

Lawrence Berkeley National Lab
Material Science Division

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Professional Preparation

July 2022- Present	Lawrence Berkeley National Lab (U.S.A) Advisor: Prof. Gerbrand Ceder.	Postdoctoral Scholar
Aug 2018 – Apr 2022	National University of Singapore (Singapore) Singapore-MIT Alliance for Research and Technology Advisors: Profs. Canepa, Pennycook & Gradečak	Ph.D. Material Science and Engineering CAP: 5.0/5.0
2014-2018	Indian Institute of Science (India)	B.Sc., Research CAP: 7.2/8.0
May 2017- August 2017	National University of Singapore (NUS) Advisor: Prof. Stephen Pennycook	Summer Internship
May 2016- August 2016	Japan Advanced Institute of Science and Technology (JAIST) Advisor: Prof. Yoshifumi Oshima	Summer Internship

Areas of Interest

1. Development of new microscopy techniques for material characterization at the nanoscale.
2. Automation of experimental characterization and sample preparation techniques for self-driving electron microscopy laboratories.

Research Experience

1. Postdoctoral Experience

- ▷ Characterized and developed of partially disordered spinel phases in the disordered rocksalt type cathode materials for all solid state batteries through electron microscopy techniques (atomic-resolution HAADF, 4D-STEM, EELS, and EDS).
- ▷ Analyzed the degradation mechanisms of solid-state Li-air batteries cathodes with the help of electron microscopy techniques.
- ▷ Automated electron microscopy and material characterization sample prep for self-driving labs.
- ▷ Developed feature in py4DSTEM package for automated multiphase detection technique from 4DSTEM data set.

2. Doctor of Philosophy

- ▷ Decoded the origin of the compositional fluctuations in InGaN light emitting diodes (LEDs) using atomic resolved electron energy loss spectroscopy.

- ▷ Developed a multiscale computational modeling approach to understand the compositional fluctuations in InGaN LEDs of varying In content.
- ▷ Developed an alternative pathway for manufacturing higher In-content defect-free InGaN LEDs through strain engineering.
- ▷ Fundamental investigations on the sodium-ion transport in NaSICON superconductors.
- ▷ Developed an all python kinetic Monte Carlo software package to model ionic transport.

3. Bachelor of Science

- ▷ Three Dimensional Structure Reconstruction from Scanning Transmission Electron Micrographs. (**Advisor:** Prof. N Ravishankar, IISc, Bangalore, India).

4. Internship Experience

- ▷ Developed a MATLAB-based image processing software at the National University of Singapore to detect the atomic displacement of cations in thermoelectric materials.
- ▷ Using the aberration-corrected scanning transmission electron microscope at Japan Advanced Institute of Science and Technology (JAIST) detected the anisotropic thermal vibrations of Cu atoms in Tetrahedrite (a high efficiency thermoelectric material).

Honours & Awards

May 2018	Institute Gold Medal for best performance in materials B.Sc. (Research), IISc Bangalore.
April 2018	Singapore-MIT Alliance for Technology and Research (SMART) fellowship. Fellowship to pursue Ph.D. under supervision of Professors from NUS and MIT.
August 2017	Most Promising Young Researcher in Materials Students Symposium, IISc Bangalore.
May 2016	JASSO (Japan Student Services Organization) scholarship for summer internship at Japan Advanced Institute of Science and Technology (JAIST)
March 2014	University Entrance Exam (KVPY) All India Rank: 105
April 2012	Chief Minister Award for State Level Mathematics Olympiad

Skills

- ▷ Quantitative material characterization using scanning transmission electron microscopy (STEM) imaging and spectroscopy techniques.
- ▷ Materials modeling using first-principles, molecular dynamics, and Monte Carlo methods.
- ▷ Image and signal processing toolkit development for quantitative information extraction from the electron microscopy measurements.
- ▷ Transmission electron microscopy sample preparation of battery and semiconductor materials using focused ion beam (FIB), polishing, and drop casting.
- ▷ Proficient in programming languages such as Python, C++, C, and MATLAB.

- ▷ Experienced in materials simulation packages such as VASP, LAMMPS, Pymatgen, CRYSTAL, and CASM.
- ▷ Experienced in electron microscopy simulation and data analysis packages such as abTEM, py4DSTEM, and Hyperspy.
- ▷ Maintenance and usage of linux based high-performance computing cluster (HPC).
- ▷ Experienced in characterization techniques such as Optical characterization (Profilometry and Ellipsometry) and Material characterization (AFM, Raman Spectroscopy, XRD, and SEM).
- ▷ Active developer to various open source data analysis packages such as Hyperspy, and py4DSTEM.

Submitted and Under Preparation Publications

13. **T. P. Mishra***, A. Bruefach, M.C. Scott, C. Ophus, *Automated phase mapping in py4DSTEM using non-negative least square of joint template matching*, (In preparation).
12. H M Hau*, **T. P. Mishra***, C. Ophus, K. Bustilo, C. Song, J. Turner, J. Bai, T. Y. Huang, X. Zhao, Y. Sun, L. Ma, B. D. McCloskey, Z. Cai, G. Ceder, *Phase transformation of large particle high capacity earth abundant cathode materials*, (In preparation).
11. **T. P. Mishra***, D Milsted*, G. Ceder, *Automated sample preparation system for electron microscopy characterization techniques*, (Waiting for acceptance of invention disclosure acceptance by Berkeley Lab).
10. J.Y. Chung, Y. Yuan, **T. P. Mishra**, P. Canepa, E. H. Sadki, S. Gradečak, and S. Garaj, *Two-dimensional materials exfoliated from non-van der waals crystal: structure and formation mechanism*, (Under review: Nat. Comm).
9. **T. P. Mishra**, J.Y. Chung, Z.Y. Deng, L. Zhang, S. Pennycook, S. Gradečak, M. Bosman, and P. Canepa, *Mitigation of compositional fluctuations and stacking fault in high Indium content InGaN Light Emitting Diodes*, (Under review: Physical Review Materials).

Peer-reviewed Publications

8. Z. Wang, **T. P. Mishra**, W.Xie, G. S. Gautam, and P. Canepa, *Kinetic Monte Carlo Simulations of Sodium Ion Transport in NaSICON Electrodes*, **ACS Materials Letters**(2023). [10.1021/acs-materialslett.3c00610](https://doi.org/10.1021/acs-materialslett.3c00610).
7. Z. Deng, **T. P. Mishra**, W. Xie, D. A. Saeed, G. S. Gopalakrishnan, and P. Canepa, *kMCpy: A python package to simulate transport properties in solids with kinetic Monte Carlo*, **Computational Material Science**(2023). [10.1016/j.commatsci.2023.112394](https://doi.org/10.1016/j.commatsci.2023.112394).

6. Z.Y. Deng, **T. P. Mishra**, E. Mahayoni, Q. Ma, A. J. K. Tieu, O. Guillon, J. N. Chotard, V. Seznec, A. K. Cheetam, C. Masquelier, G. S. Gopalakrishnan, and P. Canepa, *Fundamental investigations on the sodium-ion transport properties of mixed polyanion solid-state battery electrolytes*, **Nat. Comm** (2022). [10.1038/s41467-022-32190-7](https://doi.org/10.1038/s41467-022-32190-7).
5. Y. Gao, **T. P. Mishra**, S. H. Bao, G. S. Gautam, and P. Canepa, *Design and Characterization of Host-Frameworks for Facile Magnesium Transport*, **Annual Review of Materials Research**. [10.1146/annurev-matsci-081420-041617](https://doi.org/10.1146/annurev-matsci-081420-041617).
4. J-Y Chung, Z. Li, S. A. Goodman, J. So, G. J. Syaranamual, **T. P. Mishra**, E. A. Fitzgerald, M. Bosman, K. Lee, S. J. Pennycook, and S. Gradečak, *Light-Emitting V-Pits: An Alternative Approach toward Luminescent Indium-Rich InGaN Quantum Dots*, **ACS Photonics** (2021). [10.1021/acsp Photonics.1c01009](https://doi.org/10.1021/acsp Photonics.1c01009).
3. **T. P. Mishra**, G. J. Syaranamual, Z. Deng, J.-Y. Chung, L. Zhang, S. A. Goodman, L. Jones, M. Bosman, S. Gradečak, S. J. Pennycook, and P. Canepa, *Unlocking the origin of compositional fluctuations in InGaN light emitting diodes*, **Phys. Rev. Mater.** 05, 024605 (2021). [10.1103/PhysRevMaterials.5.024605](https://doi.org/10.1103/PhysRevMaterials.5.024605).
2. M. Li, Z. Huang, C. Tang, D. Song, **T. P. Mishra**, A. Ariando, T. Venkatesan, C. Li, S. J. Pennycook, *"Correlated Lattice Instability and Emergent Charged Domain Walls at Oxide Heterointerfaces"*, **Adv. Funct. Mat.** 29(49), 1906655 (2019) [10.1002/adfm.201906655](https://doi.org/10.1002/adfm.201906655).
1. **T. P. Mishra**, M.Koyano and Y. Oshima, "Detection of large thermal vibration for Cu atoms in tetrahedrite by high-angle annular dark-field imaging", **Appl. Phys. Express** 10, 045601 (2017) [10.7567/APEX.10.045601](https://doi.org/10.7567/APEX.10.045601).

Patents

1. Autonomous sample preparation for electron microscopy. (Invention disclosure filed with Lawrence Berkeley National Lab).

Oral Talks & Poster Presentation

5. **T. P. Mishra**, Z.Y. Deng, J.Y. Chung, S. Gradečak, S.J. Pennycook, and P. Canepa, "Detection and suppression of compositional fluctuations in InGaN Light Emitting Diodes." Accepted for 2021 MRS Fall Meeting to be held at Boston, MA, USA. (Oral Talk).
4. **T. P. Mishra**, Z.Y. Deng, J.Y. Chung, S. Gradečak, S.J. Pennycook, and P. Canepa, "Origin of Compositional fluctuations in InGaN Light Emitting Diodes." **Institute of Physics Singapore 2021** T2.128. (Oral Talk).
3. **T. P. Mishra**, G. J. Syaranamual, L. Jones, J. Y. Chung, Z. Li, S. A. Goodman, S. J. Chua, E. A. Fitzgerald, P. Canepa, S. Gradečak, and S. J. Pennycook, "Quantitative Measurement of Sub-nanometer In Fluctuations in InGaN Quantum Well", **ICMASS, Nagoya**, 1392 (2019) (Poster)

2. **T. P. Mishra**, M. Koyano and Y. Oshima, "Detection of large thermal vibration for Cu atoms in tetrahedrite by high-angle annular dark-field imaging", **ICMAT** 10, 045601 (2019). (Poster)
1. **T. P. Mishra**, M. Koyano and Y. Oshima, "Anomalous scattering at high angles stemming from anisotropic atomic vibrations", **Materials Student Symposium, Indian Institute of Science, Bangalore** (2017). (Oral Talk)

Teaching and Mentoring

1. **Spring & Fall, 2022** Mentoring Ms. Z. Jiayu for her Master project on "Impact of compositional fluctuations on InGaN LEDs using multiscale modeling."
2. **Fall, 2021** Mentoring Mr. Preston Lim (NUS) for his Final Year Project on "Machine Learning of Interatomic Potentials in InGaN alloys".
3. **Fall, 2017** Teaching Assistant, Undergraduate Core Module, UMT 202: Structure of Materials at Indian Institute of Science.

Research in the News

1. **April 28, 2021** MIT News Office: SMART investigates the science behind varying performance of different colored LEDs. <https://news.mit.edu/2021/smart-performance-different-colored-leds-0428>

References

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