








Indranil Mal

Indian Institute of Technology Delhi
Department of Physics, Hauz Khas, New Delhi 110016

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FORMAL EDUCATION

Doctor of Philosophy in Electronics and Communication Engineering (2022)

PDPM Indian Institute of Information Technology Design and Manufacturing Jabalpur

Dissertation Title: “Theoretical Investigation of the Optoelectronic Properties of III-V Alloys and Quantum Confined Structures for Infrared Applications”

Supervisor: **Dr. Dip Prakash Samajdar**

Master of Technology in Mobile Communication and Computing (2017)

National Institute of Technology, Arunachal Pradesh with first class CGPA: 9.08/10

Master of Science in Electronics (2013)

West Bengal State University with first class (62%)

Bachelor of Science in Physics (2011)

Graduated with second class honors (49%) from West Bengal State University

RESEARCH INTERESTS

- Density Functional Theory (DFT) study of III-V semiconductors
- Time Dependent Density Functional Theory (TDDFT)
- Mathematical modeling of the optoelectronic properties of III-V semiconductors using **k,p** Hamiltonian
- Growth and Characterization of III-V nanostructures based optoelectronic devices
- Transmon Qubit

RESEARCH EXPERIENCE

Research Associate (Nov 2022 till date)

Working as a Research Associate at Indian Institute Technology Delhi in the project entitled Development of Shape Memory Oxide thin-films for Aerospace applications: Understanding the Phase-switching behavior, related defect formation, and shape recovery process under the supervision of Prof. Ratnamala Chatterjee, and Prof. Brajesh Kumar Mani. The project involves theoretical and experimental development of doped PZTS and BNT perovskite for shape memory applications.

Research Associate (Feb-Nov 2022)

Worked as a Research Associate at Indian Institute of Science Education and Research Bhopal in the project entitled Excited State Dynamics Toolkit under the supervision of Dr. Varadharajan Srinivasan. The project involves development of a comprehensive toolkit for computer simulations of photo-induced phenomena based on the combination of two excited state dynamics approaches: ab initio techniques (based on TDDFT), and open quantum system approaches. Target applications include solar energy conversion (photovoltaics, water-splitting catalysts, solar fuels, etc.), opto-electronic materials, photochemistry, and photobiology.

Senior Research Fellow (Nov 2021-Feb 2022)

Worked as a Senior Research Fellow (SRF) at PDPM IIITDM Jabalpur in the project entitled Analytical Modelling and Simulation of III-V nanostructure-based Hybrid Solar Cells under the guidance of Dr. Dip Prakash Samajdar. The project involves design and simulation of nanostructures (Nano-rod, Nano-cone, and Truncated-Pyramidal) based solar cell using COMSOL Multiphysics.

Ph.D. Research (2018-2022)

During my PhD tenure, I have worked on Theoretical Investigation of the Optoelectronic Properties of III-V Alloys, and Quantum Confined Structures for Infrared Applications at PDPM IIITDM Jabalpur under the guidance of Dr. Dip Prakash Samajdar.

M. Tech Research (2016-2017)

Worked on a project entitled Studies on III-V dilute Nitride, Bismuth and Antimonide alloys using **k.p** Hamiltonian under the supervision of Dr. T. D. Das at National Institute of Technology, Arunachal Pradesh Department of Electronics and Computer Engineering.

M.Sc. Research (2012-2013)

Worked on Theoretical Investigation of Strain-Balanced $\text{Ge}_z\text{Sn}_{1-z} - \text{Si}_x\text{Ge}_y\text{Sn}_{1-x-y}$ Multiple Quantum Well LASER under the supervision of Dr. Bratati Mukhuopadhyay at department of Radio Physics and Electronics University of Calcutta.

TECHNICAL EXPERTISE

VASP, ABINIT, GPAW, OCTOPUS, NWChem, WIEN2K, Quantum Espresso, MATLAB, Mathematica, COMSOL, Lumerical, C, Python, Bash, Linux, and Windows OS.

TEACHING EXPERIENCE

- Assisting B.Tech. students in Basic Electrical and Electronics, Microwave communication, Microprocessor, Analog circuits Laboratory and teaching digital electronics and VLSI Device and Modeling courses (selected classes), at PDPM Indian Institute of Information Technology Design and Manufacturing Jabalpur Department of Electronics and Communication Engineering, Madhya Pradesh 482005 (2018-2022).
- Assisting B.Tech. students in Laboratory for one year in Basic Electrical and Electronics and Soft Computing, at National Institute of Technology, Arunachal Pradesh Department of Electronics and Computer Engineering, Yupia 791110 (2016-2017).
- PGT Teacher, in Indira Gandhi Memorial High School, Kolkata, West Bengal, India (2013-2014)

ACHIEVEMENTS

- Council of Scientific and Industrial Research (CSIR) SRF Fellowship
- GATE-2015 qualified in EC with 403 score.
- UGC NET 2014 qualified LS only in Electronic Science.

PROFESSIONAL MEMBERSHIPS AND AFFILIATIONS

Materials Research Society (Active) since from last four years

OPTICA (formerly OSA) (Active) since from last one year

IEEE Membership (Active) since from last two years

- IEEE Young Professionals
- IEEE Electron Devices Society Membership

- IEEE Photonics Society Membership
- IEEE Nanotechnology Council

LIST OF PUBLICATION

International Journals:

- [18] **I. Mal**, and D. P. Samajdar, "InPNBi/InP heterostructures for optoelectronic applications: A k·p investigation," *Mater. Sci. Semicond. Process.* vol. 149, p. 106857, (2022).
- [17] N. Jain, **I. Mal**, D. P. Samajdar, and N. Bagga, "Theoretical exploration of the optoelectronic properties of InAsN₂Bi/InAs heterostructures for infrared applications: A multi-band k·p approach," *Mater. Sci. Semicond. Process.* vol. 148, p. 106822, (2022).
- [16] **I. Mal**, and D. P. Samajdar, "Investigation of Optoelectronic and Thermoelectric Properties of InAsBi for LWIR Applications: A First Principles and k dot p Study," *Mater. Sci. Semicond. Process.* vol. 137, p. 106178, (2022).
- [15] **I. Mal**, R. Kumar, V. Tiwari, and D. P. Samajdar, "First principles studies on the structural, thermodynamic and optoelectronic properties of Boron Bismuth: A promising candidate for mid-infrared optoelectronic applications," *Mater. Sci. Semicond. Process.* vol. 121, no. 2021, p. 105352, (2021).
- [14] V. Tiwari, **I. Mal**, S. K. Agnihotri, and D. P. Samajdar, "First principles studies on the structural and optoelectronic properties of boron antimonide: A promising candidate for photovoltaic applications," *Mater. Sci. Semicond. Process.* vol. 122, p. 105505, (2021).
- [13] **I. Mal** and D. P. Samajdar, "InSbN₂Bi/InSb heterostructures for long wavelength infrared photodetector applications: A 16 band k·p study," *J. Appl. Phys.*, vol. 128, no. 9, (2020).
- [12] T. Hidouri, M. Biswas, **I. Mal**, S. Nasr, S. Chakrabarti, D. P. Samajdar, F. Saidi, "Engineering of carrier localization in BGaAs SQW for novel intermediate band solar cells: Thermal annealing effect", *Solar Energy*, 199, 183 (2020).
- [11] **I. Mal**, D.P. Panda, B. Tongbram, S. Chakrabarti, D.P. Samajdar, An Analytical Approach to Study Annealing Induced Interdiffusion of In and Ga for Truncated Pyramidal InAs/GaAs Quantum Dots, *IEEE Trans. Nano. Technol.* 19, 223, (2020).
- [10] T. Hidouri, S. Nasr, **I. Mal**, D. P. Samajdar, F. Saidia, R. Hamilaa, H. Maaref, "BGaAs strain compensation layer in novel BGaAs/InGaAs/BGaAs heterostructure: Exceptional tunability", *Applied Surface Science*, 524, 146573, (2020).
- [9] D. Roy, **I. Mal**, D. P. Samajdar, "Use of Parameter Extraction Techniques for the Evaluation of the Performance of CdTe Based Solar Array", *Adv. Sc. Eng. and Med.* 11, 1036, (2019).
- [8] **I. Mal**, D.P. Samajdar, Influence of Hydrostatic Pressure on the Performance of GaAsSbN/GaAs Quantum Well Based Optoelectronic Devices, *Sens. Lett.* 17, 481, (2019).
- [7] T. Hidouri, **I. Mal**, D. P. Samajdar, F. Saidi, T. D. Das, "Impact of localization phenomenon and temperature on the photoluminescence spectra of GaSbBi alloys and GaSbBi/GaAs quantum dots", *Superlattices and Microstructures*, 129, 252, (2019).
- [6] **I. Mal**, D.P. Panda, B. Tongbram, D.P. Samajdar, S. Chakrabarti, Analytical modeling of temperature and power dependent photoluminescence (PL) spectra of InAs/GaAs quantum dots, *J. Appl. Phys.* 124, 145701, (2018).
- [5] A. Hazra, **I. Mal**, D. P. Samajdar, T. D. Das, "Analytical modelling of organic solar cells with scattering interface", *Optik*, 168, 747, (2018).
- [4] **I. Mal**, J. Jayarubi, S. Das, A.S. Sharma, A.J. Peter, D.P. Samajdar, Hydrostatic Pressure Dependent Optoelectronic Properties of InGaAsN/GaAs Spherical Quantum Dots for Laser Diode Applications, *Phys. Status Solidi.* (2018).
- [3] **I. Mal**, D.P. Samajdar, A. John Peter, Theoretical studies on band structure and optical gain of GaInAsN/GaAs

/GaAs cylindrical quantum dot, Superlattices Micro struct. 119, 103, (2018).

- [2] **I. Mal**, D. P. Samajdar, T. D. Das, “Calculation of Band Structure and Optical Gain of Type-II GaSbBi/GaAs Quantum Wells Using 14- Band $k \cdot p$ Hamiltonian”, Superlattices Micro struct., 109, 442, (2017).
- [1] **I. Mal**, D. P. Samajdar, T. D. Das, “Effect of Sb and N resonant states on the band structure and carrier effective masses of GaAs $_{1-x-y}$ N $_x$ Sb $_y$ alloys and GaAs $_{1-x-y}$ N $_x$ Sb $_y$ /GaAs quantum wells calculated using $k \cdot p$ Hamiltonian” Superlattices Micro struct., 106, 20, (2017).

Book Chapters

- [4] **I. Mal**, D. P. Samajdar, “Investigation of the Optoelectronic Properties of InSbN $_x$ Bi with 16-band $k \cdot p$ Model”, Microelectronics, Circuits and Systems, Springer LNEE, vol. 755, 2021: pp. 245-251.
- [3] **I. Mal**, A. Hazra, D.P. Samajdar, T.D. Das, “Investigation of electronic and optical properties of GaSbBi/GaAs type-II quantum wells using 14-band $k \cdot p$ Hamiltonian”, in: Springer Proc. Phys., Springer Science and Business Media, LLC, 2019: pp. 1013–1020.
- [2] **I. Mal**, A. Hazra, D.P. Samajdar, T.D. Das, Computation of electronic and optical properties of GaAsNSb with 16 band $k \cdot p$ model, in: Springer Proc. Phys., Springer Science and Business Media, LLC, 2019: pp. 241–248.
- [1] A. Basu, A. Saha, J. Das, S. Roy, S. Mitra, **I. Mal**, S. K. Sarkar, “On the implementation of a digital watermarking based on phase congruency”, in: Springer Proc., 2014: pp. 113-120.

Conference Publications

- [12] C. Rajan, D. P. Samajdar, **I. Mal**, “First Principles Study of Structural and Optical Properties of InP and InP $_{1-x}$ N $_x$ ” Springer Proceedings in Materials, 15, 485–493, 2022.
- [13] N. Jain, **I. Mal**, D. P. Samajdar, N. Bagga, “Investigation of Optoelectronic Performance of InAsN $_x$ Bi for Infrared Detection”, Springer Proceedings in Materials, 15, 475–484, 2022.
- [11] **I. Mal**, and D. P. Samajdar, “A Study on the Consequence of Compressive and Tensile Strain on the Electronic Properties of InPN $_x$ Bi using multi-band $k \cdot p$ Hamiltonian”, Materials Today: Proceedings 2022.
- [10] S. Saurabh, **I. Mal**, S. Singh, and D. P. Samajdar, “A comparative analysis of silicon (Si) and indium phosphide nanostructure based solar cells”, Materials Today: Proceedings 2022.
- [9] S. Singh, **I. Mal**, D. P. Samajdar, and K. Dutta “Geometrical Optimization of Gallium Arsenide (GaAs) nanostructure based Solar Cells”, Materials Today: Proceedings 2022.
- [8] A. Tenwar, **I. Mal**, S. Singh, and D. P. Samajdar, “Anti-reflective nanostructures for Efficiency Improvement of GaAs based Solar Cells”, Materials Today: Proceedings 2022.
- [7] **I. Mal**, Neelesh Jain, and D. P. Samajdar, “Bandgap Tailoring of InAsBi for Long Wavelength Infrared Applications using Density Functional Theory”, Springer Proceedings in Materials 15, 513–519, 2022.
- [6] **I. Mal**, S. Singh, and D. P. Samajdar, “Design and Simulation of InAsBi PIN Photodetector for Long Wavelength Infrared Applications”, Materials Today: Proceedings 2022.
- [5] **I. Mal**, and D. P. Samajdar, “Effect of Dilute concentration of Bi on the Optoelectronic Properties of InAs for Long Wavelength Infrared Applications: A First Principles Analysis”, 63rd Electronic Materials Conference (EMC 2021), June 23rd-25th, 2021 (Presented).
- [4] **I. Mal**, D. P. Samajdar, “Origin of direct and indirect bandgap in B-X (X = Sb, Bi): A first principles study”, Materials Today: Proceedings, 2021.
- [3] **I. Mal**, D P samajdar, "Optoelectronic properties of InSbBiN: A 16 band $k \cdot p$ Model Study", IWPSD 2019, 17-20th December 2019 (Presented).
- [2] D. Roy, **I. Mal**, D. P. Samajdar, “Performance Analysis of CdTe based PV Array using Parameter Extraction Techniques”, IEEE EDKCON 2018, Kolkata, 24-25th December 2018.

[1] **I. Mal**, D.P. Samajdar, D. Roy, Hydrostatic Pressure Study of GaAsSbN/GaAs Quantum Well Based Optoelectronic Devices, IEEE EDKCON 2018, Kolkata, 24-25th December 2018.

REFERENCES

1. **Dr. Dip Prakash Samajdar**, Assistant Professor, PDPM Indian Institute of Information Technology Design and Manufacturing, Jabalpur e-mail: dipprakash010@gmail.com
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