2025/6/18 10:30-11:30
Laboratory Building (総合研究棟)B 310

Engineering Multifunctional Bismuth-Based Materials for Sustainable Energy Conversion and Storage

Dr. Vadivel S MSc, PhD
Former JSPS Fellow (Tokyo Institute of Technology, Japan)
Assistant Professor (Research) | Department of Chemistry
SRM Institute of Science and Technology
Kattankulathur Campus | Chennai - 603203, India
Email: vadivels1@srmist.edu.in & vlvelu7@gmail.com

Abstract:

The global push toward sustainable energy technologies necessitates the development of efficient, low-cost materials that can drive electrochemical processes with minimal environmental impact. This talk will highlight recent advances in the design and application of bismuth-based multifunctional materials for electrocatalysis and energy storage, with a focus on three strategically engineered systems.

First, we explore a Ru-minimised $Bi_2Ru_2O_7$@MOF-801 composite as a highly active catalyst for the oxygen evolution reaction (OER). This hybrid architecture combines the structural robustness of $Bi_2Ru_2O_7$ with the high surface area and porosity of MOF-801, resulting in superior catalytic activity while significantly reducing the use of noble metals, thereby addressing both performance and scalability. Next, we introduce α-$Bi_2Mo_3O_{12}$ as a dual-functional electrode material that facilitates both overall water splitting and supercapacitor applications. Its unique crystal structure supports rapid ion/electron transport, high electrochemical stability, and bifunctional catalytic behaviour, making it a strong candidate for integrated energy systems. Finally, we present layered bismuthene-modified Bi_2Te_3, wherein the incorporation of two-dimensional bismuthene layers enhances hydrogen evolution reaction (HER) activity. This design maximises the exposure of active sites, improves electronic conductivity, and demonstrates efficient charge transfer, offering a promising route for HER catalysis using abundant and low-toxicity elements.

These studies highlight the versatility of bismuth-based materials in addressing key challenges in the energy sector, particularly in minimising dependence on noble metals and enabling multifunctional performance. The talk will also discuss mechanistic insights, structure-activity relationships, and future directions for the real-world deployment of these materials.

References:

1. **P. Sujita, Keshav Gupta, and Sethumathavan Vadivel* et al., Nanoscale, 2025,17, 3714-3720**
2. **P. Sujita and Sethumathavan Vadivel* et al., *Chemistry: A European Journal,* 2024, 30, e202402645.**
3. **P. Sujita and Sethumathavan Vadivel* et al., Journal of Alloys and Compounds, 1003, 25, 2024, 175483**