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Defect Engineering in Hybrid Porous Materials for Enhanced Energy Technologies

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Metal-organic frameworks (MOFs) are materials made of metal centers linked by organic ligands to form two-dimensional (2D) or 3D structures, offering unique properties for sorption and electrochemical applications. However, their chemical instability, poor conductivity, and inaccessible pores limit their performance. Hybrid two-dimensional porous materials (H2DPMs), combining MOFs with robust 2D materials, address these issues, enhancing their electrochemical and physicochemical properties and expanding their application potential, although technical challenges remain. However, defect engineering in MOFs and two-dimensional porous materials involves the intentional introduction of defects to modify their properties, creating new active sites, increasing surface area, and enhancing overall performance. In my presentation, I will discuss recent advances in defect engineering of MOFs and two-dimensional materials, focusing on synthesis strategies, precise manipulation, and enhanced functionalities for heterogeneous catalysis and noble gas separation, while also addressing challenges and future application perspectives.

Kolleboyina Jayaramulu (Ram) is an Assistant Professor in the Department of Chemistry Indian Institute of Technology Jammu, India and Visting Professor at Czech Advanced Technology and Research Institute Palacký University Olomouc. He earned a PhD in Materials Chemistry at Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India. His scholarly pursuits have been further enriched by international experiences, having been honored with an Alexander von Humboldt Postdoctoral Fellowship in Germany, an ICMS Postdoctoral Fellowship and Sakura Science Exchange Program Japan. Ram is indeed a distinguished member of the prestigious Indian National Young Academy of Sciences (INYAS) (2023–2027). His research expertise is in the design and development of the structure–property relationship of hybrid (2D) porous materials for industrially relevant conditions.