

**Department of Chemical Engineering, IIT Hyderabad**  
**CH5036-Industry Lecture Series**  
**Jan-May 2025**



*Date:* 09-04-2025

*Time:* 04:00 PM (IST)

*Speaker:* Dr. Sudhir Ranganath

*Affiliation:* Tvastra InnoTech Solutions Pvt. Ltd.

*Title:* **A custom-made ternary Deep Eutectic Solvent for leaching active cathode material from spent mobile Lithium-ion batteries**

*Venue:* LHC-01

### **Abstract**

The increase in Electric vehicle (EV) consumption has raised the demand for Lithium-based batteries. Recycling and repurposing spent Li-ion batteries are critical for sustainability, as they consist of valuable elements including Co, Mn, and Fe other than Li. Current recycling methods including pyrometallurgical and hydrometallurgical processes are energy-intensive and hazardous, respectively. Therefore, a more environmental friendly approach to extract Lithium from spent Lithium-ion batteries is warranted. We have custom-designed a green, ternary Deep Eutectic Solvent (DES) with unique properties including lower freezing points, higher thermal stability, lower volatility, and tunability. This solvent comprises Hydrogen bond acceptors (HBA) and Hydrogen bond donors (HBD) in a specified molar ratio. Spent or waste batteries from mobile phones were dismantled under water and active cathode material (ACM) was separated. EDX and ICP-MS analysis of the calcined ACM revealed the absence of Aluminium and the presence of Li, Co, Mn, and Ni. Next, using our custom-made ternary DES, we demonstrated rapid leaching of cathode material in 30 min at a significantly lower temperature (90 °C) compared to pyrometallurgical processes, where the required temperature would be more than 700°C. The synthesized ternary DES showed very high efficiency to coordinate with Li<sup>+</sup> and Co<sup>2+</sup> ions and hence, resulted in an extraction efficiency of about 99% for Li<sup>+</sup> and Co<sup>2+</sup>. Further, stage-wise separation and conversion of cathode material into high purity metal oxides were achieved through precipitation post-leaching. We also aim to enhance the reusability of this DES, which helps reduce costs by allowing recycling of the ternary DES. In summary, our custom-made ternary DES represents a promising new solvent for sustainable extraction of

Lithium from spent LiBs, and hence the development of a sustainable process for LiB extraction is warranted.

**Keywords:** Active cathode material, Deep eutectic solvents, Leaching, LIBs.

## **Biography**

Dr. Sudhir Ranganath is a Director and co-founder of Tvastra InnoTech Solutions Pvt Ltd, a Tech start-up incubated at the Technology Business Incubator (STBI) at Siddaganga Institute of Technology (SIT), Tumkur.

He is also an Associate Professor and Head of the Department of Chemical Engineering at SIT, Tumkur. He is also the Principal Investigator and founder of the Center of Excellence for Biomedical Innovations via Engineering & NanoTechnology (Bio-INvENT Center of Excellence) at SIT. He was the 2022-23 INSA Visiting Scientist at IIT Bombay. He was a Roche Collaborative Research Fellow at the Indiana University School of Optometry, USA during 2021.

His startup's focus has been in the design and development of sustainable solvents for the extraction of valuable metals using Machine Learning- and computational thermodynamics-mediated solvent design approaches. In collaboration with IIT Kanpur, he has a pending patent application for a novel ternary deep eutectic solvent (DES) for the extraction of metals from spent Lithium ion batteries.

His academic research interests are nanomedicine, cell engineering, cell-based targeted drug delivery, cancer immunotherapy and mathematical modeling of transport in biological systems. Specifically, his interest lies in understanding the adverse effects of hypothermia and cytokine stresses on the functionality and health of donor corneal endothelium in the context of corneal transplantation, and has developed nanotechnological interventions to tackle them. He also focuses on the identification of molecular and pharmacological agents to overcome oxidative stress-induced barrier dysfunction and cell death in donor corneal endothelium. Another area of his interest is in developing cancer targeted drug delivery systems using stem cell membrane-coated nanoparticles. His lab has developed mitocurcumin-loaded nanoparticles coated with mesenchymal stem cell membrane to enable selective targeting of mitochondria of lung cancer cells *in vitro*. His recent focus has also been to understand the crosstalk between glioma stem cells and  $\gamma\delta$  T-cells in the context of glioblastoma immunotherapy and develop nanomedicine and cell-based approaches.

He received his B.E in Chemical Engineering from Bangalore University, M.S., & Ph.D., in Chemical Engineering from the National University of Singapore and postdoctoral experience in stem cell bioengineering at Harvard-MIT Division of

Health Sciences & Technology, USA & JNCASR, India. His research is funded by BRNS, SERB, DST-Lockheed Martin-Tata Trusts, VGST (Govt. of Karnataka), ARVO (USA), and DBT totaling more than Rs. 5.6 crores and intramurally by SSES (Rs. 1 crore). He has published more than 28 high impact research articles in the areas of cancer therapy, stem cell biology/bioengineering and drug delivery in top journals including Cell Stem Cell, Nanoscale Advances, Advanced Drug Delivery Reviews, Stem Cell Reports, Nature Scientific Reports, Biomaterials, Pharmaceutical Research, PLoS ONE, Journal of Ocular Pharmacology & Therapeutics and AIChE Journal. He also has one patent application on nanoparticles for stimulating plant defense.

Selected awards and honors:

- **Membership of Sigma Xi** (The Scientific Research Honor Society), USA (2022 - 2023)
- **INSA Visiting Scientist Fellowship** (Host: IIT Bombay) (2022)
- **Roche Collaborative Research Fellowship 2020**, ARVO, USA (2021)
- **Young Investigator**, India BioScience Group (2020)
- **Finalist** at the National Bio Entrepreneurship Competition, C-CAMP, Bangalore (2019)
- **India Innovation Growth Program University Challenge 2019 Award** and **Rs.10 lakhs grant** from DST-Lockheed Martin-Tata Trusts (2019)
- **Award for Research Publication** from VGST, Govt of Karnataka (2019)
- **Best Poster Award** at the COMSOL Conference, Bangalore (2018)
- **Certificate of Innovation** from Partners Healthcare, USA (2018)
- **DBT Travel Grant Award** (2016)
- **Young Investigator Recognition**, Indo-US Bioscience Group, MIT, USA
- **IUSSTF Postdoctoral Fellowship** from India and US Governments (2010 – 2014)
- **BMRC Research Fellowship** from Biomedical Research Council, Singapore (2009 - 2010)
- **NUS Research Scholarship** from the National University of Singapore (2006-2009)

Dr. Sudhir is a reviewer for prestigious journals including Advanced Drug Delivery Reviews, RSC Advances, American Chemical Society, and Journal of Materials Chemistry B, Journal of Ocular Pharmacology & Therapeutics. He is a member of the American Institute of Chemical Engineers (AIChE), Sigma Xi Scientific Honor Society (USA), ARVO (USA), CRS (USA) and a life member of Institute of Engineers (India). He has served as a research mentor for CSIR-SRTP

2020 program, JNCASR Summer Research Fellowship program and Indo-French Student Exchange program.