Avishek Sarbajna

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Google Scholar

Education

Program	Institution	Grades	Year
Visiting researcher	Stanford University, USA		02 to 06, 2024
Doctorate in Physics	Danmarks Tekniske Universitet, Denmark		Since 03-2022
Master of Science in Optics and Photonics	Karlsruher Institut für Technologie, Germany	1.8	2019-21
Bachelor of Technology in Electrical Engineering	MAKAUT (West Bengal State University), India	8.2	2012-16

• Expected PhD completion date: 27-May-2025

Research Interests

Nanophotonics **Optoelectronics** **Excitonic systems** **VdW materials**

Research Experiences

PhD thesis: Light-matter interaction in excitonic layered materials
Applied Nano-optics group, Department of Physics, DTU
Supervisors: Prof. Søren Raza, Prof. Nicolas Leitherer-Stenger and Prof. Peter Bøggild

PhD - Primary Projects

1. **Impact of Strong Coupling on Optoelectronic Properties of Ultra-Thin Lossy Excitonic Systems** (manuscript in preparation)
   Visiting Researcher (Feb–Jun 2022), Geballe Laboratory for Advanced Materials, Stanford University
   Supervisor: Prof. Dr. Mark L. Brongersma.
   - Conducted detailed **wavelength-resolved photocurrent measurements** to determine the **External Quantum Efficiency (EQE)** of ultra-thin excitonic materials.
   - Investigated the influence of strong light–matter coupling on optoelectronic properties, correlating far-field optical signatures with photocurrent responses.

   Key Findings:
   - Demonstrated that Rabi-like splitting observed in reflectance does not necessarily imply true strong coupling or polariton formation in lossy systems.
   - Showed tunability of the coupled system by manipulating the phase of the optical resonance without changing the physical cavity length.
2. **Encapsulated Void Resonators in van der Waals Heterostructures** (published)
   - Fabricated nanoscale air-void arrays and assembled hBN-encapsulated heterostructure devices.
   - Performed bright-field reflectance measurements for optical characterization of the resonator structures.

   Key Findings:
   - Successfully confined and tuned optical resonances from the visible to blue-violet spectral range using nano-voids, overcoming classical limitations due to material loss at shorter wavelengths.
3. **Void Resonators for Highly Directional Light Emission from Monolayer WS_2** (manuscript in preparation)
   - Fabricated monolayer WS_2-on-void heterostructure devices based on nano-void arrays.
   - Performed bright-field reflectance and photoluminescence measurements to study emission behavior.

   Key Findings:
   - By exploiting dielectric void resonators, our monolayer-on-void device could achieve up to 3500-fold photoluminescence enhancement in monolayer WS_2.

PhD – Other Projects

4. **Computational Discovery of High-Refractive-Index van der Waals Materials** (archived)
   - Developed a reactive ion etching (RIE) process to nanostructure HfS_2 into nano-disk arrays for optical resonator applications.

- Contributed to dark-field scattering and bright-field reflectance measurements on nanostructured and thin-film HfS_2 samples.

Key Findings:

- Identified HfS_2 as a promising low-loss, high-index optical material in the visible spectrum, and demonstrated its potential for efficient Mie-resonant nanophotonics.

5. **Fourier-Tailored Light–Matter Coupling in van der Waals Heterostructures** (archived)
   - Assisted in the fabrication of layered hBN/WS_2 devices integrated with Fourier surfaces.
   - Conducted reflectance spectroscopy to study the tailored light–matter interaction within the heterostructures.

   Key Findings:
   - Demonstrated that Fourier surface patterning enables engineering of the coupling between light and excitonic states in van der Waals heterostructures.

M.Sc.-projects and internships

6. **Study of self-decoupled isolated nNDI molecules as an electron-driven quantum light source**
   Master's thesis project (May-Oct 2021), Institute for Quantum Materials and Technologies, KIT.
   Supervisors: Prof. Dr. Wulf Wulfhekel and Prof. Dr. David Hunger
   - Helped to optimise the **Hanbury Brown and Twiss set-up** to increase photon collection efficiency.
   - Handled liquid Helium **cryostat**.
   - Performed **spectral analysis** of the collected light to appreciate different electron transitions.

   Key findings:
   - Observed electroluminescence and electronically driven quantum light source from a self-decoupled system.

7. **Printed thermoelectric devices**
   Research assistant (40 hours/month, Nov 2020 - Oct 2021) and Intern (Nov 2021-Feb 2022), Light Technology Institute, KIT
   Supervisors: Prof. Dr. Uli Lemmer and Dr. Mofasser Mallick
   - Helped to **synthesize and characterize** (Seebeck coefficient by a homemade set-up and electrical conductivity by hall measurement) novel thermoelectric ink.
   - Fabricated screen printed **flexible thermoelectric devices**.
   - Helped **optimizing the photonic sintering process** to improve the performance and flexibility of the printed devices.

   Key findings:
   - Developed an ultra flexible thermoelectric ink for flexible electronic applications.
   - Wrote a review article on printed thermoelectric devices.

8. **Assembling of a cryostat system and temperature-dependent optical measurements of Perovskite semiconductors**
   Intern (Aug-Oct,2020), Light Technology Institute, KIT
   Supervisor: Prof. Dr. Uli Lemmer
   - **Assembled a cryostat system** for a time-correlated single photon counting setup.
   - Performed **temperature-dependent steady-state and time-resolved photoluminescence** (TRPL) of perovskite films in a cryogenic environment.

9. **X-ray diffraction on nanoparticles**
   Research assistant (40 hours/month, Feb 2020 - Apr 2021), Institut für Funktionelle Grenzflächen, KIT
   Supervisor: Prof. Dr. Kristen Kozielski
   - Deviced and performed **X-Ray Diffraction on Cobalt Iron Oxide NPs** in the presence of varying magnetic fields to find out the effect of the magnetic field on the length change of the NPs.
   - **Characterized magnetostrictive materials** by the vibrating-sample magnetometer.

10. **Others**
    - **Teaching assistant** in Solid State Physics course (10 ECTS, 130 hours).
    - **Supervision** Two students for bachelor thesis, helping them optically characterize Hafnium disulfide nano-disks as a novel optical material.
    - **Developer** at Tata Consultancy Services, India from Oct 2016-Sep 2019.

Publications

7. **Sarbajna A**, Li Q, Danielsen D R, Selvin S P, Nguyen D H, Doan M-H, Bøggild P, Brongersma M L, Raza S. Apparent resonance splitting in self-coupled excitonic systems. (manuscript in preparation).

6. Zambrana-Puyalto X, Svendsen M K, Søndersted A H, **Sarbajna A**, Sandberg J P, Riber A L, Ermolaev G, Volkov V S, Thygesen K S, Raza S. Computational discovery of high-refractive-index van der Waals materials: The case of HfS_2. arXiv:2502.09144.
5. Danielsen D R, Lassaline N, Linde S J, Nielsen M V, Zambrana-Puyalto X, **Sarbajna A**, Nguyen D H, Booth T J, Stenger N, Raza S. Fourier-Tailored Light–Matter Coupling in van der Waals Heterostructures. arXiv:2502.02114v1.
4. **Sarbajna A**, Danielsen D R, Casses L N, Stenger N, Bøggild P, Raza S. Inorganic-Based Printed Thermoelectric Materials and Devices Encapsulated Void Resonators in Lossy Dielectric van der Waals Heterostructures. Laser Photonics Rev 2025, 19, 2401215.
3. **Sarbajna A**, Rösch A, Franke L, Lemmer U, Mallick M. Inorganic-Based Printed Thermoelectric Materials and Devices. Adv. Eng. Mater. 2022, 2200980.
2. Mallick M, **Sarbajna A**, Rösch A, Franke L, Gesswein H, Eggeler Y, Lemmer U. Ultra-flexible β-Cu_2Se-based p-type printed thermoelectric films. Appl. Mater. Today, p. 101269, 2021.
1. Kumari P, Fossati A, Gopinath P, **Sarbajna A**, Kozielski K L. Analysis of Nonresonant Powering of Magnetoelectric Nanoparticles for Deep Brain Stimulation in Mice. 10th Annual IEEE EMBS Conference on Neural Engineering, 2021.

Conferences

- **Stanford University Photonics Retreat (SUPR):** The annual event hosted by the Stanford Optical Society, 26-28 April 2024, Stanford University, USA (poster presentation).
- **Metamaterials:** The 17th International Congress on Artificial Materials for Novel Wave Phenomena, 11-16 Sep 2023, Crete, Greece (poster presentation).
- **NANOSUM:** International summer school on nanoscience and nanotechnology, 13-25 Jun 2022, France (poster presentation).

Expertise

- **Fabrication:** Electron-beam lithography, reactive ion etching, different positive and negative electron resists, exfoliation, stacking to device heterostructures.
- **Charactarization:** Bright- and dark-field spectroscopy, photocurrent measurement, HBT interferometry and photoluminescence measurement for optical characterization; Hall measurement and STM for electronic characterization; AFM, SEM and profilometry for topological characterization; cryostat and lasers for different purposes.
- **Simulation and data processing:** COMSOL, MATLAB, C++, Origin.

Achievements And Extra-Curricular

- **Grants**: Otto Mønsteds Fond (2024), William Demant Foundation (2024), Merit -Cum-Means Scholarship by West Bengle state government (2012-2016).
- Best poster award at Stanford University Photonics Retreat conference.
- Ranked 3558 among around 120 thousand students in the Engineering entrance examination (WBJEE-2012).
- Member of DTU Physics PhD committee since Jan 2023.
- Participated in International Astronomical Search Collaboration Campaigns in collaboration with NASA. Our team discovered a near-earth asteroid.
- Member of Oskar-Optics Students Karlsruhe (SPIE and OSA student chapters of Karlsruhe Institute of Technology).

References

- Søren Raza, Associate Professor, Department of Physics, Technical University of Denmark.
- Nicolas Stenger, Associate Professor, Department of Electrical and Photonics Engineering, Technical University of Denmark.
- Peter Bøggild, Professor, Department of Physics, Technical University of Denmark.
- Kristen Kozielski, Assistant Professor, Neuroengineering Materials, Technical University of Munich.