Mass Spectrometry. Number of active phytochemicals detected was 21 in petroleum ether and 29 in ethylacetate extracts. 9,12-Octadecadienoic acid (Z,Z)-, l-(+)-Ascorbic acid 2,6-dihexadecanoate, 9-Octadecenoic acid (Z)-, Pentacosane, Tetracontane, Cholest-5-en-3-ol, 6-nitro-, acetate (ester), (3.beta), 1,3-Dioxonane,5,5,6,6,7,7,8,8-octafluoro, Decanoic acid, silver(1+) salt, 1-Hexyl-2-nitrocyclohexane, 1-Oxa-3-aza-2-silacyclopentan-5-one, 2,2,3,4-tetraphenyl- were identified as major compounds.

D-038

Polarizability and Optical Basicity of Nd^{3+} Ions Doped Borate Glasses

Monika and S. L. Meena
Ceremic Laboratory, Department of Physics, Jai Narain Vyas University, Jodhpur 342001(Raj.) India.
Email: shankardiya7@rediffmail.com.

Abstract. Glass of the system: (25-x) Bi_2O_3:10ZnO:10Li_2O:10As_2O_3:10CaO:10Na_2O:10Y_2O_3:15 B2O3: xNd2O3. (Where x=1, 1.5,2 mol %) have been prepared by melt-quenching method. The amorphous nature of the glasses was confirmed by X-ray diffraction studies. The physical parameters like density, reflection loss, electronic polarizability, optical basicity, oxide ions polarizability have been evaluated. Refractive index, electronic polarizability varies with increasing mole% of Nd2O3 respectively. The theoretical value of average electronic polarizability and oxide ion polarizability were calculated by using lorentz-lorentz formula. Theoretical optical basicity of the glasses is also evaluated based on equation proposed by Duffy and Ingram. The metallization criterion has been calculated on the basis of refractive index and energy gap. The low value of metallization criterion indicates that the glass materials are amorphous natures.
Keywords: Borate glass; Optical basicity; Polarizability; Metallization criterion.

D-039

Micellar Photochemical and Thermal Spectral Studies of Er(III)-BI Doped System

Mukta Ojha, Shubh Laxmi,N. Bhojak S.N Jatolia, Rajendra Singh
GCRC, P.G. Department of Chemistry, Govt. Dungar College (A-Grade), MGS University, Bikaner334001.Raj. INDIA,
Email Id: satyanarayanjatolia@gmail.com

Abstract. A photochemical reaction occurs when a molecule absorbs light, promoting it to a higher energy state. The excitation of inner-transition elements with UV-Visible radiation to promote photochemical reactions has great interest in recent years. This energy can trigger various physical and chemical transformations, which are often, illustrated using a Jablonski diagram. In present work, the investigation of spectral parameters studies of Metal-ligand complexes in thermal and photochemical condition has been done. In this research investigation of micellar-doped Er(III) system in photochemical condition reported first time. Nine bands $^4I_{15/2} \rightarrow {}^2K_{15/2}$, $^4I_{15/2} \rightarrow {}^4G_{11/2}$, $^4I_{15/2} \rightarrow {}^2G_{9/2}$, $^4I_{15/2} \rightarrow {}^4F_{3/2}$, $^4I_{15/2} \rightarrow {}^4F_{5/2}$, $^4I_{15/2} \rightarrow {}^4F_{7/2}$, $^4I_{15/2} \rightarrow {}^2H_{11/2}$, $^4I_{15/2} \rightarrow {}^4S_{3/2}$, $^4I_{15/2} \rightarrow {}^4F_{9/2}$ transitions observed in 350 nm to 900 nm region for doped Er (III) system. Intensity parameter-Judd Ofelt (T_2, T_4, T_6) and oscillator strength (Pobs$\times 10^6$), Bonding ($b^{1/2}$), Symmetry (T_4/T_6) and Cordination (T_4/T_2), RMS deviation (σ) parameters have been computed using partial and multiple regression methods.

KEYWORDS- , Benzimidazole, Spectral Parameter, Micellar system.

E-001

Elastic Constants and Lattice Vibrations of $Pd_{0.95}Rh_{0.05}$ Alloy

Nupur P. Vora[1, #], K. G. Bhatia[2], Priyank Kumar[3], S.M. Vyas[4]
[1]*Department of Information Technology, Aditya Silver Oak Institute of Technology, Silver Oak University, Ahmedabad, Gujarat, India.*
[2] *Department of Physics, L.J.I.E.T., L.J. University, Ahmedabad- 382210, Gujarat, India.*
[3]*Department of Science & Humanities, Government Polytechnic, Dahod - 389151, Gujarat, India.*
[4]*Department of Physics, School of Science, Gujarat University, Ahmedabad-380009, Gujarat, India.*
[#]Corresponding Author's email: nupurvora94@gmail.com

Abstract. Phonon dispersion relations along the [0,0, q], [0, q, 1], [0, q, q], and [q, q, q] directions of face-centered cubic $Pd_{0.95}Rh_{0.05}$ have been studied within the framework of the pseudopotential method. Without phenomenological fitting in real space, a transition-metal pseudopotential that is directly derived from generalized pseudopotential theory (GPT) has been used. This potential has been used to compute bulk modulus (B), elastic constants (C_{11}, C_{12}, and C_{44}), and phonon dispersion curves along symmetry directions. Both solid and liquid metal properties can be effectively described by the selected pseudopotential. The calculated results show excellent agreement with existing experimental data, validating the reliability of the current methodology for Pd–Rh alloys. The study indicates that increasing Pd concentration in Pd–Rh alloys lead to a consistent improvement of elastic constants and bulk modulus, highlighting the stiffening effect of Pd on the alloy system.
Keywords: Pseudopotential methods, lattice dynamics, second order, elastic constants.

E-002

Theoretical Insights into the Optoelectronic Properties of BiSCl/AlTe van der Waals Heterostructure

Riddhi Desai[,1#] Yashasvi Naik,[1]Disha Mehta[1] I.B. Patel[1]
[1]*Department of Physics, Veer Narmad South Gujarat University, surat 395007, Gujarat, INDIA*
[#]Corresponding Author's email: desairiddhii.phy@gmail.com@gmail.com

Abstract. The Forming novel van der Waals (vdW) heterostructures by combining different two-dimensional (2D) materials is significant for achieving desirable properties. In this study, the structural, electronic, and optical properties of the BiSCl/AlTe van der Waals heterostructure are investigated using density functional theory (DFT). The BiSCl/AlTe vdW heterostructure exhibits an indirect bandgap of 0.78 eV, as calculated using the PBE functional. Its dynamic stability is confirmed through phonon spectra analysis. Furthermore, the heterostructure demonstrates enhanced optical absorption compared to the individual monolayers. These findings suggest that the BiSCl/AlTe vdW heterostructure holds potential for applications in nanoelectronic and optoelectronic devices.
Keywords: structural properties, first principal study, electronic properties, optical properties, heterostructure

E-003

Performance Optimization of $CuSbS_2$-Based Heterojunction Solar Cells with Back Surface Field Layers Using SCAPS-1D

Shankar Lal[1,2] and Rajender Parsad Kaswan[3]
[1]*Department of Physics, Vivekananda Global University, Jaipur- 303012, India*
[2]*Department of Physics MJD Govt. College Taranagar-331304, India*
[3]*Department of Chemistry, MJD Govt. College Taranagar-331304, India*
*Corresponding author email: shankarlallucky@gmail.com

Abstract. Copper-based ternary chalcogenides have garnered considerable attention as promising absorber materials for heterojunction thin-film solar cells (HJTFSCs) due to their favorable optoelectronic properties, including optimal band gap, high absorption coefficient, low cost, non-toxicity, sustainability, and environmental compatibility. Recent advancements in both experimental synthesis and numerical modeling have aimed to enhance the performance of these materials in photovoltaic applications. In this study, we investigate the performance of a p-type $CuSbS_2$ (CAS)-based HJTFSC structure incorporating a back surface field (BSF), using the one-dimensional Solar Cell Capacitance Simulator (SCAPS-1D). The proposed device architecture comprises ZnO:Al/i-ZnO/n-CdS/p-CAS/p^+-SnS/Mo layers. SCAPS-1D enables comprehensive analysis of the electronic and optical behavior of each layer, accounting for parameters such as thickness, carrier concentration, band gap, electron affinity, and other relevant material properties. Simulations were conducted under standard test conditions (AM 1.5 solar spectrum, 100 mW/cm² illumination, 300 K), with a front internal transmission coefficient of unity and an applied reverse voltage ranging from 0 to -1 V. The results provide detailed insight into the key performance metrics of the p^+-p-n heterostructure, including short-circuit current density (J_sc), open-circuit voltage (V_oc), fill factor (FF), power conversion efficiency (η), and quantum efficiency (QE). This work contributes to the optimization of copper-based chalcogenide solar cells and underscores the potential of CAS-based architectures for high-efficiency, sustainable photovoltaics.
Keywords: Chalcogenides, CAS, SnS, HJTFSC, SCAPS 1D, AM1.5.

E-004

Exploring the Electronic and Phonon Properties of Quaternary Heusler Alloy TaAlCoCu: A First-Principles Approach

Bhoopendra Kumar Dewangan[1,2,#], Sapan Mohan Saini[1]
[1]*Department of Physics, National Institute of Technology Raipur, Raipur 492010, C.G., INDIA*
[2]*Department of Physics, Govt. MLS PG College Seepat, Bilaspur 495555, C.G., INDIA*
[#]Corresponding Author's Email: dewangan.bk95@gmail.com

Abstract. In this study, we explored the structural, electronic, phono dispersion properties of quaternary Heusler alloy TaAlCoCu through first principles calculations. The electronic properties, including the band structure, and density of states, was analysed using the generalized gradient approximation. Our results indicate that TaAlCoCu behaves as an indirect band gap semiconductor. The alloy's non-magnetic nature was confirmed through the application of Slater-Pauling rule. Additionally, the phonon dispersion curves were computed using density functional theory, showing that the alloy is dynamically stable in its cubic phase, as evidence by the presence of only positive phono frequencies. These findings provide a strong foundation for further experimental studies on this material.
Keywords: Quaternary Heusler alloy; semiconductor; phonon dispersion; Slater-Pauling rule

E-005

Heat and Mass Transfer Characteristics of Stagnation Point Flow of Sisko Nanofluid Over Permeable Stretching Sheet

Praveen Kumar[1,#], R.S. Yadav[2], Pradeep Kaswan[3]
[1]Department of Mathematics, Government College, Antah, 305202, Rajasthan, India
[2]Department Of Mathematics, University of Rajasthan, Jaipur, 302004, Rajsthan, India
[3]Department of Mathematics, Dr B. R. Ambedkar Govt. College, Dabwali, Haryana,India
#Corresponding Author"s e-mail: praveenydvuor79@gmail.com

Abstract. The main objective of this study is to discuss the various impacts of MHD stagnation point flow of Sisko nanofluid past a permeable stretching sheet. Radaition, Joule heating, viscous dissipation and heat source/sink effects are also considered in this investigation. A set of appropriate similarity transformations is employed to convert the fundamental partial differential equations into nonlinear ordinary differential equations. An efficient numerical approach, MATLAB bvp-4c technique is applied to solve these governing equations. A good accord between the numerical results of the current study and earlier published papers are displayed. The impacts of various emerging physical parameters in Sisko nanofluid on velocity, temperature, solutal concentration, nanoparticle volume fraction are discussed through graphs. Furthermore, Numerical calculations of Skin friction coefficient, Nusselt number and Sherwood number are extensively investigated and comprehensively presented using tables.
Keywords: Sisko nanofluid; Stagnation-point flow;Viscous dissipation;Heat source/sink; Thermal radiation; Joule heating.

E-006

Simulation Study and Optimization of Perovskite Solar Cells

Nemeechand Goswami[1,#], M.D. Sharma[2], Bhuvneshwer Suthar[3]
Department of Physics, Government Dungar College, Bikaner 313001, Rajasthan, INDIA
[#]Email: ncgoswamimechanics@gmail.com

Abstract. This study investigates perovskite solar cell behaviour using numerical simulations with SCAPS 1D, focusing on how variations in key device parameters impact performance. By adjusting absorber layer thickness, defect density, and doping levels, the research examines effects on open-circuit voltage, short-circuit current density, fill factor, and overall efficiency. The study uniquely incorporates temperature effects to evaluate stability under real-world conditions. Results show that optimizing layer thickness and reducing defects significantly improve charge transport and reduce recombination losses, enhancing device efficiency. Controlled doping strengthens internal electric fields, facilitating better charge separation and extraction. Interface engineering is highlighted as an important factor in minimizing charge loss and improving device reliability. These findings provide valuable insights for designing and fabricating more efficient and stable perovskite solar cells, offering practical guidance toward advancing photovoltaic technology with a focus on performance and operational durability.
Keywords: Perovskite Solar cell, Solar cell optimization, Power conversion efficiency (PCE), Absorber layer thickness

A Comprehensive Analytical Model for Energy-Environment (E-E) System: Forecasting and Planning Capabilities

Sunil Kumar Pareek[#], Vipin Kumar
Department of Physics, SKD University, Hanumangarh
[#] *Email: sunilpareek912@gmail.com*

Abstract. The energy-environment (E-E) system plays a crucial role in sustainable development. A robust analytical model is needed to evaluate various energy scenarios, forecast future trends, and support strategic planning. This study develops a comprehensive E-E model, integrating thermodynamic, economic, and environmental factors. The model is tested across multiple scenarios to evaluate its forecasting accuracy and planning capabilities. The results demonstrate its effectiveness in optimizing energy consumption and reducing emissions.

Keywords: Energy-environment system, sustainable energy, forecasting model, renewable energy, carbon emissions, optimization algorithms, energy policy.

E-008

Caputo Fractional Derivative Modeling of COVID-19 Dynamics with Wavelet Based Computational Frameworks

Anil Kumar Meena
Department of Mathematics, S.M.P.B.J. Govt. College Sheoganj, Sirohi

Abstract. Researchers from a wide range of fields are attempting to comprehend and manage the virus's spread as a result of the COVID-19 pandemic. A numerical analysis of a nonlinear dynamical system under the Caputo fractional-order derivative framework is presented in this article. The natural death rates of susceptible, infected, and recovered compartments, which are caused by the spread of infectious diseases, are included in the suggested model. To handle the intrinsic complexity of fractional problems, the model is examined utilizing two wavelet-based computational frameworks: the Genocchi Wavelet Collection Method (GWCM) and the Fibonacci Wavelet Collocation Method (FWCM). The FWCM and GWCM were used in numerical experiments. According to the study, fractional calculus is an effective tool for simulating challenging real-world issues, especially those involving physical objects.

E-009

Application of Green Function to Superconductivity

Jai Ram
Department of Physics, Govt. Girls College, Ajmer

Abstract. The application of Green's function techniques has emerged as a powerful and versatile tool in the theoretical study of superconductivity. Green functions provide a systematic framework for describing the behavior of interacting many-particle systems, enabling the calculation of electronic properties, excitation spectra, and response functions in both conventional and unconventional superconductors. Within the Bardeen–Cooper–Schrieffer (BCS) theory, Green functions elegantly capture the formation of Cooper pairs and the resulting energy gap, while their extensions to Gor'kov and Nambu formalisms allow a deeper understanding of anomalous propagators and symmetry-breaking phenomena. These methods further facilitate the study of finite-temperature effects, disorder, and non-equilibrium dynamics in superconducting states. Moreover, Green function approaches underpin advanced computational techniques such as the Eliashberg theory for strong-coupling superconductivity and the analysis of quantum transport in superconducting hetero-structures. This presentation highlights the essential role of Green functions in bridging microscopic theories and observable macroscopic phenomena in superconductivity, emphasizing their relevance in exploring high-temperature superconductors, topological phases, and novel quantum devices.

Keywords: Green functions, superconductivity, BCS theory, Gor'kov formalism, Eliashberg theory, quantum transport.

E-010

Integral Representation of Ramanujan Summation

Mukesh Sharma[1], Vijay Kumar Makar[2]
[1]*Department of Mathematics, M.L.B. Govt. College, Nokha, Bikaner–334 001, Rajasthan, India.*
[2]*Department of Mathematics, Engineering College, Bikaner–334 001, Rajasthan, India.*

Abstract. Still there are many workers give their suggestions for Ramanujan Summation. In sequence of this in1987, Professor Berndt obtained a summation due to Ramanujan by using Dixon's Theorem on the sum of a ${}_3F_2$. The aim of this research paper was to obtain a very interesting integral representation of Ramanujan Summation formula using results of the generalized Dixon Theorem earlier obtained by Rathie et. al.

1,3,5-Triphenylbenzene (TPB): An Emerging Organic Semiconductor for Optoelectronic Applications

Sardul Singh Dhayal[1], Vinita[1], Priyanka[1], Kamal[2], Vinod[1,#]
[1]*Department of EEE, Guru Jambheshwar University of Science & technology, Hisar 125001, INDIA*
[2]*Department of Applied Physics, Guru Jambheshwar University of Science & technology, Hisar 125001, INDIA*
[#]Corresponding Author's email: vinodspec@yahoo.co.in

Abstract. Organic semiconductors based on aromatic hydrocarbons have gained considerable interest due to their tunable photophysical properties, low cost, and solution-processability. Among these, 1,3,5-Triphenylbenzene (TPB) stands out as a wide-bandgap, highly stable organic semiconductor with deep-blue emission, excellent crystallinity, and strong thermal stability. Recent investigations demonstrate its suitability in organic light-emitting diodes (OLEDs), organic solar cells (OSCs), and polymer–organic hybrid thin films. This review provides a comprehensive analysis of the structural, optical, electrical, and electrochemical properties of TPB thin films, with emphasis on their applicability in optoelectronic devices. Special focus is placed on TPB/polymer composites that synergistically combine optical performance with mechanical stability.
Keywords: Organic Semiconductors; 1,3,5-Triphenylbenzene; OLED, OSC

F-002

Performance Evaluation of Nanotransistors with III-V Channel Materials for Space Applications

[1]Pooja Srivastava, [2]Arvind Kumar Singh, [1]Archita Bagchi
[1]Department of Physical Sciences, Banasthali Vidyapith, Banasthali 304022, India
[2]Department of Mathematics, Institute of Science, Banaras Hindu University, Varanasi 221005, India

Abstract: The ongoing miniaturization of transistors has brought about modern electronics, but traditional silicon-based devices are under severe challenges, especially for extreme environments such as in space. The harsh space environment, high radiation, extreme thermal variations, and vacuum, necessitate devices with enhanced performance and greater ruggedness. Performance analysis of nanotransistors, i.e., Junctionless Field-Effect Transistors (JLFETs), Fin Field-Effect Transistors (FinFETs) and Nanosheets with new III-V semiconductor materials have been performed.
Short Channel Effects (SCEs) like drain-induced barrier lowering (DIBL) and subthreshold swing (SS) grow in importance as transistors are scaled down, degrading performance and raising power consumption. Nanotransistors are prospective architectures that provide better gate control over the channel, essentially preventing these SCEs from happening as opposed to conventional planar transistors. Additionally, leveraging the use of III-V materials like Indium Gallium Arsenide (InGaAs) and Gallium Arsenide (GaAs) have been material substitution has the prospect for enhanced operating speeds and power minimization, essential figures for space-based systems.
A critical comparative study have been conducted between the electrical characteristics of JLFETs and FinFETs using III-V materials, including their on-current, off-current, and I_{ON}/I_{OFF} ratio. The work also considers their resistance to individual space environment stresses, such as radiation damage and temperature cycling. This work is aimed at providing a comparative basis for selecting the most preferable nanotransistor structure and material combination for future space applications, with maximum performance and reliability as the highest priorities.
Keywords: Nanotransistors, III-V compound materials, drain-induced barrier lowering, subthreshold slope, temperature effects

G-001

AC conductivity and dielectric relaxation investigations of bismuth doped cobalt nano ferrites

Sandeep K M[1], J S Ashwajeet*[1], Raghavendra M N[1], Sathisha S[2]
[1]*Department of Studies in Physics, Davangere University, Shivagangotri, Davanagere, Karnataka, India*
[2]*Department of Physics, Post Graduate & Research Centre, Bharathi College, Bharathinagara, Mandya, India.*
**Email: ashphysics358@gmail.com*

Abstract. This study examined bismuth-doped (BCFO) and undoped (CFO) cobalt nano ferrites synthesized by the sol-gel auto-combustion process to analyse their structural, optical, and electrical properties. X-ray diffraction analyses were conducted at 2θ values between 10^0 and 80^0, confirming the presence of a single-phase cubic spinel structure with crystallite sizes ranging from 15 to 36 nm. The uniform particle distribution and elemental integration were confirmed using SEM and EDX analyses. The structural analyses were conducted using FTIR within the wavenumber range of 500 to 4000 cm^{-1}. The FTIR spectrum of the undoped CFO sample displays a peak at 467 cm^{-1}, indicative of octahedral metal bending, hence verifying the synthesis of cobalt nano ferrites. UV-Vis. measurements demonstrated a variation of the band gap from 2.46 eV to 3.56 eV with increasing Bi^{+3} content, underscoring the sample's tunability for optoelectronic applications. The ferromagnetic properties of the x = 0.75 BCFO sample were examined, revealing a saturation magnetization of 0.564 emu/g and a remanent magnetization of 0.063 emu/g. The room temperature AC conductivity and dielectric characteristics were examined within the frequency range of 50 Hz to 60 MHz. The conductivity ranged from 4.506 x 10^{-6} $\Omega^{-1}m^{-1}$ to 4.020 x 10^{-4} $\Omega^{-1}m^{-1}$ at 1 kHz frequency, and from 1.124 x 10^{-3} $\Omega^{-1}m^{-1}$ to 9.19 x 10^{-3} $\Omega^{-1}m^{-1}$ at 1 MHz frequency. Respectively, it indicates that conductivity rises with an increase in frequency and diminishes with an increase in Bi^{+3} content. The frequency exponent, denoted as s, is smaller than 1. The dielectric properties, such as dielectric constant (ε′), loss (ε″), impedance (z′ and z″), and modulus (M′ and M″), were thoroughly studied based on how they respond to changes in frequency.
Keywords: Cobalt nanoferrites (CFO), Bismuth doping (BCFO), Sol-gel auto-combustion, ac conductivity, dielectric properties.

G-002

Axion Bose--Einstein Condensates and Astrophysical Implications

Bijan Kumar Gangopadhyay
Independent Researcher, Chowdhuripara, P.O. Makardaha, Howrah
West Bengal 711409, India
Corresponding Author's email: bkgangopadhyay@gmail.com

Abstract. The prospect that dark matter axions may form Bose–Einstein condensates (BECs) establishes a profound connection between particle physics, condensed matter theory, and astrophysics. In this work, we develop the theoretical framework for axion BEC formation within the Gross–Pitaevskii–Poisson formalism, focusing on the mechanisms of axion thermalization and condensation in cosmological environments. We investigate the conditions under which condensates evolve into self-gravitating structures including solitonic halos, axion stars, and miniclusters, and assess their dynamical stability against perturbations. Particular attention is given to interactions with compact objects, such as black holes through superradiant instabilities, which may strongly influence the fate of axion condensates. On the observational side, we discuss potential astrophysical signatures, ranging from pulsar timing anomalies to gravitational wave emission, that could serve as probes of these configurations. By drawing explicit parallels with laboratory BECs, we emphasize how condensed matter analogies provide valuable insight into the nonlinear and collective dynamics of the cosmic axion field. The aim of this study is to consolidate theoretical perspectives on axion condensates and highlight their role as a testable frontier in dark matter astrophysics, paving the way for both observational searches and future numerical simulations. This work develops a theoretical and numerical framework for axion Bose–Einstein condensates, elucidates their stability and interactions with compact objects, and proposes observational signatures that can guide astrophysical searches for axionic dark matter.
Keywords: Axion, Dark Matter, Bose–Einstein Condensates

G-003

Study on Trace Elements Concentration in Medicinal Plant Using ICP-MS Technique

S.N Bajantri [1] B.M Rajeshwari [2] G.K Vinayak[3]
[1]*Department of Physics, Govt First Grade College Afzalpur-585103, Karnataka, India*
[2]*Department of physics, Vijayangar Sir Kirshanadevaraya University, Jnana Sagar Campus, Ballari-583005, Karnataka, India*
[3]*Department of Physics, Govt First Grade College for Women, Jamakhandi, Bagalkot- 587103, Karnataka, India*
*Corresponding Author E-mail: rmorabad@rediffmail.com

Abstract. The main objective of this study is to determine the concentration of trace elements in selected medicinal plant which elements used for the treatment of reduced stress and anxiety levels and reduced serum cortisol levels of Aswagandha (Withania Somnifera) were quantitatively evaluated by the inductively coupled plasma mass spectrometry (ICP-MS) technique. The analytical investigations allow totally 8 elements (Mn. Fe, Cu, K, Zn, Cr, Mg Ca,) from these plant extracts. The ICP-MS techniques are well suited for the analytical control of infusions in order to ascertain the nutritional role of medicinal plant and daily dietary intake. The results of present investigation used to set new standards for prescribing the dosage of the herbal drugs.
Keywords: ICP-MS, trace elements. Medicinal plants. Microwave digestion

G-004

A Study on Super-Zero Quantum State Preservation Techniques

Jagadish Godara* and Vipin Kumar
Department of Physics, SKD University, 335801 Hanumangarh, Rajasthan, India
*Corresponding author: jagadishgodara97@gmail.com

Abstract. Quantum states degrade due to decoherence and environmental interactions. This paper explores *super-zero preservation* as a method to stabilise fragile states. We apply modified dynamical decoupling with error suppression strategies. Results show higher fidelity compared with conventional approaches. Findings align with recent studies in superconducting and Kagome systems.
Keywords: Quantum state preservation; Super-zero method; Decoherence; Fidelity; Quantum computing; Noise suppression.

G-005

Tris[4-(Diethylamino)Phenyl]Amine (TDAPA): A Versatile Organic Semiconductor for Optoelectronics and Energy Applications

Vinod Kumar[1], Sardul Singh Dhayal[1,#]
[1]*Department of EEE, Guru Jambheshwar University of Science & technology, Hisar 125001, INDIA*
[#]Corresponding Author's email: sardulsingh@gmail.com

Abstract. Tris[4-(diethylamino)phenyl]amine (TDAPA), a triphenylamine derivative with electron-rich diethylamino substituents, has emerged as a promising organic semiconductor due to its strong hole-transporting ability, tunable optical bandgap, and stable electrochemical response. This review highlights the structural, optical, and charge transport properties of TDAPA, with particular focus on its potential in organic field-effect transistors (OFETs), organic light-emitting diodes (OLEDs), polymer composites, and metal-free electrocatalysis. Emphasis is placed on the unique molecular design of TDAPA, its solvent-dependent optical properties, and the advantages of TDAPA/polymer hybrid thin films for multifunctional applications.
Keywords: Organic Semiconductors; Tris[4-(diethylamino)phenyl]amine; Versatile OSC

G-006

Quantum Confinement–Induced Thermoelectric Enhancement Theory for Nanoscale Heusler Alloys

Rakesh kumar Ahirwar[1], Sadhna Singh[2]
[1,2]*Department of Physics, Barkatullah University, Bhopal 462001, Madhyapradesh, INDIA*
[#]Corresponding Author's email: narsinhchandla96@gmail.com

Abstract. In this paper, we propose a novel model that combines Mott's theory of thermoelectric transport with the effects of quantum confinement in nanoscale Heusler alloys. Quantum confinement significantly alters the electronic structure of nanomaterials, leading to changes in the band structure, density of states (DOS), and, consequently, the thermoelectric properties. By integrating Mott's theory with quantum confinement, we aim to explain the enhanced Seebeck coefficient and figure of merit (ZT) observed in Heusler alloys at the nanoscale.
Keywords: Quantum Confinement,Thermoelectric Properties, Heusler Alloys, Seebeck Coefficient,Figure of Merit (ZT)

G-007

Study on Renewable Energy Resources and Energy Storage Devices

Bhuvneshwari[1], Avinash vyas[1#], Sunil kumar meena[2#]
[1] *Department of Physics, Shri Baldev Ram Mirdha Govt. College Nagaur (Raj).*
[2] *Department of Physics, Govt. College Jayal, Nagaur (Raj).*
[#]Email : vyasavinash2050@gmail.com, nimeshsamay6sec@gmail.com

Abstract. The present work focuses on renewable energy resources and the importance of energy storage devices. Nowadays, humans live in the chain of supply and demand; every product's manufacturing and production depend on the supply of energy. To fulfill energy demand, fossil fuels are burned for transportation, industry, heat, electricity, and other uses. Poisonous gases released into the environment and climate is affected. To clean Earth's environment, green energy resources should be appreciated. After producing energy from renewable sources, storage is required. Recently, using electrochemical materials, many storage devices have been developed. Electrochemical materials are the backbone of energy storage devices such as rechargeable batteries, fuel cells, and supercapacitors, which are crucial for storing and converting energy efficiently. The project highlights how these materials contribute to integrated renewable energy, reduce dependence on fossil fuels, and support applications such as electric vehicles, portable electronics, and large-scale energy storage systems. These devices fulfill the requirements of energy and resolve environmental challenges. We are discussing these roles in minimizing greenhouse gas emissions by promoting clean and sustainable energy solutions. Through this study, the project emphasizes not only the scientific principles of electrochemical materials but also their real-world applications. It is one step towards the potential for shaping a greener and more sustainable future.

Keywords: Renewable energy resource, electrochemical materials, Storing devices, Li-Ion and Na-Ion battery.

G-008

Structural and Dielectric Properties of Lithium Nitrate based Polymer Blend Composite

G K Sahana[1,2]*, Shreedatta Hegde[1], V Ramaraja Varma[1], Mohan Kumar[1], Sushma[1], Ganesh Sanjeev[1*]

[1]*Microtron Centre, Department of Studies in Physics, Mangalore University, Mangalagangothri-574199, India*

[2]*Department of Physics, Srinivas Institute of Technology, Mangaluru-574143, India*

*E-mail: sahana.shiva86@gmail.com, ganeshsanjeev@rediffmail.com

Abstract. In this work, flexible and free-standing films of lithium nitrate ($LiNO_3$) based polyvinyl alcohol (PVA) and polyvinyl pyrrolidone (PVP) blend composites (50:50) were prepared by solution casting method. The prepared films were subjected to various characterization techniques such as X-ray diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), Dielectric studies in order to investigate their structural, chemical, and dielectric properties. XRD analysis revealed that the pure PVA/PVP blend exhibited a semicrystalline nature, while the degree of crystallinity decreased progressively with increasing $LiNO_3$ concentration, confirming the influence of dopant incorporation on the microstructure. FTIR spectra confirmed that interactions between functional groups of the host polymers and $LiNO_3$ results into complexation. Furthermore, dielectric studies showed that dielectric constant and dielectric loss attained higher values at low frequency and saturated at higher frequencies. Nyquist curves indicated the non-Debye behaviour of polymer composites. DC conductivity is calculated and is found to be increased from 1.173×10^{-9} S/cm (pure PVA/PVP) S/cm to 1.70×10^{-5} S/cm for 6wt% based polymer blend sample. Based on the outcome of investigations carried out, the present polymer blend system can play a role in the energy storage applications.

Keywords: Polymer composite, Solution casting method, X-ray diffraction, Fourier Transform Infrared Spectroscopy.

G-009

Utilisation of Solar Radiation in Future Possibilities of Photogalvanic Cell

Sushil Kumar Yadav
Solar Photochemistry Research Lab, P.G. Department of Chemistry, Govt. Dungar College (A Grade), Bikaner 334001, India
E-mail-suashil@gmail.com

Abstract. The utilisation of solar radiation through photogalvanic cells offers promising future possibilities in the field of renewable energy. Photogalvanic cells convert sunlight into electrical energy by employing photo-induced redox reactions in suitable dye–electrolyte systems. Unlike conventional photovoltaic cells, they combine the dual functions of energy conversion and storage, making them attractive for sustainable power generation. Ongoing research is focused on enhancing their efficiency, durability, and scalability by incorporating advanced dyes, redox mediators, and nanostructured materials. With improvements in design and material optimization, photogalvanic cells may provide low-cost, eco-friendly, and decentralized energy solutions, especially in regions were conventional solar technologies face limitations. In the future, the integration of photogalvanic systems with smart grids, portable devices, and rural electrification projects could significantly broaden their application. Thus, the effective utilisation of solar radiation through photogalvanic cells holds immense potential for shaping a cleaner and more sustainable global energy landscape.

G-010

The Role of Solar Cell Materials in Achieving Carbon Neutrality

Hemant Kumar Damor
Department of Physics, S.B.P. Govt. College, Dungarpur -314001, India

Abstract. The transition toward carbon neutrality requires scalable, affordable, and sustainable energy technologies, with solar photovoltaics (PV) playing a central role. The efficiency, durability, and environmental impact of solar cells are fundamentally determined by the materials used in their design. Crystalline silicon, the most established material, has enabled large-scale deployment due to its stability and proven reliability. However, emerging alternatives such as perovskites, organic semiconductors, thin films, and nanostructured materials offer opportunities for enhanced light absorption, flexibility, and reduced production costs. These innovations promise not only higher efficiency but also lower carbon footprints through reduced material use and energy-intensive manufacturing processes. Moreover, the integration of advanced solar cell materials into applications such as building-integrated photovoltaics (BIPV), transportation, and portable devices enhances the versatility of renewable energy systems. Challenges such as material toxicity, recycling, and long-term stability remain, yet continuous progress in material science and engineering is bridging these gaps. By enabling clean and abundant electricity generation, solar cell materials are indispensable in global strategies to achieve carbon neutrality and combat climate change.

G-011

Enhancement of the hydrogen storage properties and sorption kinetics of Mg – $La_{28.9}Ni_{67.5}Si_{3.6}$ nanocomposites

Kanhaiya Chawla[1,2,*]
[1]*Department of Physics, University of Rajasthan Jaipur, JLN Marg, Jaipur, 302004, Rajasthan, India*
[2]*Department of Physics, Government College Pratapgarh, 312605, Rajasthan, India*
*Corresponding author: E-mail: kanhaiyachawla27@gmail.com

Abstract. The challenges of elevated ab/desorption temperatures and sluggish sorption kinetics continue to pose obstacles for the potential use of Mg/MgH_2-based hydrides as hydrogen storage materials in automobile applications. LaNiSi alloy is a superior catalyst for molecular hydrogen dissociation. So, to improve the hydrogen sorption kinetics as well ab/desorption capacity of magnesium, here in this report we added $La_{28.9}Ni_{67.5}Si_{3.6}$ alloy as a catalyst. The alloy of $La_{28.9}Ni_{67.5}Si_{3.6}$ was synthesized by an Arc melting furnace into an inert environment. Study of surface morphology and crystal structure of synthesized nanocomposites has been done by a HRTEM and XRD analysis. XRD confirm the presence of various phases in the composites, which is possibly during ball milling and de/rehydrogenation reaction. The PCT analysis demonstrates that the introduction of $La_{28.9}Ni_{67.5}Si_{3.6}$ nano composites leads to enhancements in both the hydrogen storage capacity and sorption kinetics of Mg/MgH2. Specifically, Mg with a 5 wt% addition of $La_{28.9}Ni_{67.5}Si_{3.6}$ nanocomposites exhibits the highest hydrogen storage capacity, measuring approximately 6.44 wt%, nearly twice that of pure Mg subjected to 50 h of milling. DSC analysis provides corroborating evidence, revealing that as the concentration of $La_{28.9}Ni_{67.5}Si_{3.6}$ increases, the dehydrogenation temperature of Mg/MgH2 decreases. Furthermore, the addition of $La_{28.9}Ni_{67.5}Si_{3.6}$ 6 composites leads to a reduction in the activation energy of the dehydrogenation reaction of MgH2, decreasing it from 191.27 to 77.89 -kJ/mol.
Keywords: Hydrogen storage, Magnesium hydride, PCT, DSC, Cycle life.

G-012

Role of Dye, Reductant and Surfactant in Solar Energy Conversion: A Review

Abhilasha Sonel, Madhu Sudan Sharma*
Department of Chemistry, Govt. Dungar College, Bikaner
*Corresponding Author: mssharma2186@gmail.com

Abstract. India's energy needs are expected to grow 2 to 2.5 times by 2047 to meet a growing economy's developmental priorities and aspirations. For sustainable development India requires an orderly transition to a diversified mix of energy sources with a significant share of renewable energy resources.
Solar energy has a significant contribution in renewable energy resources, sharing 1.2% of installed power capacity in 2024.There are many approaches of solar energy harnessing among which only photogalvanics has ability to convert and store solar energy into electrical energy. Photogalvanic cells are based on the photogalvanic effect called the Becquerel effect.
Science Direct was selected as the database for this review. Only Dye-Reductant-Surfactant type systems are included in the search. Primitive research is excluded. Only English language research and review, research, reports and patents were included in search. We reviewed around 180 articles of which 30 were eliminated based on the article's main title, 25 by evaluation of the abstract and 30 by reading the entire paper. 95 results were chosen and thoroughly inspected twice.
The results of electrical parameters (open circuit potential, short circuit current,current at power point,fill factor, conversion efficiency, storage capacity) were also reviewed. Although significant growth is witnessed in this area, there are still many challenges and limitations in this area that must be overcome to use PG cells at commercial scale.
Keywords: Renewable energy, Solar energy, Photogalvanics, Fill factor, storage capacity.

G-013

New Frontiers in Thermal Conductivity of Crystalline Solids

Anita Kumari Maliyan[1,#], Sanjeev K Verma[2]
[1]*Department of Physics, S.G.R.R. (P.G.) College, Dehradun, Uttarakhand, INDIA*
[2]*Department of Physics, IILM University, Greater Noida, INDIA*
[#]Corresponding Author's email: anitasgrrpg.ddun@gmail.com

Abstract. The *ab initio* investigation of thermal conductivity which has greatly attracted the attention of physicists these days, is carried out on the basis of thermal transport in crystalline solids. The problem is initiated with the help of Boltzmann transport equation including the effects of fields, diffusion and collisions. In this formulation, the rate of change of distribution function of heat carriers plays the pivotal role as a result of which the single or multi-mode relaxation time (life times) is invoked in the heart of the problem, which readily addresses the phenomenon of heat transport to obtain the modified expression of thermal conductivity. The phonons (lattice vibrations) are found to be majority heat carriers in non-metallic solids while in metallic systems the electrons impart this role and accordingly the heat transport is heavily influenced by respective modified distribution functions of phonons and electrons. The heat carriers do limit the thermal transport by a large number of scattering processes, namely; scattering of phonons from crystal boundaries, impurities (isotopic, dislocations, stacking faults, etc.), electrons, anharmonic phonon fields and interfering fields which prevalently appear in the expression of relaxation time. The status of these scattering mechanism has been reported via many body quantum dynamical derivations which manifests the phenomenon totally in a new framework different from earlier thermal conductivity models. This formulation explores the possibilities to evaluate the thermal conductivity of high temperature superconductors in a more accurate manner.

Keywords: Thermal conductivity; Boltzmann transport equation; Relaxation time; Many body quantum dynamics; Phonon scattering

G-014

Solar cell Material & Application

Neeraj Meena
Department of Physics, Govt. Girls PG College, Dausa
Email: nmphysicsdu@gmail.com

Abstract. Solar cells, also known as photovoltaic (PV) cells, are pivotal in the transition toward sustainable energy systems. The efficiency and scalability of solar energy largely depend on the materials used in solar cell fabrication. Traditional silicon-based solar cells dominate the market due to their proven performance, stability, and mature manufacturing processes. However, emerging materials such as perovskites, organic polymers, quantum dots, and tandem structures offer promising alternatives with advantages like low-cost production, flexibility, and lightweight characteristics. Each material system presents unique challenges and opportunities related to efficiency, stability, and environmental impact.

Applications of solar cells extend beyond conventional electricity generation. They are integrated into building materials (BIPV), portable electronics, vehicles, satellites, and remote power systems. Innovations in solar cell technology continue to drive down costs while improving efficiency, making solar power more accessible and practical across diverse sectors. The ongoing development of next-generation materials and advanced fabrication techniques is expected to significantly enhance the role of solar energy in global energy systems.

Keywords: Solar cell, pv, sustainable, fabrication, electricity generation, global

G-015

Stream Condition of Relative Velocity for Classical and Einstein Physics

Tulasi Ram Kumawat, Ajay Kumar Nagar
Department of Physics, Government Dungar college, Bikaner 334001, Rajasthan, INDIA
[#]Corresponding Author's email: jaishreenathjitulasi@gmail.com

Abstract. In general absolute velocity are not possible. Classical Physics (3 - dimensional/ Galilean transformation) Relative Velocity & Einstein Physics (4 - dimensional/ Lorentz transformation) Relative Velocity are useful for physical body or partical & Mass less partical. Above topic shows that the elastic collision in both are Massless Particles at stream & special case/condition in vacuum. If particle Massless comes to opposite side and after elastic collision if Massless / Photon particles velocity are same (with direction) or passing to each other's. Above Situation in general we find a Relative Velocity form to each other particles or third reference of frame 2C or -2C or other. But we find out the relative velocity maximum range [close interval] [-C C] at different - different conditions of velocity of particles (or Photons / light particles).

Keywords: Absolute velocity; Relative Velocity; Classical Physics; Einstein Physics; Elastic collision; Photon particles / Massless ; Stream condition.

G-016

Quantum Well Solar Cells for Space Photovoltaic Applications

A.K. Agarwal
Department of Physics. S.G. S. G. Government College, Nasirabad 305601, Rajasthan, INDIA
Email: agarwalatul75@gmail.com

Abstract. Quantum Well Solar Cells (QWSCs) represent a promising advancement in photovoltaic technology, offering enhanced performance and radiation tolerance crucial for space applications. By integrating low-dimensional semiconductor structures—quantum wells—into the intrinsic region of a p-i-n solar cell, QWSCs exploit quantum confinement effects to extend the absorption spectrum and increase photocurrent without significantly compromising open-circuit voltage. This paper reviews the theoretical principles, material systems (notably III-V compounds like GaAs/InGaAs), and fabrication techniques employed in QWSCs, with an emphasis on their suitability for extraterrestrial environments. We evaluate the performance of QWSCs under AM0 conditions, highlight their superior resilience to high-energy particle irradiation compared to conventional solar cells, and discuss their integration into multi-junction architectures for next-generation space power systems. Our findings suggest that QWSCs offer a pathway to higher efficiency, longer mission lifetimes, and improved power-to-weight ratios, making them strong candidates for future space photovoltaic technologies.
Key Words: Quantum Well Solar Cells; p-i-n Solar Cell ; Space Photovoltaic Technologies

G-017

Effects of Rotation and Compressibility on the Stability of a Partially Ionized Plasma Saturated in a Porous Medium

Ravi Prakash Mathur
Department of Mathematics S. G. S. G. Government College Nasirabad 305601, Rajasthan, INDIA
Email: rpm298@gmail.com

Abstract. This study investigates the combined effects of rotation and compressibility on the stability of a partially ionized plasma saturating a porous medium. Such systems are relevant to a wide range of fields, including astrophysics (e.g., stellar atmospheres, accretion disks) and geophysics. By employing linear stability theory and normal mode analysis, we derive the governing equations and obtain a dispersion relation that accounts for the influence of these parameters. Our analysis reveals that both rotation and compressibility have a stabilizing effect on the system, delaying the onset of convection. Specifically, we find that the rotation introduces oscillatory modes, while compressibility helps to dampen the instability. The interplay between these two factors, along with the porous medium, is found to significantly modify the critical Rayleigh number, which determines the threshold for convection. The results of this research provide new insights into the fundamental physical processes that govern the stability of partially ionized plasmas in complex, structured environments.
Keywords: Stability; Rotation; Partially Ionized Plasma

G-018

Essence of Erbium doping in glasses as a laser material

Vandana Ranga[#]
Department of Physics, Samrat Prithviraj Chauhan Government College, Ajmer, 305001, Rajasthan, INDIA
[#] Email: a.vandana20@gmail.com

Abstract. Erbium-doped glasses have emerged as highly promising materials for solid-state lasers and optical amplifiers owing to the unique optical transitions of Er^{3+} ions, emission around 1.54 μm. This wavelength coincides with the low-loss transmission window of silica optical fibers and lies in the eye-safe region of the near-infrared spectrum, making erbium a central dopant for applications in optical communications, biomedical devices, remote sensing, and defense. Among various host matrices, sol–gel derived glasses have attracted significant attention because they provide a versatile, low-temperature route to synthesize bulk glasses, thin films, and waveguides with high compositional flexibility and chemical purity. The sol–gel process enables homogeneous dispersion of rare-earth ions and compatibility with integrated photonic device fabrication, features that are difficult to achieve using conventional high-temperature melting methods. Despite these advantages, erbium doping in sol–gel glasses faces several inherent challenges. A primary limitation is concentration quenching, which arises from clustering of Er^{3+} ions at doping levels beyond ~0.5–1 mol%. Such clustering promotes non-radiative energy transfer and reduces emission efficiency. Another major concern is the presence of hydroxyl (OH^-) groups, which are typically retained during the hydrolysis and condensation stages of the sol–gel process. OH^- groups exhibit strong absorption near 1.5 μm, leading to pronounced quenching of erbium luminescence. Additionally, thermal treatment is required to densify the sol–gel network and eliminate OH^-, yet excessive heating can also drive dopant segregation or crystallization, undermining optical performance. Therefore, optimization of both dopant chemistry and processing conditions is essential for achieving efficient laser action.
Keywords: erbium, laser, optical

G-019

Micellar Effect on Mixed Dyes Photosensitiser in Conversion and Storage of Solar Energy

H. S. Bhandari[1]*, Hemant Panwar[1], N. K. Gahlot[1], Ravi Parihar[2]
GCRC, P. G. Department of Chemistry, Govt. Dungar College, Bikaner
Department of Botany, Govt. Dungar College, Bikaner
*E- Mail: hsbhandari78@gmail.com

Abstract. Micelles create a unique microenvironment that alters the photophysical and photochemical properties of dyes. Micelles function as nanoreactors, increasing dye solubility, stability, and electron transfer efficiency. This micellar effect enhances the performance of dyes used in solar energy conversion and storage systems, making it a promising approach for green and sustainable energy technologies. Solar cells, devices that convert sunlight into electrical energy, its fabrication aims to improve solar energy conversion efficiency while remaining affordable. For this purpose, micellar system has been used in photoelectrochemical cells based on the photogalvanic effect.

The fabricated cell included Sodium Lauryl Sulphate as a surfactant, mixed dyes toluidine blue and malachite green as a photosensitizer, and D-Arabinose as reductant. Long-term open circuit voltage measurements were performed to ensure the cells' consistency. Investigations into light on-off reproducibility were also carried out throughout the cell's operation. The effect of various parameters, such as reductant concentration, dye concentration, pH, and so on, on the cell's electrical output has been studied. The cell's performance was tested in the dark at its power point.

G-020

Advanced Materials for Nano-Chemistry

Raja Ram
GCRC, Department of Chemistry Govt Dungar College, Bikaner 334001, Rajasthan, India

Abstract. Nano-chemistry, an interdisciplinary frontier of science, relies heavily on advanced materials with tailored properties at the nanoscale. The development of nanostructured materials such as carbon-based nanomaterials, metal and metal oxide nanoparticles, quantum dots, and advanced polymeric frameworks has revolutionized applications in catalysis, energy storage, drug delivery, and environmental remediation. These materials exhibit unique surface-to-volume ratios, quantum confinement effects, and tunable physicochemical properties that are unattainable in their bulk counterparts. Recent advances in synthesis techniques, including green and sustainable approaches, have further enhanced their precision, scalability, and functionality. This paper highlights the design principles, synthetic strategies, and emerging applications of advanced nanomaterials, emphasizing their role in addressing global challenges in energy, environment, and health. The future of nano-chemistry depends on integrating advanced materials with artificial intelligence, nanofabrication, and sustainable chemistry to unlock next-generation technologies

G-021

Quantum Chromodynamics: A Fundamental Theory of Strong Interactions

Pradeep Kumar
Department Of Physics, Government College Sirohi
Email: pradeepkumar271997@gmail.com

Abstract. Quantum Chromodynamics (QCD) is the fundamental theory describing the strong interaction, one of the four fundamental forces in nature. It explains the behavior of quarks and gluons, the elementary particles that compose hadrons such as protons and neutrons. QCD is a non-Abelian gauge theory based on the SU(3) color symmetry, where quarks carry color charge and interact by exchanging gluons. Unlike the electromagnetic force, the strong force exhibits unique properties such as asymptotic freedom and color confinement. Asymptotic freedom implies that quarks behave as free particles at extremely high energies, while color confinement ensures that quarks cannot be isolated, remaining bound within hadrons under normal conditions. The theory is highly nonlinear due to gluon self-interactions, which contribute to the complexity of hadronic matter. Perturbative techniques allow accurate predictions in high-energy processes, while lattice QCD provides a numerical framework to study non-perturbative phenomena such as hadron masses and phase transitions. QCD plays a critical role in understanding the early universe, neutron stars, and particle collisions in accelerators. Despite its success, challenges remain in fully solving QCD analytically, especially in the low-energy regime. Continued theoretical and experimental research advances our comprehension of the strong interaction, enhancing the broader framework of the Standard Model of particle physics.

G-022

Entropy Generation Analysis in Viscoelastic Fluid Flow through Partially Porous Channels: Effects of Variable Fluid Properties

Kuldeep Singh[1]
[1]*Department of Mathematics, Shri Govind Guru Govt College, Banswara, Rajasthan, 327001, India*
E-mail: kmaderna@gmail.com

Abstract. This paper presents a detailed investigation into entropy generation in viscoelastic fluid flow through channels partially filled with porous media, while accounting for variable fluid properties. Such systems are widely used in engineering and industrial processes, yet studies that simultaneously consider viscoelastic behavior and temperature-dependent fluid properties remain limited. To address this gap, we develop a mathematical model that combines non-Newtonian rheology, porous media effects, and temperature-dependent viscosity and thermal conductivity. The governing equations, derived from conservation principles and viscoelastic constitutive relations, are solved using a hybrid approach of perturbation techniques and numerical simulations. Our analysis highlights the influence of key dimensionless parameters, including the Deborah number, Darcy number, and Brinkman number, on flow behavior and entropy generation. The findings show that viscoelastic effects significantly modify velocity distributions and irreversibilities, while the properties of the porous medium strongly affect flow resistance and entropy production. Temperature-dependent fluid properties further intensify their impact on heat transfer and entropy generation, particularly under high-temperature gradients. Moreover, the interplay between viscous dissipation and heat transfer, represented by the Brinkman number, emerges as a critical determinant of temperature profiles and overall system irreversibilities. These results offer valuable guidance for designing and optimizing thermal-fluid systems involving viscoelastic fluids in porous media, with potential applications in heat exchangers, polymer processing, and enhanced oil recovery operations.

Keywords: Viscoelastic fluid flow, Entropy generation, Porous media, Variable fluid properties

G-023

Study on Stability and Photovoltaic Performance of Mixed Dye System and Electrolyte for Dye Sensitized Solar Cells

S K Verma[#]
[1]*GCRC, P.G. Department of Chemistry, Govt. Dungar College, Bikaner, Rajasthan-334001*
[#]Email: vermask008@gmail.com

Abstract. The efficiency and long-term stability of dye-sensitized solar cells (DSSCs) largely depend on the choice of sensitizing dyes and electrolytes. In this study, we investigate the stability and photovoltaic performance of a mixed dye system in combination with optimized electrolyte compositions. The rationale for employing mixed dyes lies in their complementary absorption spectra, which enhance light-harvesting across a broader wavelength range. A systematic analysis was conducted by varying the dye ratios and electrolyte formulations to evaluate their influence on photo-conversion efficiency, open-circuit voltage, short-circuit current, and fill factor. Stability assessments were carried out under continuous illumination and thermal stress conditions to simulate real operating environments. The results demonstrate that certain mixed dye combinations not only improve overall efficiency compared to single-dye systems but also exhibit superior photostability due to reduced aggregation and enhanced dye regeneration kinetics. The choice of redox mediator and ionic additives in the electrolyte was found to further modulate charge transport and suppress recombination losses. This synergistic interaction between mixed dyes and electrolyte composition highlights a promising strategy to overcome the traditional trade-off between efficiency and stability in DSSCs. The findings contribute to the development of more durable and efficient next-generation photovoltaic devices.
Keywords: Dye-sensitized solar cells (DSSCs), mixed dye system, electrolyte composition, photovoltaic performance.

G-024

Solutions of Fractional Bagley-Torvik Equations with Certain External Forces

Vikram Kumar[1#]
[1]*Department of Mathematics, Government College, Jayal, Nagaur, 341023, Rajasthan, INDIA*
[#]Email: vikramgodara500@gmail.com

Abstract. The Bagley-Torvik equation is a quintessential fractional differential equation that captures the essence of viscoelastic damping in materials and structures, bridging the gap between classical and fractional calculus theories. In this study, we have considered the fractional Bagley-Torvik equation with three special forms of the external forces: constant force, linearly increasing force, and piecewise-defined external force. We employ an innovative approach for solving the fractional Bagley-Torvik equation, the Laplace Adomian Decomposition Method (LADM), taking the Caputo-type fractional order derivative. To confirm the validity of the results, we compare them with the other results available in the literature.

Keywords: Caputo Fractional Derivative, Bagley-Torvik Equation, Fractional Calculus, Fractional Differential Equation, Laplace Adomian Decomposition Method.

G-025

Impact of Heavy Metals on Environmental Depletion and Pathways for Sustainable Management

Sant Kumar Meena
S.B.D. Government College, Sardarshahar 331403, India
Email: skmeena100@gmail.com

Abstract. Heavy metals, particularly lead (Pb) and zinc (Zn), are integral to numerous industrial activities, but their persistence in the environment generates serious risks for ecosystems and human health. These metals enter the environment from multiple sources, including natural, agricultural, industrial, atmospheric, and domestic effluents. However, the major contributors remain untreated domestic and industrial wastes, which are often discharged directly into agricultural fields and water bodies. This practice contaminates drinking water, degrades soil quality, reduces fertility, hampers microbial functions, and negatively influences seed germination, plant nutrition, and water status. In aquatic ecosystems, heavy metal accumulation disturbs ecological balance, harming fish, invertebrates, and overall biodiversity. This study highlights the complex linkages between heavy metal exposure and ecological degradation while underscoring the urgency for comprehensive mitigation measures. Advanced approaches such as phytoremediation, microbial techniques, nanotechnology, sensor-based monitoring, and green chemistry provide significant potential for remediation. Moreover, global cooperation is essential to establish sustainable policies that restrict heavy metal release, promote recycling, and encourage responsible resource utilization to reduce reliance on freshly mined lead and zinc. Ultimately, acknowledging both the industrial importance and ecological consequences of these metals can guide the development of integrated strategies that harmonize societal progress with environmental resilience, paving the way for a sustainable future.
Keywords: Heavy metals, biodiversity, remediation strategies, sustainable policies, ecological resilience

G-026

Implications of prolonged exposure of highly intense Background radioactive radiation

Karan Singh Vinayak
Department of Physics, D.A.V. Postgraduate College, Sector 10, 160011, Chandigarh, INDIA
Email: drksvinayak@gmail.com

Abstract. The aim of this paper is to exclusively showcase the impact of the highly intense background radioactive radiation. The term "Background radiation" here means the sum of all the radiation to which we are exposed to in our background. The background radiation constitutes all the types of radiation, which could be harmful (ionizing), or non harmful (non-ionizing). This implies that if the radiation surrounding us is of high intensity, it can most likely produce ionization and have every possibility to damage the environment and human cells. Meager or low intensity cannot produce ionization and cannot damage the humans and environment. The background radiation includes generally includes radiation from natural or man-made sources. It could be from air, soil, water, sun (ultraviolet) or external cosmos (cosmic radiation) etc. which are natural sources. It can also be from devices or medical facilities like, X-rays, I.R., Microwave, radio waves, etc., which are man-made or artificial sources of background radiation. Background radiation can have serious and damaging effects on humans in case the exposure to highly intense radiation is prolonged and the dosage is above the permissible limits (which is approximately Average 20 milli Sievert/year or 2 r.e.m./year). The highly and prolonged exposure can even prove fatal and cause serious damages to the population living in that zone as the radiation cannot be experienced without any devices. It is only when the serious consequences like cancer, skin diseases etc. appear on the surface one comes to know about such extreme and high exposure. To say the least, the radiation cannot be seen or observed directly. Thus any preventive or curable action is only executed when there is an extreme suspicion of high dosage, or when the serious damage by the radiation has already been done. Therefore, we hereby tend to acknowledge the long term exposure or damaging effects of high dosage of Background radiation in case it is exists for a prolonged time.
Keywords: Background radiation, radioactive sources

G-027

Radioactive radiation – the most damaging constituent of Background radiation

Paras Agrawal
Department of Physics, D.A.V. Postgraduate College, Sector 10, 160011, Chandigarh, INDIA
Email: agrawalparas@gmail.com

Abstract. This paper aims to focus on the concept of background radiation in general and it's most important and critical constituent, i.e., radioactive radiation in particular. The Background radiation is the sum of all the sorts of radiation surrounding us. Either it is harmful or non-harmful. Either it is natural or man-made. The background radiation in context of the natural radiations means the radiation emitted from air, soil, earth, water, from external cosmos (cosmic radiation) or any other radioactive elements present in any of our surroundings. The radioactive radiation, the most important aspect or constituent of background radiation can either be due to any natural source (from any radioactive nuclei present inherently in air, soil or water etc.) or artificial source (from any device, medical facility, mobile phone generating radio-waves or e.m. waves, microwave, nuclear reactor facilities). One must note that the cosmic radiation or cosmic showers (mostly very high energy charged particles) are knocked down or repelled strongly by the magnetic field of the earth. Thus the background radiations damaging impact on human mainly comes explicitly from the strong and highly energetic radioactive radiation. The radioactive radiation in nature contributing toward the background radiation can be due to unstable radioactive nuclei emitting continuous radio-active radiation to attain stability or through any nuclear reaction (especially fission or fusion reaction). However, in current times, the man made or artificial sources like accelerator facilities, radio-nuclear facilities, and medical devices like X-ray machines can also contribute to background radiation. Here, we shall discuss that how this radio-active radiation can damage and destruct the health of population or environment which is exposed to a background radiation, when it is above permissible levels. Moreover, there is every probability that such a damaging effect can always be mainly due to the radio-active radiation which is the most critical and damaging constituent of the background radiation.