Debarghya Mallick — Curriculum Vitae

Address of correspondence:
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Profile: Experienced condensed matter physicist with a strong background (7+ years) in electron beam lithography, optical lithography, nanodevice fabrication, working in clean-room environment, working with cryogen (liquid Helium, liquid Nitrogen), working with thin films, electrical measurements at high magnetic field and low temperature. Studied quantum physics with different emergent quantum materials and data analysis.

Education:

- Indian Institute of Science, Bangalore, India

  Doctor of Philosophy - Ph.D
  July, 2015 - October, 2020

  I have worked on the electrical transport properties of different topological materials. This project implements detailed knowledge of semiconductor, mesoscopic device physics and device fabrications skill sets, handling of cryogenic systems, cryogens and low temperature electrical measurements.

- Ramkrishna Mission Residential College, Narendrapur (Affiliated with University of Calcutta), Kolkata, India

  Masters of Science (In Physics)
  July, 2013 - June, 2015

  I learnt the theory and lab works related to fundamental and applied physics courses. Basic computer programming language Fortran, was taught.

- Serampore college (Affiliated to univeristy of Calcutta), Serampore, India

  Bachelor of Science (Majored in physics, Minor in Maths and Electronics)
  July, 2010 - April, 2013

I attended the courses learning the basics of physics, maths and electronics and computer programming language (Fortran).

Job experience :

- Oak Ridge National Lab, Oak ridge, TN, USA

  Post Doctoral Associate
  May, 2024 - Present

  As a part of quantum science centre at ORNL, I am Working on fabricating Josephson Junction using photolithography and focussed ion beam on a topological superconductor $FeTe_{0.5}Se_{0.5}$and measuring at low temperature in a Physical property measurement system (PPMS) (2K and 9T).

- Rutgers, the state university of New Jersey, NJ, USA.

  Post Doctoral Associate
  August, 2021 - Present

  During this time I set up the fabrication protocol and an optical lithography system (MJB3) in a cleanroom environment. I was also optimizing dry etching (Reactive ion etching) and wet etching recipes, for various oxide thin films such as, $PdCoO_2$, Cr_2O_3 and different topological materials and superconductors and their heterostructures, such as Bi2Te3/MnTe, supercondcutor FeTeSe/Bi2Te3, Nb etc and performing electrical measurements using a probe station (room temprature current-voltage measurements) or cryostat or Physical property measurement system (PPMS) (2K and 9T).

- Indian institute of science, Bangalore, India.

  Research Associate
  Nov, 2020- April, 2021

  As a research associate, I was working on device fabrications, involving exfoliation of topological insulator single crystals, followed by e-beam lithography, metal deposition and wire bonding and then followed by performing electrical measurements using an Oxford cryostat (2K and 8T).

Mentorship experience :

- Currently I am mentoring two undergrad students at Rutgers, for their research projects.

One of the students is working on understanding the topography of various thin films, such as MBE grown oxides and topological insulator thin films using Atomic Force Microscope (AFM).

The other student is involved in writing LabVIEW programs for current induced switching of magnetic moments of a heterostructure, consisting topological insulator and antiferromagnet.

Scholastic Achievements :

- Secured all India rank **12** in Graduate Aptitude Test for Engineering (GATE) (2015) (Physics, GATE score - 784).
- Secured all India rank **158** in Joint Entrance Screening Test (JEST) (2015) (Percentile - 96.58).
- Recipient of INSPIRE scholarship for five years (2010 - 2015), Department of Science & Technology, Govt. of India, New Delhi, India (for being in top 1% in both Secondary and Higher Secondary Examination).
- Recipient of *West Bengal Merit Cum Means Scholarship* for two years (2008-2010), Govt. of West Bengal, Kolkata, India.

Ph.D Thesis Title : Investigation of quantum interference and quantum oscillations in 3D topological insulators.
Thesis advisor : Prof. P S Anil Kumar
Institute : Indian Institute of Science, Bangalore.
Year of Submission : October, 2020.

Research Interest during PhD:

My research interest lies in growing single crystals and thin films of different topological materials. I investigate the electron dynamics in the quantum regime at low temperature (2 K), with high magnetic field (8 T) in nano devices and in thin films of topological materials. I mainly focus on the magnetotransport measurements exploiting different quantum mechanical phenomena of the electron waves.

Experimenatal Skills

- Sample preparation :
  - Designed and custom-make a dual-zone furnace for crystal growth.
  - Single Crystal Growth by Vertical Bridgman method and Chemical Vapour Transport method.
  - Thin Film deposition by Pulsed Laser Deposition (PLD) technique (Using Excimer Laser).

- Characterization :
  - Hands on experience on characterization techniques such as X ray diffraction (XRD), Atomic force microscopy (AFM), Raman spectroscopy.
  - Apart from these, I had exposure (moderately) to Scanning electron microscopy (SEM), Electron dispersive spectroscopy (EDS) and Electron probe micro analyser (EPMA).
- Device Fabrication processes :
  - Mechanical exfoliation.
  - Making heterostructure by dry transfer technique.
  - Optical lithography and Electron Beam Lithography (Extensive hands on experience).
  - Designing photomask for Optical lithography.
  - Have extensive experience of working in cleanroom (class 100).
  - Have experience of handling devices inside glovebox under Argon atmosphere (Oxygen level<0.1 ppm)
  - Dry etching (Reactive ion etching, Argon ion milling).
  - Wet etching
  - Focussed ion beam (Using Gallium, Xenon, Argon ion)
  - Magnetron sputtering
- Packaging :
  - Wire bonding technique (both ball and wedge bonding)(Hands on experience),
- Measurements :
  - Extensive experience of measurements in an Oxford cryostat (wet system, upto 2 K) aided with 8 T superconducting magnet (Hands on experience).
  - Have extensively used Physical Property Measurement System (PPMS) (upto 2 K and with 14 T magnet) (Hands on experience).
  - Data acquisition using Lock-in amplifier.
  - Have substantial experience of dealing with cryogen such as liquid Helium and liquid nitrogen; transfer of liquid Helium from dewar to cryostat (Hands on experience).
  - Measurement using Closed Cycle Refrigerator upto 5 K (Hands on experience).
  - Participated in setting up and optimizing Dilution Refrigerator (dry system, upto 30 mK).

Technical Skills

- Origin
- LabVIEW
- Microsoft power point, Microsoft word
- LaTeX
- Fortran
- ELPHY (Software for designing pattern for electron beam lithography),
- CleWin (Software for designing pattern for optical lithography)

Publications: My Google Scholar

1. **Debarghya Mallick**, Shoubhik Mandal, Yugandhar Bitla, R Ganesan and P S Anil Kumar, *Emergence of electron-phonon coupling in a dual topological insulator BiTe.*, Materials Research Express 6, 126321 (2019).
2. **Debarghya Mallick**, Shoubhik Mandal, R Ganesan and P S Anil Kumar, *Fermi level tuning and the robustness of topological surface states against impurity doping in Sn doped Sb2Te2Se.*, Applied Physics Letters 118 (15) (2021).
3. **Debarghya Mallick**, Shoubhik Mandal, R Ganesan and P S Anil Kumar, *Existence of electron - hole charge puddles and the observation of strong universal conductance fluctuations in a 3D topological insulator.*, Applied Physics Letters 119 (1) (2021).
4. Shoubhik Mandal, **Debarghya Mallick**, R Ganesan and P S Anil Kumar, *Bulk-surface coupling in dual topological insulator Bi1Te1 and Sb-doped Bi1Te1 single crystals via electron-phonon interaction.*, Journal of Physics: Condensed Matter 35 (28), 285001 (2023).
5. Shoubhik Mandal, **Debarghya Mallick**, R Ganesan and P S Anil Kumar, *Bulk-surface coupling in dual topological insulator Bi1Te1 and Sb-doped Bi1Te1 single crystals via electron-phonon interaction*, Physical Review B 107 (24), 245418 (2023).
6. J Stensberg, X Han, Z Ni, X Yao, X Yuan, **Debarghya Mallick**, A Gandhi, S Oh, L Wu, *Observation of terahertz second harmonic generation from surface states in the topological insulator BiSe*, arXiv:2301.05271 (2023).

Conferences and workshops attended :

- Presented poster on "SdH oscillation and non-trivial Berry Phase in Sn doped Sb_2Te_2Se" at "The international workshop on Advances in 2D Materials (IW2DM)" during 22-23rd July, 2019 at Indian Institute of Science Education & Research (IISER) Thiruvananthapuram, India.
- Presented poster on "SdH oscillation and non-trivial Berry Phase in Sn doped Sb_2Te_2Se" at "2nd annual conference on quantum condensed matter (QMAT)" during 8-10th July, 2019 at Indian Institute of Science (IISc) Bangalore, India.

Teaching Experience:

- Served as teaching assistant for the laboratory part of the undergraduate course UP201 (Thermal and Modern Physics) at Indian Institute of Science, Bangalore, India, Aug-Dec 2017.

References:

- Prof. Seongshik Oh
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    Rutgers, the state university of New Jersey, NJ- 08854, USA.
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- Prof. P S Anil Kumar (Ph.D. Thesis Advisor)
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    Indian Institute of Science, Bangalore-560012, India.
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- Prof. Gaurab Rimal
  - *Address*: Department of Physics,
    Western Michigan University, 1903 W Michigan Ave, Kalamazoo, MI 49008-5252 USA
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    Indian Institute of Science, Bangalore-560012, India.
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