Abstract:

The development of highly efficient corrosion-resistant photoelectrode materials and their processing technologies are critical in the context of efficient hydrogen production from solar energy through water photolysis. The central physicochemical parameters in meeting this are band-gap, band-edge alignments, band bending, surface electrocatalytic activity, stability in solution and most importantly, abundant availability at low cost. To date, no suitable material (nanostructure/film) has been demonstrated to meet all these requirements. While modulation of properties via variations in chemical composition has been explored extensively in the context of hydrogen generation using photoelectrochemical (PEC) systems, comprehensive modulation of properties via variation of nanostructure has not been pursued. We propose and demonstrate that modulation of desirable material properties can be achieved by stabilization of ‘non-native’ structures which are nanostructures having discrete translational symmetry in the sub-surface regions different from that present in the sub-surface regions of the thermodynamically most stable form of large crystals. These non-native structures have different physico-chemical properties (e.g. band-gap, band-edges) and catalytic activity in comparison to bulk ‘native’ structure due to different chemical coordination. Further, charge carrier separation can be addressed through formation of native@non-native isomaterial heterostructure and these nanostructures have been integrated into a wide variety of photoreactors via a generalized processing techniques centered around “Click Chemistry”.

About the Speaker:

Raj Pala is an Associate Professor in Chemical Engineering at IIT Kanpur. He obtained his B. Tech in Chemical & Electrochemical Engineering and MS in Biophysical Chemistry from central Electro-Chemical Research Institute (Karaikudi) and IISc-NCBS Bangalore respectively. After earning PhD in Physical Chemistry from University of Utah, he pursued his post-doctoral research in Heterogeneous Catalysis at University of California, Santa Barbara. Electrochemical and Reaction Engineering & Chemical approaches to Solar Energy capture, conversion and storage are his primary research interests.