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Department of Physics
Dayananda Sagar University

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Item	Details
Faculty Name:	Dr. Manasa R Shankar
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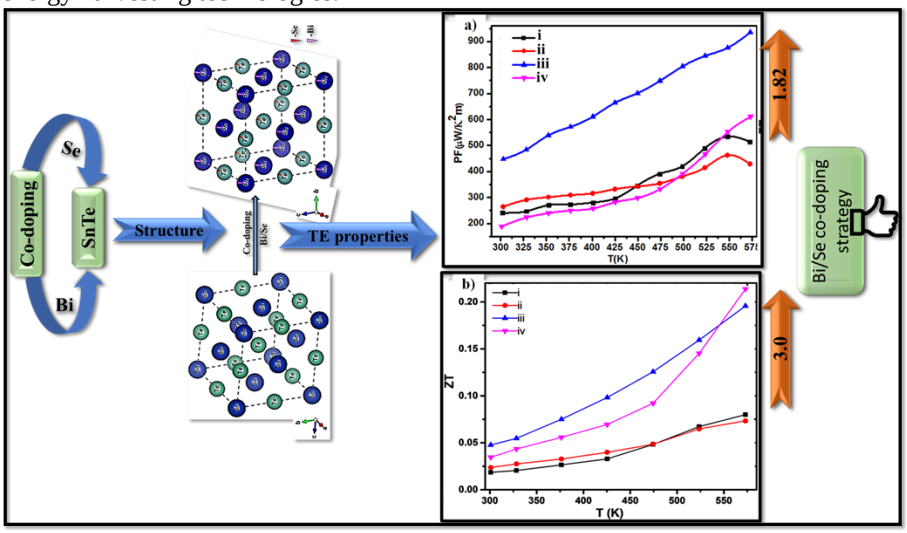
Research Area:	Thermoelectrics (Bulk and flexible Thermoelectric generators, screen printing)
Publications (Past 5 years)	1. **M.R. Shankar,** A.N. Prabhu, A review on structural characteristics and thermoelectric properties of mid-temperature range Chalcogenide-based thermoelectric materials, J Mater Sci, 2023,58:16591– 16633. https://doi.org/10.1007/s10853-023-09028-8. (Q1) 2. **M.R. Shankar,** A.N. Prabhu, A.M. Ashok, N. Davis, B. Srinivasan, V. Mishra, Role of Bi/Te co- dopants on the thermoelectric properties of SnSe polycrystals: an experimental and theoretical investigation, J Mater Sci 59 (2024) 13055–13077. https://doi.org/10.1007/s10853-024-09984-9. (Q1) 3. **M.R. Shankar,** A.N. Prabhu, A. Rao, U.D. Shanubhogue, B. Srinivasan, Potential improvement in thermoelectric properties of SnTe polycrystals via anionic and cationic substitution, Ceram Int 50 (2024) 46869–46881. https://doi.org/10.1016/j.ceramint.2024.09.037. (Q1) 4**. M.R. Shankar,** A.N. Prabhu, T. Srivastava, Materials Advances Bismuth and tellurium co-doping : a route to improve thermoelectric efficiency in, RSC Material Advances (2024) 9823–9837. https://doi.org/10.1039/d4ma01011f. (Q1) 5. **M.R. Shankar,** A.N. Prabhu, R. Nayak, M. Saquib, Optimization of thermoelectric parameters in Ag/MnO_2 nanocomposite-based flexible thermoelectric generators, Ceram Int (2025). https://doi.org/10.1016/j.ceramint.2025.01.035. (Q1) 6. **M.R. Shankar,** A.N. Prabhu, A. Rao, P. G, J. Kasthuri, Reducing thermal conductivity in Bi-Se co- doped InTe for next-generation thermoelectric materials, Materials Science and Engineering: B 321 (2025) 118465. https://doi.org/10.1016/j.mseb.2025.118465. (Q1) 7. **M.R. Shankar,** A.N. Prabhu, A co-doping strategy for p- to n-type transition and performance boost in SnSe-based flexible thermoelectric generators, RSC Sustainable Energy and Fuels, (2025). https://doi.org/10.1039/d5se00175g. (Q1) 8. **M.R. Shankar**, A.N. Prabhu, R. Nayak, Flexible and eco-friendly thermoelectric generators enabled by Bi and Se co-doped SnTe inks for energy harvesting, Ceramic International, (2025). https://doi.org/10.1016/j.ceramint.2025.10.117. (Q1) 9. **M.R. Shankar,** P.A. Yoshitha, A.N. Prabhu, R. Nayak, A. Rao, G. Poojitha, Fabrication and characterisation of a flexible thermoelectric generator using PANI/graphite/bismuth telluride composites, RSC Adv 14 (2024) 40117–40132. https://doi.org/10.1039/d4ra04565c. (Q1) 10. Apurva Sharma, Ramakrishna Nayak, Prakasha Shetty, Lakshmikanth M, Mohammad Saquib, Selvakumar M, **Manasa R. Shankar,** Cu3Se2/graphite (p-type) and β-MnO2 (n-type)-based screen-printed flexible thermoelectric generator: Improved power factor through compositional tuning of graphite, Ceramic international, 51 (2025), https://doi.org/10.1016/j.ceramint.2025.02.412. (Q1) 11. Manasa R Shankar, A.N. Prabhu, Ramakrishna Nayak, "Enhancing the Power Output of InSe-Based Screen-Printed Flexible Thermoelectric Generators through a Bi-Te-Co-Doping Strategy," ACS Omega, (2025) https://doi.org/10.1021/acsomega.5c09692. (Q1)

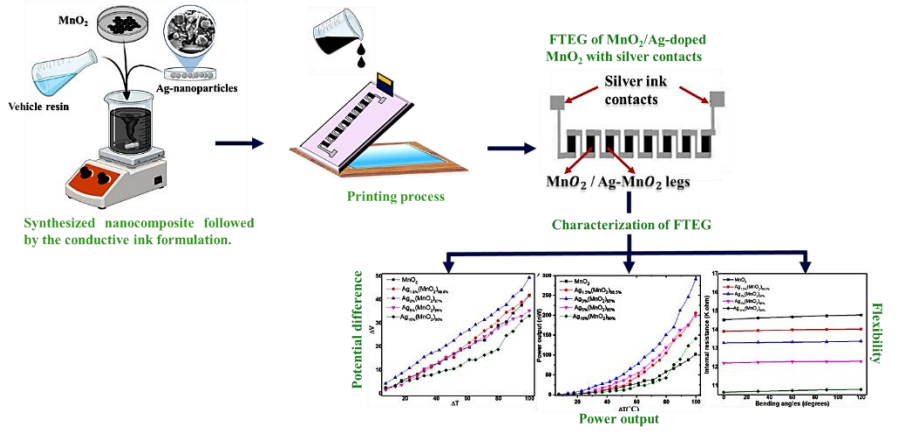
	12. **Manasa R Shankar**, A.N. Prabhu, Ramakrishna Nayak," Unveiling InTe for Flexible Thermoelectric Applications with Enhanced Performance via Bi/Se Co-Doping and MnO_2 Integration", Journal of Scientific Reports (2026) (16) 5597, https://doi.org/10.1038/s41598-026-35782-1. (Q1) 13. Mohammad Saquib, Shilpa Shetty, **Manasa R. Shankar**, A. N. Prabhu, Ramakrishna Nayak, M. S. Santosh and M. Selvakumar, "A multifunctional flexible SnTe/MWCNT crystalline hybrid for energy storage and humidity sensing with 3D-printed device integration", Journal of material chemistry A (2026), https://doi.org/10.1039/D5TA10103D. (Q1) 14. Sidharth S Rao, **Manasa R Shankar**, G Poojitha, AN Prabhu, Ashok Rao, Pramoda Kumara Shetty, "Impact of neutron irradiation on structural stability and thermoelectric properties of Sb2Te3", Journal of Materials Science: Materials in Electronics (2026), https://doi.org/10.1007/s10854-026-17692-0. **(Q2)**
Sponsored Projects (Past and Ongoing)	
Profile Links : Scopus and Orcid	https://scholar.google.com/citations?hl=en&user=jd-xmYAAAAAJ **Scopus ID:** 58679456600 **Orcid:** 0009-0003-1765-1221

Research Activities (Write about your best research results max of 2-3 pages including diagrams)	My research focuses on the design and development of high-performance thermoelectric materials and flexible thermoelectric generators (FTEGs) for sustainable energy harvesting. My work integrates material synthesis, carrier engineering, thermoelectric property optimisation, and scalable device fabrication. I began my research with SnSe, the successful conversion of p-type SnSe into n-type material through simultaneous substitution of Bi at the Sn site and Te at the Se site. Achieving stable n-type SnSe has remained a major challenge due to its intrinsic p-type nature. By carefully optimizing the Bi and Te concentrations, I successfully modified the carrier concentration and electronic band structure, resulting in stable n-type conduction. The co-doped samples exhibited enhanced electrical conductivity while maintaining a high Seebeck coefficient and low thermal conductivity. The optimized composition demonstrated significantly improved thermoelectric performance compared with pristine SnSe, confirming that simultaneous cationic and anionic substitution is an effective strategy for carrier polarity switching. This work provides an environmentally friendly alternative to conventional lead-based thermoelectric materials and contributes toward the realization of all-SnSe thermoelectric modules. Building on this work, I explored Bi and Te co-doping in InSe, where controlled cationic and anionic substitution improved the electrical conductivity, optimised the carrier concentration, and reduced lattice thermal conductivity through enhanced phonon scattering. These combined effects resulted in improved thermoelectric performance. To further understand low thermal conductivity chalcogenides, I investigated InTe, focusing on its crystal structure, transport properties, and carrier engineering. This work provided insights into the mechanisms governing electrical and thermal transport in mixed-valence Zintl thermoelectric materials and established strategies for further performance enhancement. I subsequently extended my research to SnTe, where co-doping and defect engineering were employed to improve its thermoelectric properties. Through optimised compositional tuning, significant improvements in the Seebeck coefficient, electrical transport, and overall thermoelectric performance were achieved, providing an environmentally friendly alternative to conventional lead-based thermoelectric materials.

To translate these materials into practical applications, I developed flexible thermoelectric generators (FTEGs) using a simple, low-cost, and scalable screen-printing technique. Printed devices based on optimised p-type and n-type thermoelectric materials demonstrated stable electrical output under applied temperature gradients while maintaining excellent mechanical flexibility.

As part of this effort, I also demonstrated the first screen-printed Ag–MnO_2 composite flexible thermoelectric generator, where Ag incorporation significantly improved electrical conductivity. The optimised 3 wt% Ag–MnO_2 device delivered a maximum output power of approximately 292 nW at $\Delta T = 100°C$, highlighting the potential of printable oxide thermoelectrics for wearable energy harvesting applications.
Overall, my research has established effective strategies for carrier polarity conversion, thermoelectric property enhancement through co-doping, and scalable fabrication of flexible thermoelectric generators, contributing to the development of next-generation energy harvesting technologies.





Collaborations	Dr. Ashwath Narayan Prabhu, Associate Professor, MAHE, Manipal Dr. Bhuvanesh Srinivasan, Assistant Professor, IIT Madras Prof. Anuradha M Ashok, Head of the Physics department, PSG Institute of advanced studies, Tamil Nadu Dr. Ramakrishna Nayak, Associate Professor, MAHE, Manipal Prof. Ashok Rao, MAHE, Manipal Dr. Ganesh Shreedhar Hegde, Assistant Professor, REVA, Bangalore
Invited Talks	
Group Members (PhD Students and Projects) Open Positions: If any	