EPPD Webinar

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ELECTRONIC & PHOTONIC PACKAGING DIVISION

Thermal Transport in Lithium-ion Cells and Battery Packs

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Abstract

High-efficiency electrochemical energy storage in Li-ion cells may play a key role in meeting the energy challenges of the future such as in electric vehicles and the storage of renewable energy. Li-ion cells pose several interesting scientific questions related to thermal and fluid transport that directly affect their performance and safety. Understanding these questions and optimizing the nature of multiscale heat transfer in Li-ion cell materials, components and systems remain critical research challenges.

This talk will first present an overview of the key thermal transport phenomena and challenges that occur in a Li-ion cell, including performance deterioration at low temperatures and thermal runaway hazards at elevated temperature. The talk will then discuss ongoing experimental and theoretical research towards meeting some of these challenges. Multiscale thermal conduction measurements that identify poor thermal transport across the cathode-separator interface as the fundamental root cause of the low thermal conductivity of Li-ion cells will be discussed. A molecular bridging technique that improves this interfacial thermal transport by 4X will be discussed. System-level multiphysics simulations that model and predict the highly non-linear thermal runaway phenomenon in a battery pack will be discussed. Finally, motivated by thermal runaway in Li-ion cells, stability analysis of multilayer diffusion-reaction problems will be discussed, including recent work on the use of Heaviside functions for solving problems with a very large number of layers. Key outcomes of this theoretical work include derivation of a new non-dimensional number to predict the occurrence of thermal runaway, and analysis of the existence of multiple but finite number of imaginary eigenvalues in such problems.

Biography

Ankur Jain is a Professor in the Mechanical and Aerospace Engineering Department at The University of Texas at Arlington. His research interests include energy conversion in Li-ion batteries, phase change heat transfer, additive manufacturing, electrochemistry and theoretical thermal conduction. He has published 162 journal papers, and given 78 invited/keynote/plenary talks, seminars and tutorials. He received the ASME K16 Clock Award (2023), UTA President's Award for Excellence in Teaching (2022), UTA College of Engineering Lockheed Martin Excellence in Teaching Award (2018), College of Engineering Outstanding Early Career Award (2017), NSF CAREER Award (2016) and the ASME EPP Division Young Engineer of the Year Award (2013). He is a Fellow of ASME. He received his Ph.D. (2007) and M.S. (2003) in Mechanical Engineering from Stanford University, where he received the Stanford Graduate Fellowship, and B.Tech. (2001) in Mechanical Engineering from Indian Institute of Technology, Delhi with top honors.