Aashutosh Mistry

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Transport processes are at the heart of every functioning system, living or artificial. Intrinsic properties of materials, as well as their specific geometrical arrangement, govern the efficacy of these processes. I am a continuum theoretician with a strong belief in controlled experimentation.

EDUCATION

Purdue University*

2017 – Doctor of Philosophy in *Mechanical Engineering* GPA: **-/4.00** (Lambert teaching fellowship awardee)

Texas A&M University*

2015 – 2017 Doctor of Philosophy in *Mechanical Engineering* GPA: **4.00/4.00**

Indian Institute of Technology Kanpur, India

2012 – 2014 Master of Technology in *Fluid and Thermal Sciences* (Mechanical Engineering) GPA: **10.00/10.00** (Gold medalist)

Sardar Vallabhbhai National Institute of Technology Surat, India

2008 – 2012 Bachelor of Technology in *Mechanical Engineering* GPA: **9.95/10.00** (Gold medalist)

* Moved from A&M to Purdue in Fall 2017

AWARDS AND HONORS

1. *Featured news report on Thermal Cross-talk Research* (4th Dec 2017)
2. *Lambert Teaching Fellowship, School of Mechanical Engineering, Purdue University (Spring '18 – Fall '18)*
   This prestigious and highly competitive fellowship is awarded to ME graduate students with an extraordinary research and academic accomplishment and who holds a potential for a career in academia.
3. *Reporter for MRS Fall '17 meeting* (27-30th Nov 2017)
   To summarize and prepare press-briefs for talks that are of interest to a broader audience
4. *Reporter for MRS Spring '17 meeting* (17-21st Apr 2017)
   To summarize and prepare press-briefs for talks that are of interest to a broader audience
5. *Reviewer for IEEE ITHERM 2017 conference*
6. *Organizer and judge at Inaugural Texas A&M Energy Conference* (26-28th Sep 2016)
7. *Invited judge at Summer Undergraduate Research Poster Competition, Texas A&M University* (5th Aug 2016)
8. *Invited graduate student participant and tutorial lecturer at College of Multiscale Computational Modeling of Materials for Energy Applications, International Center for Theoretical Physics, Trieste, Italy* (4th Jul – 15th Jul 2016)
   Modeling and Analysis of Electrochemical Performance of Lithium-Sulfur Batteries
9. *Invited participant at Indo-US Workshop on Recent Advances in Multiscale Multiphysics Analysis of Energy Conversion in Li-ion Batteries, IIT-Bombay, India* (17th Jun – 19th Jun 2016)
   Long Range Interaction in Lithium-Ion Battery Electrodes
10. *Invited judge at Summer Undergraduate Research Poster Competition, Texas A&M University* (7th Aug 2015)
11. *First prize at Texas A&M Non-fossil based Technologies for Energy* (24th Jun 2015)
    Investigating Chemical and Electrochemical Interactions during Discharge of a Lithium Sulfur Cell
12. *Organizer for IITK Student Research Convention* (9-10th Aug 2014)
    Conceptualized, planned and organized a two-days conference at IIT Kanpur for undergraduate and graduate students. The conference had 4 invited lectures by IIT

Kanpur professors, 32 oral presentations (8 sessions), 68 posters, and a small expo by start-ups being supported by IIT Kanpur.

13. *Sashi Pundir Meomrial Gold Medal* (Jun 2014 at IIT Kanpur)
    For best Master's thesis in Fluid Mechanics and Transport Phenomena
14. *Academic Excellence Award* (Feb 2014 at IIT Kanpur)
    The certificate of merit for academic excellence in the Master of Technology program in Mechanical Engineering
15. *Gold Medal* (Aug 2012 at SVNIT Surat)
    For securing the 1st merit rank in Bachelor of Technology program in Mechanical Engineering
16. *Smt. Laxmi Bala Majumdar Gold Medal* (Aug 2012 at SVNIT Surat)
    For securing the 1st merit rank across all the disciplines of Bachelor of Technology program
17. *Siddhartha Gupta Gold Medal* (Aug 2012 at SVNIT Surat)
    For securing the 1st merit rank in Bachelor of Technology program in Mechanical Engineering
18. *Siddhartha Gupta Gold Medal* (Aug 2012 at SVNIT Surat)
    For securing the 1st merit rank across all the disciplines of Bachelor of Technology program

RESEARCH EXPERIENCE

Doctoral Thesis

Mesoscale Interactions in Porous Electrodes

Advisor: Dr. Partha Mukherjee (Purdue: Fall '17 onwards, A&M: Spring '15 – Summer '17)

Keywords: Intercalation (Li-ion) and conversion chemistry (Li-sulfur & Li-air batteries), Porous electrode theory, Polysulfide shuttle effect, Poromechanics, Electrode microstructure

Project Associate

Jun 2014 – Dec 2014 *AnuPravaha I*

Principal Investigator: Dr. Malay Das (IIT Kanpur)

Work description: To speed up *AnuPravaha I* – a general purpose structured CFD solver through code parallelization and faster matrix inverter

Master's Thesis

Generalized Lagrangian Model for Drop Spreading on Textured Surfaces

Supervisor: Dr. Krishnamurthy Muralidhar (IIT Kanpur)

Keywords: Surface tension, Contact line motion, Dynamic contact angle, Integral analysis

Bachelor's Project

Numerical and Experimental Investigation on Heat Transfer in Nanofluids

Guide: Dr. Jyotirmay Banerjee (SVNIT Surat)

Keywords: Thermal and hydrodynamic behavior of Nanofluids, Laminar, Incompressible flow, Natural convection, Forced convection, Nusselt number, Single-phase model, Two-fluid model, Semi-explicit Finite Volume Navier-Stokes solver

Journal Publications

1. **A. Mistry** and P. P. Mukherjee, *Analyzing Electrode Microstructural Heterogeneity and Electrochemical Implications in Lithium-ion Battery Cathodes*, Adv. Energy Mater. (under review)
2. **A. Mistry**, K. Smith, and P. P. Mukherjee, *Secondary Phase Stochastics in Li-ion Battery Cathodes*, Appl. Mater. Interface (under review)
3. **A. Mistry**, M. Balasundaram, P. Balaya and P. P. Mukherjee, *A Thermodynamically Consistent Method to Quantify Different Modes of Heat Generation in Li-ion Cells*, J. Power Sources (under review)

4. N. Kotak, P. Barai, **A. Mistry**, A. Verma and P. P. Mukherjee, *Electrochemistry-mechanics Coupling in Intercalation Electrodes*, J. Electrochem. Soc. (under review)
5. **A. Mistry** and P. P. Mukherjee, *Precipitation – Microstructure Interaction in Li-S Battery Cathode*, J. Phys. Chem. C 121 (47), 26256
6. C.-F. Chen, **A. Mistry** and P. P. Mukherjee (2017) *Probing Impedance and Microstructure Evolution in Lithium-sulfur Battery Electrodes*, J. Phys. Chem. C 121 (39), 21206
7. Z. Liu, **A. Mistry** and P. P. Mukherjee (2017) *Mesoscale Physicochemical Interactions in Lithium-sulfur Batteries: Progress and Perspective*, J. Electrochem. Energy Storage Conver. 15 (1), 010802
8. M. Stein IV, **A. Mistry** and P. P. Mukherjee (2017) *Mechanistic Understanding of the Role of Evaporation in Electrode Processing*, J. Electrochem. Soc. 164 (7), A1616
9. K. Shah, N. Balsara, S. Banerjee, M. Chintapalli, A. P. Cocco, W. K. S. Chiu, I. Lahari, S. Martha, **A. Mistry** *et al.* (2017) *State-of-the-art and Future Research Needs for Multiscale Analysis of Li-ion Cells*, J. Electrochem. Energy Storage Conver. 14 (2), 020801
10. G. J. Nelson, L. J. Ausderau, J. R. Buckley, S. Shin, **A. Mistry**, P. P. Mukherjee and V. De Andrade (2017) *Transport-geometry Interactions in Li-ion Cathode Materials Imaged using X-ray Nanotomography*, J. Electrochem. Soc. 164 (7), A1412
11. **A. Mistry**, D. Juarez-Robles, M. Stein and K. Smith, P. P. Mukherjee (2016) *Analysis of Long-range Interaction in Lithium-ion Battery Electrodes*, J. Electrochem. Energy Conver. Storage 13 (3), 031006
12. P. Barai, **A. Mistry** and P. P. Mukherjee (2016) *Poromechanical Effect in the Lithium-sulfur Battery Cathode*, Extreme Mech. Lett. 9 (3), 359-370
13. A. D. Dysart, J. C. Burgos, **A. Mistry** *et al.* (2015) *Towards Next Generation Lithium-sulfur Batteries: Non-conventional Carbon Compartments/ Sulfur Electrodes and Multi-scale Analysis*, J. Electrochem. Soc. 163 (5), A730-A741
14. **A. Mistry** and K. Muralidhar (2015) *Axisymmetric Model of Drop Spreading on a Horizontal Surface*, Phys. Fluids 27(9), 092103

In preparation Manuscripts

15. **A. Mistry** and P. P. Mukherjee, *Demystifying Physicochemical Evolution in Li-S Cathode: Concentrated Solution Effects and Chemical Reactions*, ACS Energy Lett.
16. **A. Mistry** and P. P. Mukherjee, *Electrodics Cross-talk: A Holistic Paradigm in Energy Storage*, Energy Environ. Sciences
17. **A. Mistry**, H. Reddy Palle, and P. P. Mukherjee, *In Operando Calorimeter-free Characterization of Heat Generation in Li-ion Cells*, J. Electrochem. Soc.

Book Chapters

1. P. P. Mukherjee, **A. Mistry** and A. Verma (2017) *Porous Media Applications: Electrochemical Systems, in Modeling Transport Phenomena in Porous Media with Applications*, eds. M. K. Das, P. P. Mukherjee, K. Muralidhar, Springer
2. P. P. Mukherjee, A. Verma, and **A. Mistry** (2017) *Mesoscale Interactions of Transport Phenomena in Polymer Electrolyte Fuel Cells, in Modeling Transport Phenomena in Porous Media with Applications*, eds. M. K. Das, P. P. Mukherjee, K. Muralidhar, Springer

Conference Proceedings

1. **A. Mistry** and K. Muralidhar, *Non-isothermal Spreading of Liquid Drops: Effect of Fluid Convection*, Asian Symposium on Computational Heat Transfer and Fluid Flow, November 2015
2. **A. Mistry** and K. Muralidhar, *Study of Front Tracking Methodology for Simulation of Multiphase Flow*, Proceedings of Fortieth National Conference on Fluid Mechanics and Fluid Power, December 2013
3. **A. Mistry**, A. Verma and M. K. Das, *Modeling of Polymer Electrolyte Membrane (PEM) Fuel Cell Cathode with Agglomerate Catalyst Layer*, Proceedings of Fortieth National Conference on Fluid Mechanics and Fluid Power, December 2013

4. **A. Mistry** and J. Banerjee, *A Comparative Analysis of Single-phase and Two-fluid Model for Nanofluid Heat Transfer in Forced Convection Regime*, Proceedings of Thirty Ninth National Conference on Fluid Mechanics and Fluid Power, December 2012

Presentations and Posters

1. **A. Mistry** and P. P. Mukherjee, *Thermal Cross-talk in Lithium-ion Battery Safety*, Materials Research Society Fall Meeting, Boston, MA (1st Dec 2017)
2. **A. Mistry** and P. P. Mukherjee, *Simulated Calorimetry based Thermal Characterization of Lithium-ion Cells*, International Mechanical Engineering Congress & Exposition – IMECE 2017, Tampa, FL (9th Nov 2017)
3. **A. Mistry** and P. P. Mukherjee, *Hysteresis in Li-S Battery Performance*, Advanced lithium Batteries for Automotive Applications – ABAA 2017, Oakbrook, IL (23rd Oct – 25th Oct 2017)
4. **A. Mistry** and P. P. Mukherjee, *Microstructural Limitations in Lithium-sulfur Battery Performance*, 232nd Meeting of Electrochemical Society, National Harbor, MD (4th Oct 2017)
5. **A. Mistry** and P. P. Mukherjee, *Non-intercalating Phases and Electrochemical Behavior of Lithium-ion Battery Cathode*, 232nd Meeting of Electrochemical Society, National Harbor, MD (4th Oct 2017)
6. **A. Mistry**, A. Verma, and P. P. Mukherjee, *Mesoscale Physics and Stochastics in Energy Storage*, Hawkins Lecture, Purdue Mechanical Engineering, West Lafayette, IN (21st Sep 2017)
7. **A. Mistry** and P. P. Mukherjee, *Virtual Electrode Engineering: From Mesoscale Underpinnings to System Characteristics*, Advanced Automotive Battery Conference – AABC 2017, San Francisco, CA (20th Jun 2017)
8. **A. Mistry** and P. P. Mukherjee, *Demystifying Microstructure Limitations in Li/S Cells: Surface Passivation vs. Pore Blockage*, Materials Research Society Spring Meeting, Phoenix, AZ (20th Apr 2017)
9. **A. Mistry** and P. P. Mukherjee, *Mesoscale Probing of Transport-Interface Interaction in Lithium-ion Battery Electrodes*, TMS 2017 146th Annual Meeting and Exhibition, San Diego, CA (1st Mar 2017)
10. **A. Mistry**, D. Juarez-Robles, and P. P. Mukherjee, *Thermo-electrochemical Analytics in Li-ion Battery Safety*, ESS Safety Forum 2017, Santa Fe, NM (22nd Feb 2017)
11. **A. Mistry**, Z. Liu and P. P. Mukherjee, *Mesoscale Modeling of Transport Limitations during Discharge of a Li-S cell*, 12th Annual Lithium Battery Power Conference, Bethesda, MD (2nd Nov 2016)
12. **A. Mistry**, *Modeling and Analysis of Electrochemical Performance of Lithium-Sulfur Batteries*, College of Multiscale Computational Modeling of Materials for Energy Applications, International Center for Theoretical Physics, Trieste, Italy (4th Jul – 15th Jul 2016)
13. **A. Mistry** and P. P. Mukherjee, *Improving Discharge Performance of Li-air Batteries with Electrode Microstructural Modifications*, College of Multiscale Computational Modeling of Materials for Energy Applications, International Center for Theoretical Physics, Trieste, Italy (4th Jul – 15th Jul 2016)
14. **A. Mistry**, C.-F. Chen, Z. Liu and P. P. Mukherjee, *Probing Polysulfide Shuttle Effect in the Li-S Battery*, International Meeting on Lithium Batteries – IMLB, Chicago, IL (17th Jun 2016)
15. **A. Mistry**, C.-F. Chen, Z. Liu and P. P. Mukherjee, *Mesoscale Modeling of Transport Limitations during Discharge of a Li-S Cell*, Indo-US Workshop on Recent Advances in Multiscale Multiphysics Analysis of Energy Conversion in Li-ion Batteries, IIT-Bombay, India (17th Jun – 19th Jun 2016)
16. **A. Mistry**, C.-F. Chen, A. Verma and P. P. Mukherjee, *Long Range Interaction in Lithium-Ion Battery Electrodes*, Indo-US Workshop on Recent Advances in Multiscale Multiphysics Analysis of Energy Conversion in Li-ion Batteries, IIT-Bombay, India (17th Jun – 19th Jun 2016)
17. **A. Mistry**, P. Barai, and P. P. Mukherjee, *Precipitation Induced Stress and Degradation in the Lithium-sulfur Battery Cathode*, 229th Meeting of Electrochemical Society, San Diego, CA (29th May – 2nd Jun 2016)

18. **A. Mistry**, A. Verma, R. Mukherjee and P. P. Mukherjee, *Image-based Reconstruction and Statistical Characterization of the Li-ion Battery Electrode Microstructure*, 229th Meeting of Electrochemical Society, San Diego, CA (29th May – 2nd Jun 2016)
19. **A. Mistry**, C.-F. Chen, Z. Liu and P. P. Mukherjee, *Mesoscale Modeling of the Physicochemical Interplay in the Li-sulfur Battery Porous Cathode*, Interpore 2016, Cincinnati, OH (8th May – 12th May 2016)
20. **A. Mistry**, A. Verma, D. Juarez-Robles and P. P. Mukherjee, *How Electrode Processing Affects Li-ion Battery Performance?*, Material Challenges in Alternative and Renewable Energy – MCARE 2016, Clearwater, FL (17th Apr – 21st Apr 2016)
21. **A. Mistry**, A. Verma, D. Juarez-Robles and P. P. Mukherjee, *Physicochemical Evolution Behavior in the Li-air Battery Electrode*, Material Challenges in Alternative and Renewable Energy – MCARE 2016, Clearwater, FL (17th Apr – 21st Apr 2016)
22. **A. Mistry**, P. Barai and P. P. Mukherjee, *A Two-way Coupled Mechano-Electrochemical Model for Estimating Active Material Degradation in Lithium-ion Battery Electrodes*, International Mechanical Engineering Congress & Exposition – IMECE 2015, Houston, TX (13th Nov – 19th Nov 2015)
23. **A. Mistry**, D. Juarez-Robles, F. Cano-Banda, A. Hernandez-Guerrero and P. P. Mukherjee, *Correlating Precipitation Morphology in the Air Electrode to the Lithium-air Battery Discharge Performance*, 52nd Annual Technical Meeting of Society of Engineering Sciences – SES 2015, Texas A&M (26th Oct – 28th Oct 2015)
24. P. P. Mukherjee, Z. Liu, C.-F. Chen and **A. Mistry**, *Investigating Chemical and Electrochemical Interactions during Discharge of a Lithium Sulfur Cell*, Texas A&M Non-fossil based Technologies for Energy – Research Workshop, Texas A&M (20th Oct 2015)
25. P. P. Mukherjee, A Hernandez-Guerrero, Z. Liu, C.-F. Chen, **A. Mistry**, D. Juarez-Robles and F. Cano-Banda, *High-performance Electrode Architecture for Lithium-Air Batteries*, Texas A&M – CONACyT Symposium 2015, Texas A&M (24th Jun 2015)
26. **A. Mistry** and K. Muralidhar, *Prediction of Drop Spreading in a Lagrangian Framework*, Departmental Poster Presentation, IIT Kanpur (21st Mar 2014)

Scientific Journalism

1. **A. Mistry**, *Asphalt porous structure enables fast-charging high-capacity Li metal anode* (
2. **A. Mistry**, *X-ray nanotomography reveals 3D internal magnetization structure* (6th Oct 2017)
3. **A. Mistry**, *Electrolyte gating induced insulator-to-metal transition in WO_3 mechanism identified* (19th Sep 2017)
4. **A. Mistry**, *Intermolecular forces for self-assembly identified through simulations* (10th Jul 2017)

MRS Fall Meeting, 2017

5. **A. Mistry**, *Bio-inspired Bistable Shape-changing Displacement Sensors* (1st Dec 2017)
6. **A. Mistry**, *Data Mining in Small-scale Plasticity* (30th Nov 2017)
7. **A. Mistry**, *Bio-inspired Anti-fogging Materials: from the Mosquito Effect to the Cicada Effect* (29th Nov 2017)
8. **A. Mistry**, *Analyzing the Stability and Kinetics of the Li metal – solid electrolyte Interface* (29th Nov 2017)
9. **A. Mistry**, *Safe, High-energy-density Solid-state Li Batteries* (29th Nov 2017)
10. **A. Mistry**, *Enhancing Superhydrophobicity and Icephobicity through Surface Flexibility Inspired by Butterfly Wings* (29th Nov 2017)
11. **A. Mistry**, *Phase Field Models and Interfacial Evolution: a Critical Test of Simulation* (29th Nov 2017)
12. **A. Mistry**, *Benchmarking Problems for Phase Field Codes* (29th Nov 2017)
13. **A. Mistry**, *Controlling the Electrical Properties of Organic Electronics: a Path Towards Low-power Printed Electronics* (29th Nov 2017)
14. **A. Mistry**, *Design of Lubricant Infused Surfaces* (28th Nov 2017)
15. **A. Mistry**, *Enhancing Understanding of the Solid-electrolyte Interface: Multi-modal Characterization of Battery Systems* (28th Nov 2017)
16. **A. Mistry**, *Graphene Quantum Dots from Coal* (28th Nov 2017)

17. **A. Mistry**, *The DAGS chemistry: Droplet Assisted Growth and Shaping for Synthesis of Polymeric Nano- and Microstructures* (28th Nov 2017)
18. N. Briggs, X. Gong and **A. Mistry**, *Special Workshop on Nanomaterials and Their Applications* (27th Nov 2017)
19. **A. Mistry**, *3D Printing of Transparent and Conductive Heterogeneous Hydrogel-elastomer Systems* (27th Nov 2017)
20. **A. Mistry**, *Towards Photo-rechargeable Lithium-ion Battery* (27th Nov 2017)
21. **A. Mistry**, *Garnet-based Li-metal Batteries* (27th Nov 2017)

MRS Spring Meeting, 2017

22. **A. Mistry**, *Solar CO_2 Reduction Coupled with Water Oxidation—Semiconductor/Metal-Complex Hybrid System* (17th Apr 2017)
23. **A. Mistry**, *Photoelectrochemical Solar Energy Storage—Hydrogen Production vs Direct CO2 Reduction and Photoredox Flow Batteries* (18th Apr 2017)
24. **A. Mistry**, *Nanogenerators for Self-powered Systems and Large-scale Blue Energy* (18th Apr 2017)
25. **A. Mistry**, *Surface-bound Enzymatic Reactions Organize Microcapsules and Protocells in Solution* (18th Apr 2017)
26. **A. Mistry**, *Data Analytics for Mining Process-Structure-Property Linkages for Hierarchical Materials* (20th Apr 2017)
27. **A. Mistry**, *A Multiscale Approach to Cathode Design Based on Mapping Intercalation Gradients within Individual Particles and across Particle Aggregates* (20th Apr 2017)
28. **A. Mistry**, *Needs and Challenges Associated with High Energy Batteries with an Emphasis on Thermodynamic Underpinnings* (21st Apr 2017)
29. **A. Mistry**, *Understanding the Nature of Chemical and Electrochemical Stability of Electrolytes at Mg Anode Surfaces* (27st Apr 2017)

Professional Societies

1. American Society of Mechanical Engineering (ASME) since Nov 2015
2. Electrochemical Society (ECS) since Nov 2015
3. Materials Research Society (MRS) since Mar 2017

TEACHING EXPERIENCE

Teaching Assistantships

1. Spring 2014: *Experimental Methods in Thermal Sciences* (ME 649) class strength – 18
2. Fall 2013: *Programming and Numerical Analysis* (ME 685) class strength – 22
3. Spring 2013: *Fluid Mechanics* (ME 231) class strength – 105

Lectures and Workshops

1. Jul 24th-25th, 2014: *How to generate Technical Diagrams/Figures using Asymptote* (IIT Kanpur)
2. Jun 30th- Jul 4th, 2014: *How to become Friends with MATLAB?* (IIT Kanpur)
3. Aug 27th-31st, 2013: *Basics of MATLAB programming* (IIT Kanpur)
4. Mar 28th, 2012: *Application of Mathematics in "Real-life Problems"* (SVNIT Surat)
5. Sep 15th, 2010: *Steering and Differential* (SVNIT Surat)

STUDENT MENTORING

1. Akash Verma (B. Tech IIT Kanpur, India) May 2016 – Jul 2016
   A Reduced-order Model to Quantify Thermal Behavior of Li-ion Cells during Electrochemical Testing
2. Team of 15 Students (Texas A&M University, TX) Sep 2015 – Dec 2015
   AggieChallenge 2015
3. Fernando Cano-Banda (M. S. University of Guanajuato, Mexico) Jun 2015 – Nov 2015
   Macro-scale Mathematical Model for Discharge Performance of Lithium Air Cells
4. Leigha Lewis (B. S. Sam Houston State University, TX) May 2015 – Jul 2015

Data-driven Characterization of Transport Properties for Electrode Microstructure of Lithium Sulfur Batteries

5. Mohit Singhal (B. Tech IIT Kanpur, India) May 2015 – Jul 2015
   Oven Test to Measure Thermal Abuse Tolerance of Li-ion Batteries: A Lumped Model
6. Aditya Tiwari (B. Tech SVNIT Surat, India) May 2015 – Jul 2015
   Drying of Particulate Slurry: A Model for Preparation of Electrodes

MISCELLANEOUS

Computer Skills

Languages known: C/C++, Fortran 77/90/95/2003, MATLAB, LabVIEW, LaTeX, Asymptote
Programming style: modular, parallel programming (OpenMP, MPI and GPU parallelization)
Software: Solidworks, Pro/Engineer, AutoCAD

Hobbies: Sketching & Painting, Programming, Electronics

Extra-curricular Activities:

1. Planning, designing and coordinating events in technical festivals
2. Managing activities of student chapters