Kalyan Mandal

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Guidance of Students/Post-Docs/Scientists

a) Ph.D. Students

1. Subrata Ghosh; Magnetocaloric effect; Thesis submitted
2. Dipika Mandal; Microwave properties of ferrite nanostructures; Thesis submitted
3. Dipanjan Maity; Electrochemical water splitting; Under progress
4. Priyanka Saha; Ferrites nanostructures; Under progress
5. Swarnali Hait; Multiferroic materials; Under progress
6. Anupam Garai; Microwave properties of ferrite nanostructures; Under progress
7. Sudipta Chatterjee; Transport and magneto-transport properties of Heusler alloys; Under progress
8. Saheli Samanta; Magnetocaloric effect; Under progress

b) Post-Docs

1. Deblina Majumder; Biomedical applications of magnetic nanostructures

Teaching

1. Spring semester; Magnetism and superconductivity (PHY 409); Integrated PhD; 5 students; with 1 (Ranjan Chaudhury,) co-teacher
2. Spring semester; Advanced condensed matter physics (PHY 601); PhD; 6 students; with 1 (Ranjan Chaudhury,) co-teacher
3. Spring semester; Advanced Experiments (PHY 391); Integrated PhD; 12 studnets; with 4 (T. Setti, R. Mitra, and M. PradhanR. Das) co-teachers
4. Autumn semester; Basic experiments (PHY 291); Integrated PhD; 12 students; with 1 (Pratip Kumar Mukhopadhyay,) co-teacher

Publications

a) In journals

1. Subrata Ghosh, Pintu Sen and **Kalyan Mandal**, *Magnetostructural transition and large magnetocaloric effect in* $(Mn_{0.6}Fe_{0.4})NiSi_{1-x}Al_x$ *(x = 0.06–0.08) alloys*, Journal of Magnetism and Magnetic Materials, 500, 166345, 2020
2. Subrata Ghosh, Arup Ghosh, Pintu Sen, and **Kalyan Mandal**, *Giant Room-Temperature Magnetocaloric Effect Across the Magnetostructural Transition in* $(MnNiSi)_{1-x}(FeCoGa)_x$ *Alloys*, Physical Review Applied, 14, 014016, 2020
3. SouvanikTalukdar, Priyanka Saha, Indranil Chakraborty and **Kalyan Mandal**, *Surface functionalized CoFe2O4 nano-hollowspheres: Novel properties*, Journal of Magnetism and Magnetic Materials, 513, 167079, 2020
4. Dipanjan Maity, Keshab Karmakar, Dipika Mandal, Debashish Pal, Gobinda Gopal Khan and **Kalyan Mandal**, *Earth abundant transition metal ferrite nanoparticles anchored ZnO nanorods as*

efficient and stable photoanodes for solar water splitting, Nanotechnology, 31, 475403, 2020

5. Swarnali Hait, Srabantika Ghose and **Kalyan Mandal**, *Effect of Ba and Y co-doping on the structural and magneto-electric properties of $BiFeO_3$ ceramic*, Journal of Alloys and Compounds, 822, 153614, 2020
6. Deblina Majumder, Indranil Chakraborty and **Kalyan Mandal**, *Room temperature blooming of CeO_2 3D nanoflowers under sonication and catalytic efficacy towards CO conversion*, RSC Advances, 10, 22204-22215, 2020
7. Mahebub Alam, **Kalyan Mandal** and Gobinda Gopal Khan, *Origin and tuning of room temperature ferromagnetism and ferroelectricity in double perovskite Y_2NiMnO_6 nanostructured thin films*, Journal of Alloys and Compounds, 822, 153540, 2020
8. Mahebub Alam and **Kalyan Mandal**, *Room temperature ferromagnetism and ferroelectricity in double perovskite Y_2NiMnO_6 thin film*, Journal of Magnetism and Magnetic Materials, 512, 167062, 2020
9. Keshab Karmakar, Dipanjan Maity, Debashish Pal, **Kalyan Mandal**, and Gobinda Gopal Khan, *Photo-Induced Exciton Dynamics and Broadband Light Harvesting in ZnO Nanorod-Templated Multilayered Two-Dimensional MoS_2/MoO_3 Photoanodes for Solar Fuel Generation*, ACS Applied Nano Materials, 3, 1223-1231, 2020

b) Conference proceedings / Reports / Monographs / Books

1. S Ghosh, A Ghosh, P Sen, K Mandal, "Magnetic and magnetocaloric properties in TbCo2Si2 alloy", AIP Conference Proceedings 2265 (1), 030553 (2020).
2. M Alam, S Ghosh, K Mandal, "Magnetic and magnetocaloric properties in double perovskite multiferroic Y2NiMnO6 nanoparticle", AIP Conference Proceedings 2265 (1), 030592
3. Folate modified zinc ferrite nano-hollowspheres for drug delivery and intrinsic fluorescence S Talukdar, P Saha, K Mandal AIP Conference Proceedings 2265 (1), 030131

Talks / Seminars Delivered in reputed conference / institutions

1. "Novel properties of transition metal oxide nanostructures", in the conference "Recent success and challenges in nanoscience and nanotechnology (experiment and theory) (RSCNN 2020), 25-27th September, 2020; Organized by School of Applied Sciences and Humanities, Haldia Institute of Technology; Sep 25, 2020; On-line; one hour
2. "Magnetic properties and their measurements: bulk to nano", in C. K. Majumdar Memorial Workshop in Physics; 28 December 2020 - 04 January 2021; Jan 2, 2021; On-line; one hour

Administrative duties

1. Head of the Department, Condensed Matter Physics and Materials Sciences
2. Chairman, Security Committee
3. Chairman, Library Committee
4. Chairman, Purchase Committee

Membership of Learned Societies

1. Indian Physics Teachers' Association
2. Materials Research Society of India
3. IEEE Magnetic Society (USA)
4. Non-destructive Society of India

Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Study of magneto-structural transitions and magneto-caloric effects in inter-metallic compounds: a search for eco-friendly magnetic refrigerant; Department of Science and Technology; 3 years; Co-PI

Conference / Symposia / Schools organized

1. C. K. Majumdar Memorial Workshop in Physics 2020; December 28, 2020; S. N. Bose National Centre for Basic Sciences, Salt Lake, Kolkata; 8 days

Scientific collaborations with other national / international institutions (based on joint publications)

1. Photoelectrochemical water-splitting with Dr. Gobinda Gopal Khan, Tripura Central University, Agartala, Tripura; Sl. No. 4, 7, 9; National
2. Magnetocaloric effect with Dr. Pintu Sen, Variable Energy Cyclotron Centre, Salt Lake, Kolkata; Sl. No. 1, 2; National

Areas of Research

Magnetism and magnetic materials, Nanomaterials, Energy materials

Multi-layered nano-hollow spheres for efficient electromagnetic wave absorption Ferrite nano-hollow spheres (NHS) are of great significance to improve electromagnetic (EM) wave absorption performance. The deposition of dielectric SiO_2 (SiO) and ferrimagnetic $CoFe_2O_4$(CFO) layers on $MnFe_2O_4$ (MnFO) NHS are found to be an effective strategy to enhance EM wave attenuation. EM wave absorption properties of as-synthesized bare and bi-layered samples are investigated within a widely-used frequency range of 1 - 17 GHz. MnFO/CFO bi-layered NHSs exhibit an excellent reflection loss (*RL*) of -47.0 dB at only 20 wt% filler content with an effective broad bandwidth (*BW*) of ~ 2.2 GHz (frequency region for $RL < -10$ dB). Attenuation constant is observed to increase from 191.6 Np/m to 457.8 Np/m for bare MnFO and MnFO/CFO NHSs respectively. Larger interfacial area, higher magnetic anisotropy, internal reflections and scattering from NHSs are responsible for superior absorption properties of MnFO/CFO NHSs. Moreover, best impedance matching, $|Z_{in}/Z_0| \sim 1$, promotes the optimum *RL* in MnFO/CFO at 5.96 GHz. MnFO/SiO bi-layered NHSs result in a sufficiently high $RL \sim -30.0$ dB with a composite absorber of thickness only 3mm. Analysis from /4 model for best matching thickness (t_m) displays a good agreement between experimental and simulated t_m values. This study demonstrates optimized MnFO/CFO NHS as a highly promising low-cost and light-weight EM wave absorber suitable for practical high-frequency applications.

$ZnCo_2O_4$/ZnO a p-n type –II heterojunction photoanode for PEC water splitting application

Poor light absorption, severe surface charge recombination and fast degradation are the key challenges with ZnO nanostructures based electrodes for photoelectrochemical (PEC) water splitting. In this study we have attempt to design an efficient and durable nano-heterojunction photoelectrode by electrochemical deposition of $ZnCo_2O_4$ (ZCO) over chemically grown ZnO nanorods. This nano-heterojunction photoanode exhibits improved visible light-harvesting performance due to the narrow band gap of ZCO. The type-II band alignment between $ZnCo_2O_4$ and ZnO Nanorods (NRs) accelerates the charge transfer process and reduces the photogenerated electron-hole pair recombination. The $ZnCo_2O_4$ surface layer also passivates the surface states in ZnO, resulting in a remarkable reduction in photocarrier recombination which improve the current density of bare ZnO photoanode from a value 0.35 $mA.cm^{-2}$ to 1.58 $mA.cm^{-2}$ at 1.23V vs. RHE. This work demonstrates an innovative strategy to improve the PEC water oxidation of ZnO NRs by incorporating $ZnCo_2O_4$ which acts both as an OER catalyst and a *p*-type light-harvesting semiconductor, which helps in the rapid separation of photocarrier.

Plan of Future Work Including Project

1. To prepare low-cost transition metal-based materials with high magnetocaloric properties
2. Better materials for electrochemical water-splitting will be prepared and studied in details.
3. Multilayered nano-hollow spheres of ferrites and dielectric materials for microwave absorption will be investigated.
4. Effort to prepare multiferroic materials with better magneto-electric coupling will be continued.