Kalyan Mandal

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Professor Kalyan Mandal is a former student of Ramkrishna Mission (Asansol), Presidency College (Calcutta) and the University of Calcutta. He received his Ph.D. degree in Physics from the Indian Institute of Technology (Kharagpur). He also worked in Queen's University (Canada), Instituto de Magnetismo Aplicado (Spain), IFW-Dresden (Germany), Durham University (UK) and Osaka University (Japan).

Supervision of Research / Students

Ph.D. Students

1. Arup Ghosh: "Magnetic, magnetocaloric and magnetotransport properties of Heusler alloys", awarded Ph.D. degree in August 2016
2. Rupali Rakshit: "Tuning of magnetic and electromagnetic response of 3d-transition metal oxide based magnetic nanostructures", Ph.D. thesis submitted in July 2016
3. Souvanik Talukdar: "Magnetic and optical properties of oxide nanomaterials", on-going
4. Indranil Chackraborty: "Bio-medical applications of oxide nanostructures", on-going
5. Mahebub Alam: "Multiferroic materials", on-going
6. Keshab Karmakar:"Energy materials", on-going

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Anupam Gorai, SNBNCBS: "Study of exchange-coupled core-shell nanostructures"
2. Shashank Gupta, SNBNCBS: "Study of multiferroic materials"
3. Priya Maity, Indian School of Mines: "Preperation and study of Co/ MnFe2O4 core-shell structure"

Post Doctoral Research Scientists

1. Madhuri Mandal

Teaching activities at the Centre

1. PHY 291, Basic experiments, second semester
2. PHY 391, Advanced experiments, third semester
3. PHY 409, Magnetism and superconductivity, fourth semester
4. PHY 601, Advanced Condensed Matter Physics-II, fourth semester

Publications in Journals

1. R. Das, S. Sharma and **K. Mandal;** *Aliovalent Ba^{2+} doping: A way to reduce oxygen vacancy in multiferroic $BiFeO_3$;* Journal of Magnetism and Magnetic Materials; 2016; **401**; 129-137.
2. A Sarkar, GG Khan, A Chaudhuri, A Das, **K Mandal;** *Multifunctional $BiFeO_3$/ TiO_2 nano-heterostructure: Photo-ferroelectricity, rectifying transport, and nonvolatile resistive switching property;* Applied Physics Letters; 2016; **108;** 033112.
3. M Alam, **K Mandal,** GG Khan; *Double perovskite Y_2NiMnO_6 nanowires: high temperature ferromagnetic-ferroelectric multiferroic;* RSC Advances; 2016; **6**; 62545-62549.
4. A. K. Singh, D. Sarkar, K. Karmakar, **K. Mandal,** and G. G. Khan; *High-Performance Supercapacitor Electrode Based on Cobalt Oxide-Manganese Dioxide-Nickel Oxide Ternary 1D Hybrid Nanotubes;* ACS Applied Materials and Interfaces; 2016; **8;** 20786-20792.
5. M Pal, R Rakshit, AK Singh, **K Mandal;** *Ultra high supercapacitance of ultra small Co_3O_4 nanocubes;* Energy; 2016; **103;** 481-486.
6. R. Rakshit, K. Serita, M. Tonouchi, **K. Mandal;** *THz conductivity of semi-insulating and magnetic $CoFe_2O_4$ nano-hollow structures through thermally activated polaron;* Journal of Applied Physics; 2016; **120;** 203901.
7. A. Sarkar, K. Karmakar, A. K. Singh, **K. Mandal** and G. G. Khan; *Surface functionalized $H_2Ti_3O_7$ nanowires engineered for visible-light photoswitching, electrochemical water splitting, and photocatalysis;* Physical Chemistry Chemical Physics; 2016; **18;** 26900-26912.
8. K. Karmakar, A. Sarkar, **K. Mandal** and G. G. Khan; *Stable and Enhanced Visible-Light Water Electrolysis Using C, N, and S Surface Functionalized ZnO Nanorod Photoanodes: Engineering the Absorption and Electronic Structure;* ACS Sustainable Chemistry & Engineering; 2016; **4;** 5693-

5702.

9. A. Ghosh, P. Sen and **K. Mandal;** *Measurement protocol dependent magnetocaloric properties in a Si-doped Mn-rich Mn-Ni-Sn-Si off-stoichiometric Heusler alloy;* Journal of Applied Physics; 2016; **119;** 183902.
10. A. K. Singh and **K. Mandal;** *Growth and Magnetic Characterization of 1D Permalloy Nanowires Using Self Developed Anodic Aluminium Oxide Templates;* Journal of Nanoscience and Nanotechnology; 2016; **16;** 994-997.
11. M. Alam, K. Karmakar, M. Pal and **K. Mandal**; *Electrochemical supercapacitor based on double perovskite Y_2NiMnO_6 nanowires;* RSC Advances; 2016; **6;** 114722.

Lectures Delivered

1. "Magnetism in nanostructured materials", in C. K. Majumdar Memorial Workshop-2016 held in SNBNCBS, on 22 June 2016.

Membership of Committees

External Committee

Member of Executive Committee, Magnetics Society of India; Member, Executive Committee of Material Research Society of India (Kolkata Chapter); Ph.D. Viva-Voce examiner of many students

Internal Committee

Library Committee; Visitors Associates and Students Programme Committee; SCRE Committee and many other committees of SNBNCBS

Awards / Recognitions

1. Material Research Society of India Medal - 2016

Sponsored Projects

1. "Functionalization of transition metal oxide nanoparticles for biomedical applications" funded by SNBNCBS (2016-2018).

Conference / Symposia / Workshops / Seminars etc. organized

1. "Young Scientist Colloquium - 2016" of MRSI on 16 September 2016 at SNBNCBS. Role: Convener

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

1. Dr. G. G. Khan, University of Calcutta (Sl. No. 2, 3, 7, 8)

International

1. Professor M. Tonouchi, Osaka University, Japan (Sl. No.6)

Member of Editorial Board

1. Transaction of Indian Ceramic Society, a Tailor Francis Journal.

Significant research output / development during last one year

General research areas and problems worked on

Study of magnetic and optical properties of surface functionalised nanostructures of transition metal oxides, magnetoicaloric effect, Use of nanostructured oxide magnetic materials in THz frequency, Supercapacitor, stable and enhanced Visible-Light Water Electrolysis

Interesting results obtained

1. Stable and enhanced visible-light water electrolysis for clean and sustainable energy :

The successful implementation of photoelectrochemical (PEC) cell to produce the Hydrogen fuel by water splitting and the fixation of CO_2 into hydrocarbons by using the clean and abundant sun light are promising approaches to face this energy challenge.

We prepared Highly oriented arrays of C, N and S surface functionalized/surface doped ZnO Nanorods (NRs) by a simple chemical bath deposition followed by wet chemical method as shown in Fig.1(a). Surface functionalization significantly improved both the photocurrent and photostability of the ZnO NRs electrodes under visible-light irradiation along with the reduction in onset-potential for water oxidation (Fig.1(b)). Surface engineered ZnO NRs also exhibited enhanced visible light harvesting efficiency and significantly quenched electron-hole recombination due to the presence of surface states leading to greatly efficient carrier separation.

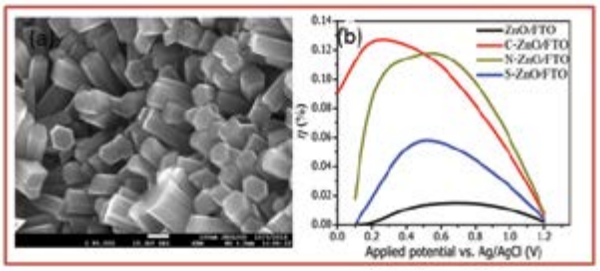

Fig: 1 (a) FESEM image of ZnO NRs,
(b) Photoconversion efficiency.

2. Room temperature ferromagnetic and ferroelectric properties of double perovskite Y_2NiMnO_6 nanowires:

This work demonstrates the unusual room temperature ferromagnetism, ferroelectricity and strong magnetoelectric coupling of the double perovskite multiferroic Y_2NiMnO_6 nanowires (Fig.2), fabricated using a facile solvothermal route. The studies indicate that the large concentration of surface spin and the surface charge polarization associated with the surface

electrons of the unique one dimensional high aspect ratio nanowires are responsible for the ferromagnetism and ferroelectricity, respectively at room temperature.

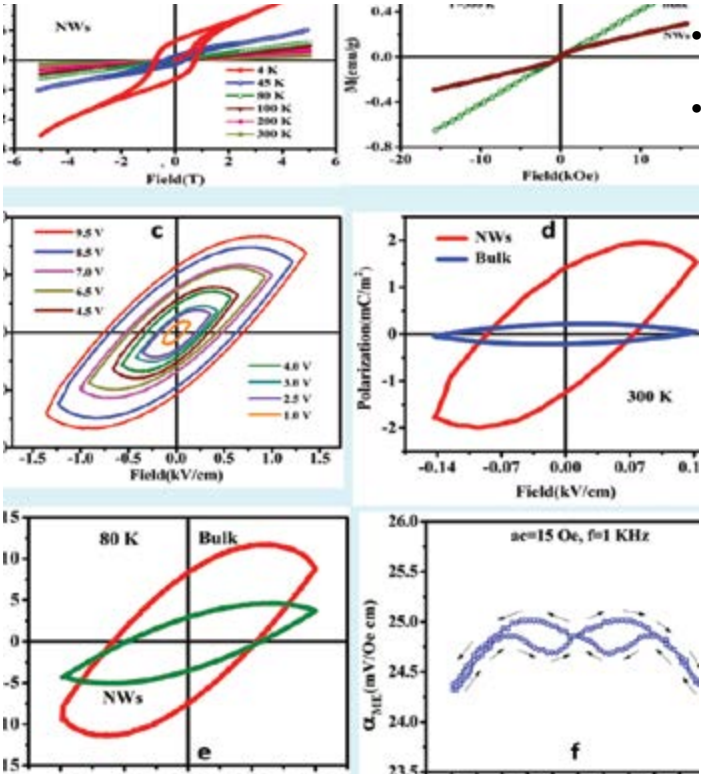

Fig: 2. (a) Magnetization versus magnetic field hysteresis loops for the Y_2NiMnO_6 NWs at 4, 50, 80, 100, 200 and 300 K and (b) Y_2NiMnO_6 NWs and bulk samples at 300 K. (c) Variation of the room temperature (300 K) P–E hysteresis loops with applied voltage for the Y_2NiMnO_6 NWs, Variation of the P–E hysteresis loops for the Y_2NiMnO_6 NWs and bulk at (d) 300 K and (e) 80 K, (f) DC bias magnetic field dependence of longitudinal magnetoelectric coefficients (α_{ME}) for Y_2NiMnO_6NPs in ac magnetic field of frequency f = 1 kHz.

Proposed research activities for the coming year

- To develop electrodes with nanostructured materials for stable and enhanced visible-light water electrolysis for clean and sustainable energy
- To find better multiferroic materials with stronger magnetoelectric coupling.
- To prepare water soluble magnetic nanoparticles with good magnetic as well as fluorescent properties due to surface functionalization.