Mr. Sumit Bera

Research Scholar, UGC-DAE Consortium for Scientific Research, DAVV Campus, Khandwa Road, Indore-452001, MP, India.
Email: sumitbera164@gmail.com
bera7874@gmail.com
Google Scholar
https://scholar.google.com/citations?user=rXXdRIIAAAAJ&hl=en
Researchgate
https://www.researchgate.net/profile/Sumit-Bera

1. Academic credentials

Name of the Degree/Course	Institution	Duration of the course	Title of the Project/research	Supervisor
Doctorate of Philosophy (Ph.D.)	UGC-DAE Consortium for Scientific Research, Indore, degree from Devi Ahilya Viswavidyalays, Indore 452001, MP, India	2015- Present, thesis submitted in July and waiting for defence viva)	Morphological and Physical Properties of Systems including materials of Topological interest	Dr. V. Ganesan (Supervisor, former center director of UGC DAE CSR, Indore) Dr. R. Venkatesh (Co-supervisor)
Ph.D. Course Work **(First class)**	Devi Ahilya Viswavidyalays, Indore 452001, MP, India	2015-2016	~	~
Post-graduation (M. Sc) **(First class)**	Vidyasagar University	2012-2014	Study of Antibacterial Effect of Cadmium Sulphide-Zinc Oxide (CdS-ZnO) & Silver Titanium Oxide ($AgTiO_2$)	Dr. Kuntal Chatterjee (Assistant professor, Vidyasagar University)
Graduation(B.Sc) **(First class)**	Vidyasagar University	2009-2012	Design and Fabrication of ± 12 V Regulated Power Supply to Study its Output Characteristics	Dr. Debasish Aich (Assistant professor)

2. Introduction and significance of my research work

Topological insulators are the newly discovered quantum materials that conduct through the surface or edges while the bulk of the materials show insulating behavior due to the presence of a finite band gap. The survival of the quantum states depends on the co-existence of strong spin-orbit interactions and time-reversal symmetry [1]. Having various exotic properties that are important in various fields such as spintronics, and quantum computation, topological insulators materials continue to fascinate researchers with unique perspectives [2]. In the early days, research in the topological insulators were performed in good crystalline samples only. But, development in theoretical research breaks the trend, and it is anticipated that topological surface state conduction is possible in nanomaterials as well as in amorphous systems [3,4]. Nanomaterials have gained prominence in technical applications deal of

interest owing to their tunable physical, chemical and biological properties with enhanced performance over their bulk counterparts [5]. High surface-to-volume ratio of the nanomaterials predicts the enhancement of surface state conduction as well as ultra-low thermal conductivity (κ) which leads to the high thermoelectric figure of merit (ZT) [5-8]. Similarly, there are certain materials called phase change materials which show high resistance at amorphous phase and low resistance at the crystalline phase, leading to application of in the phase change random access memory (PCRAM) in the future [9].

References

1. M. Z. Hasan and C. L. Kane, Rev. Mod. Phys. 82, 3045 (2010).
2. X.-L. Qi and S.-C. Zhang, Rev. Mod. Phys. 83, 1057 (2011)
3. G. Siroki, et al. Phys. Rev. Mater. 1, 024201 (2017).
4. A. Agarwala and V. B. Shenoy, Phys. Rev. Lett. 118, 236402 (2017).
5. H. J. Goldsmid, Thermoelectric Refrigeration (Plenum, New York, 1964)
6. S. Bera et al. Surf. Sci., 496,143654, (2019).
7. S. Bera et al. J.Supercond. Nov. Magn. 33.6, 1645-1651 (2020)
8. S. Bera et al. J. Appl. Phys 129, 194304 (2021)
9. Z. Min et al. g, J. Alloy. Compd. 509, 10105–10109 (2011)

3. Notable outcomes of my research work

1) Optimization of the synthesis of chalcogenide Bi_2Se_3, Bi_2Te_3, and Sb_2Te_3 topological insulator nanomaterials using microwave synthesis technique with some strategies including variation of morphologies, elemental doping, and defects engineering. In addition to this, we also grew Sb_2Te (phase change material) crystal using chemical vapour transport method.

2) The quantum transport phenomenon like electron-electron interaction, quantum interference, and their variation with temperature and magnetic field were investigated.

3) We analyzed the quantum interference effect by 2D HLN fit to the low field magnetoconductivity revealing the temperature variation of phase coherence length which specifies the nature of the conduction (2D or 3D).

4) The origin of low temperature resistivity upturn, negative magnetoresistance (Sb_2Te_3 and Bi_2Te_3), and positive linear magnetoresistance (Bi_2Se_3) were deeply explored in our research.

5) The thermoelectric power and heat capacity measurement of the nanomaterials were performed to correlates the phenomenon that occurred in resistivity measurements of the materials.

6) Infrared-spectroscopy measurement was employed to obtain optical band gap energy (E_g), and how E_g varies with the variation of particle size of the nanostructures.

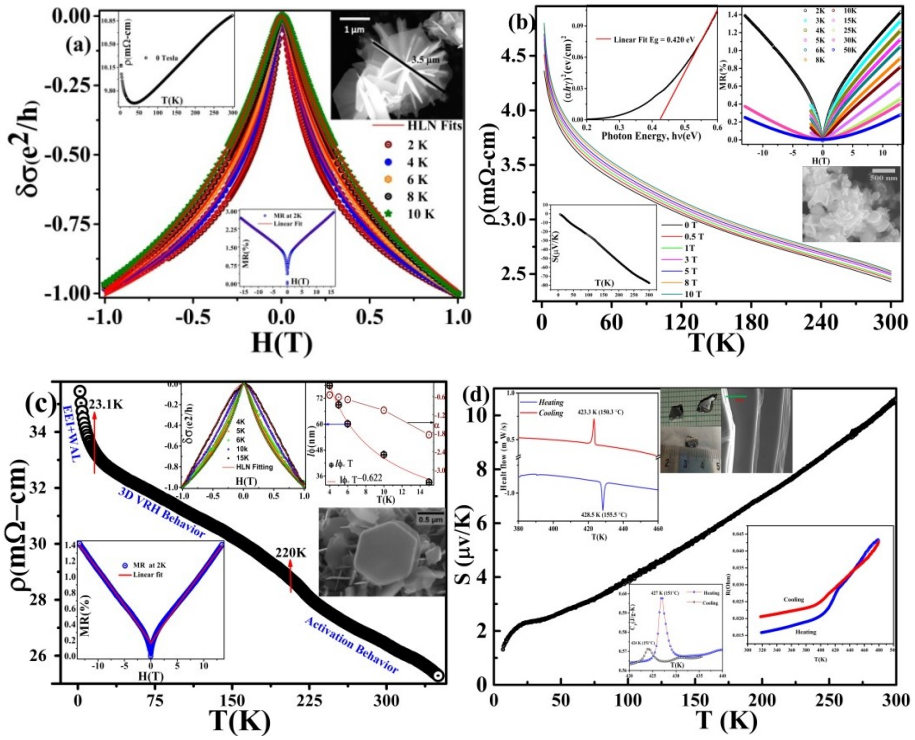

Fig. 1: (a-d), Brief diagrams of magnetotransport, morphology, thermoelelctric properties of (a) Bi_2Se_3, (b) Bi_2Te_3, (c) Sb_2Te_3, and (d) Sb_2Te respectively.

4. Research Skills

Material synthesis:

Synthesis of chalcogenide nanostructures (Bi_2Se_3, Bi_2Te_3, $Bi_{1-x}Co_xTe_3$, Sb_2Te_3, $Sb_{1-x}Co_xTe_3$) with different morphologies, selenium and tellurium nano-wires using microwave solvothermal synthesis technique. Sb_2Te Single crystal growth experience by using 3-zone furnace (using chemical vapour transport method). Worked together with lab-mate for the preparation by arc melting ($ZrTe_5$) (water-cooled copper earth, argon gas environment), or/and solid-state reaction ($TiSe_2$) techniques. In the post-Ph.D. position I have been learning growth of two-dimensional quantum materials using chemical vapour deposition technique.

Instrumentation skills:

(1) Operation of Physical Property Measurement System (**PPMS**) equipped with Dilution Refrigerator (DR) for heat capacity and electrical resistivity measurements in temperature 50 mK- 400 K and fields upto ± 16 T, PPMS.

(2) Nanomaterial preparation by microwave assisted solvothermal synthesis technique.

(3) Sample preparation by arc melting machine (water-cooled copper earth, Argon gas environment), or/and solid-state reaction techniques.

(4) Single crystal growth experience by using 3-zone furnace (using chemical vapour transport method) and optical floating zone furnace.

(5) h-BN and TMDS furnace operation for CVD growth

(6) Handling experience of **FEI Nova Nano FESEM** 450 (1.4 nm- 40 kV). Handling experience of **Bruker, Bio-AFM**.

Software Skills: Fullprof Suite for Rietveld refinements, Image J for FESEM data analysis, WSxM for AFM data analysis, Origin and Matlab.

5. List of Publications (Total 17)

(a) Papers published in journals (total 7)

1. Weak antilocalization in Sb_2Te_3 nano-crystalline topological insulator, Sumit Bera, P. Behera, A.K. Mishra, M. Krishnan, M.M. Patidar, R. Venkatesh, V. Ganesan. *Appl. Surf. Sci. 496, 143654 (2019).*

2. Magnetotransport and thermal properties of microwave synthesized nanostructured Bi_2Te_3, P. Behera, R. Venkatesh, V. Ganesan. *J. Appl. Phys 129, 194304 (2021).*

3. Survival of Topological Surface States in Cobalt doped Sb_2Te_3, Sumit Bera, P. Behera, A.K. Mishra, M. Krishnan, M.M. Patidar, R. Venkatesh, V. Ganesan. *J Supercond Nov Magn 33:1645–1651 1647 (2020).*

4. Magnetotransport and thermoelectric properties of Cobalt doped Bi_2Te_3 nanostructures, Sumit Bera, Prakash Behera, V Ganesan and R Vekatesh, *Mater. Lett 309,* 131389, (2021).

5. Transport properties of a modified CDW insulator Co_x:$TiSe_2$. Behera, Prakash, Sumit Bera, M. M. Patidar, A. K. Mishra, M. Krishnan, R. Venkatesh, U. P. Deshpande, M. Gangrade, and V. Ganesan. *Physica B: 540,412145 (2020).*

6. Transport and thermal properties of polycrystalline $ZrTe_5$ P. Behera., Patidar, M. M. Sumit Bera., Deshpande, U. P., Venkatesh, R., & Ganesan, V. *J. Appl. Phys, 127(23), 235110 (2020).*

7. Correlation Between Magnetic Ordering and Crossover from Weak Anti-Localization (WAL) to Weak Localization (WL) in Cobalt-and Manganese-Doped $Bi_{0.94}Sb_{0.06}$ Topological Insulator Nanoparticles.Afzal, Hasan, Sumit Bera, A. K. Mishra, M. Krishnan, Manju Mishra Patidar, R. Venkatesh, and V. Ganesan. *J. Supercon Nov Magn 33, 1645-1651 (2019).*

(b) Papers published in Conferences (total 10)

1. Magnetoresistance behavior in nano-bulk assembled Bi_2Se_3 topological insulator; Sumit Bera, P. Behera, A. K. Mishra, M. Krishnan, Manju Mishra Patidar, Durgesh Singh, R. Venkatesh, D. M. Phase, and V. Ganesan; *AIP Conf. Proc. 1953,1, 030122 (2018).*

2. Morphological evolution of Bi_2Se_3 nano-crystalline materials synthesized by microwave assisted solvo-thermal method; Sumit Bera, P. Behera, A. K. Mishra, M. Krishnan, M. M. Patidar, D. Singh, M. Gangrade, R. Venkatesh, U. P. Deshpande, D. M. Phase, and V. Ganesan. *AIP Conf. Proc. 1942, 050098-1–050098-4 (2018).*

3. Possible evidence for topological surface states in nanocrystalline Bi_2Te_3; Sumit Bera, P. Behera, A. K. Mishra, M. Krishnan, M. Gangrade, U. P. Deshpande, R. Venkatesh, and V. Ganesan; *AIP Conference Proceedings 2115, 030144 (2019.*

4. Magnetic field induced enhancement of resistance in polycrystalline $ZrTe_5$; Prakash Behera, Sumit Bera, Manju Mishra Patidar, Durgesh Singh, A. K. Mishra, Krishnan M., M. Gangrade, U. P. Deshpande, R. Venkatesh, and V. Ganesan; AIP Conf. Proc. 1942 (2018) 110041.

5. CDW transition in Fe intercalated $TiSe_2$; P. Behera, Sumit Bera, M. M. Patidar, and V. Ganesan; *AIP Conf. Proc. 2100, 020113 (2019).*

6. Signatures of trivial to topological phase transition in Bi_{1-x} Sb_x nanocrystals synthesized by microwave assisted solvothermal method. Afzal, Hasan, Sumit Bera, A. K. Mishra, M. Krishnan, U. P. Deshpande, R. Venkatesh, and V. Ganesan. *AIP Conf. Proc, 2115, 1030161. (2019).*

7. Influence of sulphur doping in Sn Senanoflakes prepared by microwave assisted solvothermal synthesis. Satyendra Singh, Sumit Bera, Hasan Afzal, Vinay Kaushik, M. M. Patidar, and R. Venkatesh. *AIP Conf. Proc 2100, 020108 (2019).*

8. One pot facile synthesis of selenium nanostructures by microwave assisted solvothermal process. Sushil Kumar, Satyendra Singh, Sumit Bera, Vinay Kaushik, Hasan Afzal, and R. Venkatesh. *AIP Conf. Proc 2100, 020120 (2019).*

9. Effect of cobalt doping on Bi_{1-x} Sb_x nano particles. Afzal, Hasan, Sumit Bera, A. K. Mishra, Vinay Kaushik, and R. Venkatesh. *AIP Conf. Proc, 2100, 1,020127 (2019).*

10. Facile and fast, microwave assisted solvothermal synthesis of Sb_2Se_3 nanostructures for thermoelectric applications. S Kumar, *Sumit Bera*, V Kaushik, S Singh, M Krishnan, *AIP Conf. Proc ,2265.1.(2020)*

(c) Papers Communicated:

1. Quantum Interference Effects in Bi_2Se_3 nanostructured bulk materials, Communicated in nanotechnology (IOP),

2. Growth and Thermal Properties of Sb_2Te Crystal, communicated in materials characterization

6. International and National Conference/Workshops Attended

1. Participation and poster presentation in **DAE Solid State Symposium** national conference during Dec 26-30, 2017 held in BARC Mumbai.
2. Participation in **ICC -2017** International Conference, Bikaner, Rajasthan.
3. Participation and poster presentation in **ICMAGMA-2018** during 28th -30th Jan –2019 organized by SRM University, Chennai.
4. Participation and poster presentation in **DAE Solid State Symposium** national conference during Dec 22-30, 2018 held in Hisar, Haryana.
5. Participation in Workshop and **Annual Day Celebration** of UGC-DAE Consortium for Scientific Research in Jan-2019 Indore MP India.
6. Participation in **CSR lectures series** on Magnetism during August 27-31, 2018 at UGC-DAE Consortium for Scientific Research Indore MP India.
7. Participation and oral presentation in **ICONN-2021** during 1th -3th Feb –2021 organized by NISER Bhubaneswar.

7. Qualified Examinations in National Level

1. **JAM** 2012: Rank: AIR **296**
2. **JEST**2015: AIR **83**

8. Additional Interests and Activities

Love to play Tabla, Playing Football , Cooking New Dishes, Fitness and running.

REFERENCES

Dr. V. Ganesan Former centre director, UGC-DAE CSR, Indore-452001, Presently Vellore Institute of Technology, Kotri Kalan, Ashta, Near, Indore Road, Bhopal, Madhya Pradesh- 466114, India Email: vganesancsr1@gmail.com.	**Dr. R. Venkatesh** Scientist-E, UGC-DAE CSR University Campus, Khandwa Road, Indore-452001, India Email: rvenkatesh@csr.res.in Fax: 0731-2465437

DECLARATION

I hereby declare that the details stated above are true and correct to the best of my knowledge.

Sumit Bera