“ALL ARE WELCOME''

Title: “Exploring Multifunctional Batteries. How to build batteries that do work?”

Date/Time: 8 November 2024/ 3.30-4.30 PM

Venue: MSB 241

Speaker: Dr. Nitin Muralidharan

Biography of the Speaker:

Professor Nitin Muralidharan is a Material Scientist and Chemical Engineer with background in the area of next-generation energy storage technologies for Electric Vehicle (EV) and Electric Vertical Take-off and Lift (EVTOL) applications. His research expertise encompasses key directions into Li, Na ion and metal batteries, solid state batteries and next-gen electrochemical energy storage systems and has several notable publications in the field. He was part of recipient team winning two R&D 100 awards also termed as the Oscars of Innovation, in 2020 and 2022 for inventions such as novel cathode material for co-free batteries and SOLIDPAC – Solid State Battery Performance Analyzer & Calculator. Prior to joining IITM, Dr. Nitin Muralidharan was a Staff Scientist at United States Department of Energy's (US. DOE) Oak Ridge National Laboratory (ORNL). He was also a Post-doctoral Research Associate at ORNL at the US. DOE's Battery Manufacturing Facility (BMF). He was also the finalist for the prestigious globally competitive Weinberg Distinguished Staff Fellowship at ORNL in 2018. He received his Doctoral Degree in Interdisciplinary Materials Science from Vanderbilt University in Nashville, Tennessee, USA. Prof. Nitin joined Indian Institute of Technology Madras (IITM), Department of Chemical Engineering in April 2023 and leads the EMERGE R&D group aimed at developing material driven solutions to combat the challenges pertaining to the climate-water-energy nexus.

Affiliation of the Speaker: Indian Institute of Technology Madras

Abstract:

Batteries have been in the limelight for quite some time now due to their extreme versatility in catering to a multitude of applications ranging from electric vehicles, eVTOLs, renewables, portable electronics and many more. Batteries are dynamic mechano-electrochemical systems where the components and interfaces are subjected to significant mechanical stresses and strains during operation. Most current research approaches discard the coupled mechanical processes as an unavoidable by-product or something detrimental that has to be managed. However, the coupling between mechanics and electrochemistry, mechano-electrochemical coupling, is a powerful and relatively unexplored tool. Here, I will talk about building batteries that perform functions that are not ordinarily expected from them. I will also cover how understanding and isolating this fundamental phenomenon followed by developing new classes of energy devices that leverage these findings can enable several unique applications. First, using principles of elastic strain engineering, I will discuss our efforts in controllable modulation of electrochemical parameters governing energy storage systems as a function of applied strain. Next, building off these findings, we have developed electrochemical-mechanical energy harvesters for harnessing ambient mechanical energy at very low frequencies (<5 Hz), a regime where the conventional state of the art piezoelectric and triboelectric energy harvesters have drastically reduced performances. The unique frequency tuning capabilities in this class of energy harvesters enable development of devices for use in human motion harvesting/sensing applications and multifunctional transient energy harvesting/storage devices. Additionally, to further understand the relationship between mechanical and electrochemical properties, we have also developed multifunctional structural supercapacitor and ultra-battery composites for use in load-bearing

applications. Overall, our findings provide a broad framework for using mechano-electrochemistry as a design tool for developing next generation energy storage devices

Regards,

Department of Chemical Engineering, IITM