

Understanding 2D-3D Semiconductor Interfaces for thermoelectrical, photoelectrochemical and gas sensor applications.

B.R. Mehta

Department of Physics

Indian Institute of technology Delhi, New Delhi, India.

Interfaces play a key and fundamental role in solar cell, thermoelectric, photoelectrochemical and other semiconductor devices. Interfaces or junction properties are inherently determined by crystal structure, lattice constant, energy band differences between two semiconductors forming the interface. In case of 2D materials, the lower thickness of the 2D layer and the modifications at the 2D-3D contact results in complex but interesting and useful junction properties. In this presentation, a number of examples based on the work carried out in our laboratory will be used to demonstrate the important features of 2D-3D interfaces. In the first example, the effect of incorporation of 2D nanoflakes on an n-type and a p-type Bi_2Te_3 and Sb_2Te_3 thermoelectric layers, respectively, has been studied. KPFM investigations of 2D-3D $\text{MoS}_2/\text{Sb}_2\text{Te}_3$ (n-p) and $\text{MoS}_2/\text{Bi}_2\text{Te}_3$ (n-n) heterojunctions with varying MoS_2 thicknesses shows a large surface charge accumulation at lower thickness, which has a large influence on the interface characteristic of 2D junctions. This results in multilayer $\text{Sb}_2\text{Te}_3/\text{MoS}_2$ structure having large enhancement in thermoelectric power factor. In another study, the role of In_2S_3 2D/ ZnO layers shows large enhancement in the photo-electrochemical response due to increased visible light absorption in the 2D layer and a favourable band alignment at the 2D-3D interfaces. Electronic interaction at the Metal- MoO_2 (2D) interface has been shown to result in enhanced and electronically reverse gas sensing response at lower temperature in comparison to MoO_2 thin films. It is concluded that layer dependent properties of 2D layers and novel features of 2D-2D and 2D-3D interfaces have large potential for fabricating semiconductor devices.