Data related to Research and Extension (2018 – 2023)

Curriculum vitae (in brief)

A.	Name	: Anindya Sarkar
B.	Designation	: Assistant professor in Physics
C.	Address for Communication	: Bangabasi Morning College, 19 R. C. Sarani, Kolkata 700 009 (0091-33-2360-7586) e-mail: **anindyasarkar@bangabasimorning.edu.in**
D.	Academic Qualification	: M.Sc. (Physics), Ph. D. (Physics, Experiment).
E.	Positions held	: (a) Junior & Senior **Research fellow, Council of Scientific and Industrial Research** (CSIR), Govt. of India, (01.03.1997 to 06.08.2001),
F.	Award/Prize/Certificate etc.	: Awarded CSIR (Govt. of India), JRF (NET) on December 11, 1996
G.	Teaching	: From 07.08.2001 till now at **Bangabasi Morning College**, **Guest Lecturer** ((2005-2016)) at **Bengal Engineering and Science University (IIEST** at present**),** Howrah.
H.	Publications	: Research Papers (Int.) **59 (Fifty nine)** National Journal/Proc. **02 (two)** Reports **1** Book chapter **2** In preperation **3** Popular articles **02** Conference poster **17** Invited Talk/Oral presentation **15** Google scholar https://scholar.google.co.in/citations?user=_DMvnzoAAAAJ&hl=en, ORCID ID https://orcid.org/0000-0002-7957-9638 Vidwan ID https://vidwan.inflibnet.ac.in/profile/511108
I.	International Exposure	: Visited **ESRF, Grenoble, Grenoble High Magnetic Field Laboratory & Synchrotron SOLEIL (France), Department of Physics, University of Trento, & MEM-CNR Institute, Area delle Scienze Parma (Italy).**
J.	Completed Projects	: Two (**Minor research Project, UGC**)

LIST OF PUBLICATIONS (2018 – 2023)

[1] **Clustered vacancies in ZnO: Chemical aspects and consequences on physical properties**, S. Pal, N. Gogurla, A. Das, S. S. Singha, P. Kumar, D. Kanjilal, A. Singha, S. Chattopadhyay, D. Jana and A. Sarkar, *J. Phys. D: Appl. Phys*. **51** (2018) 105107.

[2] **Ab-initio calculation and experimental observation of room temperature ferromagnetism in 50 keV nitrogen implanted rutile TiO_2**, H. Luitel, M. Chakraborti, A. Sarkar, S. Dechoudhury, D. Bhowmick, V. Naik and D. Sanyal, *Mater. Res. Exp.* **5** (2018) 026104.

[3] **Raman spectroscopic analysis on Li, N and (Li,N) implanted ZnO**, ApuMondal, S.Pal, A.Sarkar, T.S.Bhattacharya, Avishek Das, N.Gogurla, S.K.Ray, Pravin Kumar, D.Kanjilal, K. D. Devi, A.Singha, S.Chattopadhyay and D.Jana, *Mater. Sci. Semicond. Processin*g **80** (2018) 111.

[4] **Raman investigation of N-implanted ZnO: Defects, disorder and recovery**, Apu Mondal, S. Pal, A. Sarkar, T. S. Bhattacharya, Sourabh Pal, A. Singha, S.K. Ray, Pravin Kumar, D. Kanjilal and D. Jana, *J. Raman Spectrosc.* **50** (2019) 1926.

[5] **Depth resolved defect characterization of energetic ion irradiated ZnO by positron annihilation techniques and photoluminescence**, A Sarkar, M Chakrabarti, D Sanyal, N Gogurla, S K Ray, P Kumar, R S Brusa and C Hugenschmidt, *J. Phys.: Condens. Matter* **32** (2020) 085703.

[6] **Site disorder and its tailoring in N implanted post-annealed ZnO: Prospects and problems:** Apu Mondal, S. Pal, Suvadip Masanta, Sourabh Pal, Rajib Saha, Pravin Kumar, A. Singha, S. Chattopadhyay, D. Jana and A. Sarkar, *Mater. Sci. Semicond. Processin*g **135** (2021) 106068.

[7] **Ion beam induced defects in ZnO: A radiation hard metal oxide**, S. Pal, A. Mondal, A. Sarkar, S. Chattopadhyay and D. Jana (Book Chapter 18, in **Metal Oxide Defects: Fundamentals, Design, Development and Applications**, published by **Elsevier** under the Elsevier Woodhead Imprint (Eds. **V. K. Vijay, S. Som, V. Sharma, H. C. Swart**) (https://doi.org/10.1016/B978-0-323-85588-4.00008-8).

INVITED TALK/ORAL PRESENTATIONS (2018-2023)

[1] Short oral presentation entitled **"Defect microstructure and its unique identification in semiconductors using positron annihilation spectroscopy"** at Third DAE-BRNS Trombay positron meeting (POSITRON-2018), **23-24 March, 2018, Bhaba Atomic Research Centre, Mumbai, India.**

[2] Flash oral presentation (**ONLINE**) entitled "**Comprehensive understanding of defect complexes in ion irradiated ZnO using positron annihilation spectroscopy**" at 6th International virtual conference on Nanostructuring by ion beams (ICNIB 2021), **5-8 October, 2021, jointly organized by IUAC, New Delhi and IOP, Bhubaneswar**.

[3] Oral presentation (**ONLINE**) entitled **"Vacancy clusters in ZnO: interesting features of positron annihilation, photoluminescence and Raman spectroscopic investigations"** at 19th International Conference on Positron Annihilation (ICPA-19), **22-26 August, 2022 (Hosted by University of Helsinki, Finland).**

[4] Invited talk entitled "ion irradiation on ZnO and other metal oxides: prospects, challenges and future directions" in the **"Theme Meeting on Scientific Opportunities of ANURIB", 25-27 April, 2023, organized by Variable Energy Cyclotron Centre (VECC), Kolkata.**

[5] Oral presentation on **"Photocatalytic dye degradation by disordered TiO_2 under sunlight"** at the International conference on "Renewable Energy and its social impact" **organized by Bangabasi College, Kolkata, 5th & 6th August, 2023.**

COLLABORATIONS

[1] With **Dr. D. Sanyal, Radioactive Ion Beam (RIB) division, Variable Energy Cyclotron Centre (VECC), Kolkata**.

[2] With **Prof. Debnarayan Jana, Department of Physics, University of Calcutta, Kolkata**.

[3] With **Dr. Pravin Kumar, Low Energy Ion Beam Facility (LEIBF), Nuclear Science Centre (NSC), New Delhi.**

[4] With **Dr. Saptarshi Pal, Department of Physics, GLA University, Mathura.**

[5] With **Dr. Apu Mandal, Department of Basic Science & Humanities, Cooch Behar Government Engineering College, Cooch Behar.**

[6] With **Dr. Amit Kumar Dutta, Department of Chemistry, Bangabasi Morning College, Kolkata.**

[7] With **Prof. Achintya Singha, Department of Physics, Bose Institute, Kolkata.**

[8] With **Prof. Christoph Hugenschmidt, Forschungs-Neutronenquelle Heinz Maier-Leibnitz and Physics Department, Technische Universität München, Germany.**

[9] With **Roberto Sennen Brusa, Department of Physics, University of Trento, Trento, Italy.**

[10] With **Vincent Sallet, Groupe d'Etude de la Matière Condensée (GEMAC), CNRS-UVSQ, Université de Versailles St Quentin en Yvelines, Versailles Cedex, France.**

RESEARCH EXPERIENCES

[1] Polycrystalline sample preperation mainly **HTSC, CMR, spinel oxides, II-VI semiconductors**.

[2] Preperation of **nanophase materials** by **ball-milling** and **chemical process**.

[3] **Experience of developing Positron lifetime measurement set-up with very low time resolution (185 ps).**

[4] **Experience of setting up Coincidence Doppler broadening set up in the Calcutta University Positron Laboratory.**

[5] **Experience on low temperature experiments (30 K) of resistivity, Photoluminescence, Positron and Mossbauer spectroscopy.**

[6] Participated in ten beam time experiments at **Pelletron accelarator** and **Low energy ion beam facility** at IUAC, New Delhi.

[7] Participated in two beam time experiments at **Cyclotron accelerator** at VECC, Kolkata.

[8] Participated in one beam time experiment (**Compton scattering expt.**) at ESRF, Grenoble, France.

[9] Experience in experiments with positron beam (**positron scattering experiment with molecular gases**) at Trento, Italy (with **Training and Research in Italian Laboratories, TRIL fellowship, two times**) .

[10] Knowledge on **optical absorption** measurement and analysis.

[11] **DFT** calculation by VASP.

[12] Growth and characterization of **ZnO nanowires**.

OTHER ACADEMIC WORKS

[1] Reviewer of **Elsevier Science, IOP** and **Wiely** publishing journals.

[2] Life Member of **Indian Physical Society** & **Society for Positron Annihilation and Nuclear Probes (SPAN)**.

[3] Guided two M. Tech. thesis on **high temperature superconductivity** at School of Materials Sci. & Engg., Bengal Engineering and Science University (BESU), Howrah, India.

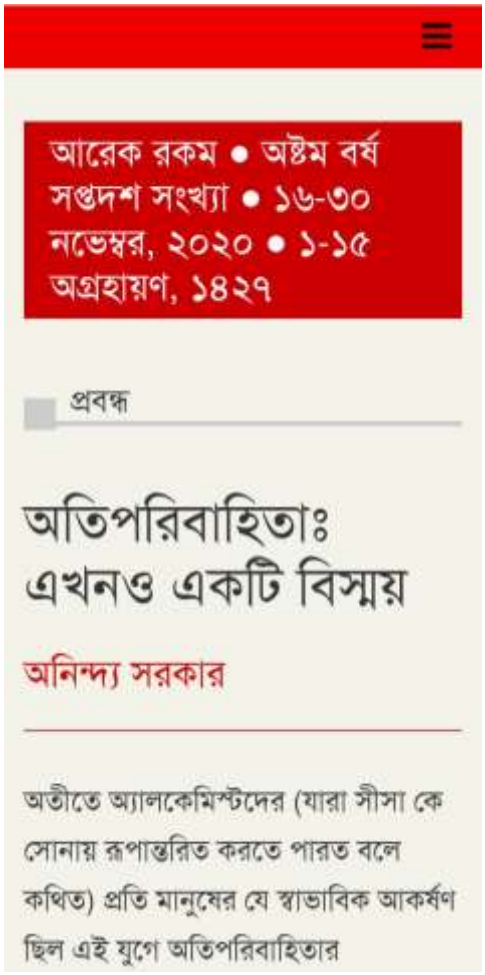
[4] Guided one **M. Sc. project "Analysis of defective state of ZnO material using Raman, Photoluminescence and X-ray diffraction spectroscopy"** for Mr. M. Rahaman (Raiganj University, Raiganj) (2019).

[5] Ongoing two **M. Sc. Projects** for Mr. Sourashis Sarkar, Department of Physics, Ramakrishna Mission Vivekananda Centenary College, Rahara (**Hall coefficient measurement in Germanium with arbitrary shape and its evolution with defects in the crystal**) and for Mr. Tufan Banerjee, Department of Physics, West Bengal State University, Barasat, (**Photocatalytic activity of ZnO-TiO_2 composites**).

[6] Guided one **research level project** on "**Precise Hall voltage measurement in Germanium crystal"** for class XII student (Ribhaya Saraf, La Martiniere for Girls, Kolkata) (2023).

(Above) Monitoring 80 MeV N^{14} ion irradiation (16 hours long beamtime on 27-28th February, 2023) on ZnO semiconductors at Inter University Accelerator Centre (IUAC), New Delhi.

(Below) Class XII student is carrying out research level project and successfully completing it.



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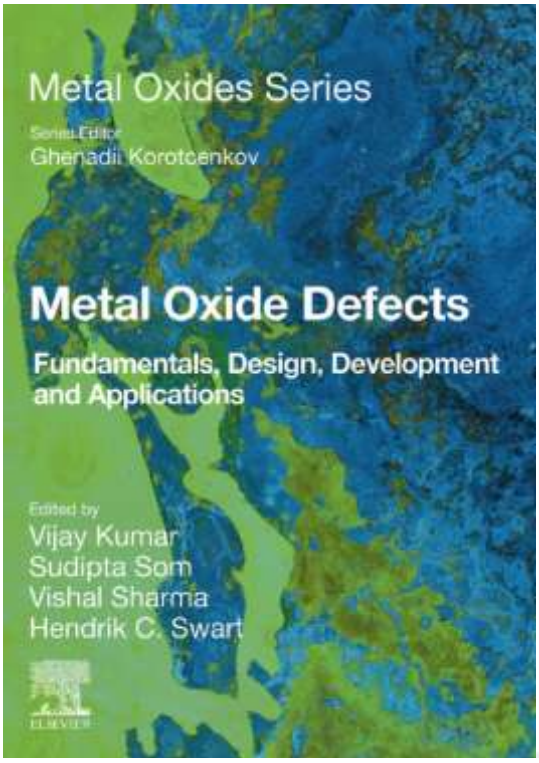

Ion beam-induced defects in ZnO: A radiation hard metal oxide

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S. Pal[1,2], A. Mondal[1,3], A. Sarkar[1], S. Chattopadhyay[4] and D. Jana[5]
[1]Technical Research Centre, S. N. Bose National Centre for Basic Sciences, JD Block, Sector-III, Salt Lake City, Kolkata, India; [2]Department of Physics, University of Calcutta, Kolkata, India; [3]Department of Physics, Bangabasi Morning College, Kolkata, India; [4]Department of Physics, Sovarani Memorial College, Jagatballavpur, Howrah, West Bengal, India; [5]Department of Physics, Institute of Applied Sciences and Humanities, GLA University, Mathura, Uttar Pradesh, India; [6]Department of Basic Science & Humanities, Cooch Behar Government Engineering College, Vill- Harinchawra, Ghughumari, Cooch Behar, West Bengal, India

1. Introduction

The applicability of ion beam bombardment techniques in present semiconductor industries is versatile [1,2]. Starting from the key advantageous controlled selective area doping, several cutting-edge technological steps in integrated circuit fabrication like dry etching and creating an electrical isolation layer are being executed using an energetic ion beam [3]. This technique also allows doping beyond the solid solubility limit thus heavily doped region can easily be achieved, following which degenerate semiconductor fabrication is possible [3]. However, during the passage of an ion inside a material, it collides with several atoms in the host matrix along its path, out of which few get displaced thus initiating the generation of point defects in a nonequilibrium manner. Although a fraction of generated defects gets dynamically annealed out just after creation, a substantial amount of defects get stabilized, which could dramatically change several physical properties of the system. It is worth mentioning that such changes are sometimes undesirable from an application point of view, and associated ion-induced defects are then called "unwanted defects." Further, various types of post-annealing like conventional annealing, rapid thermal annealing (RTA), and flash lamp annealing (FLA) are being employed for healing purposes, which can again trigger complex defect structures in the target material. Thus, a clear understanding of the defect generation, its solid dynamic annealing, and post-annealing (if required) is very much desirable for the practical use of particular materials as well as for understanding the basic physics involving defects inside the material.

In this perspective, zinc oxide (ZnO) bears special attention for possessing radiation hardness properties [4–6]. ZnO is a traditionally well-known semiconductor for its eco-friendly nature and technologically favorable properties like direct wide band gap (3.37 eV at 300 K), large exciton binding energy (60 meV), high electron

Metal Oxide Defects, https://doi.org/10.1016/B978-0-12-819781-4.00018-4

One of the book chapters (2023)