

ID-035

Nanoheterostructure Ag₂S/CdS/ZnO and Bi₂S₃/Ag₂S/ZnO for Solar Photoelectrochemical CellsZulkarnain Zainal^{a,b*}, Araa Mebdir Holi^c and Asla Abdullah Al-Zahrani^d

^a*Department of Chemistry, Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia*

^b*Nanomaterials Synthesis and Characterization Laboratory, Institute of Nanomaterials and Nanotechnology (ION2), Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.*

^c*Department of Physics, College of Education, Al-Qadisiyah University, Al-Diwaniyah, Al-Qadisiyah, Iraq*

^d*Department of Chemistry, College of Science, Imam Abdulrahman bin Faisal University, P.O. Box 1982, Dammam 31441, Saudi Arabia*

*Corresponding author: zulkar@upm.edu.my

Abstract. Nanoheterostructure materials comprising metal oxides and chalcogenides are extensively studied in the pursuit of clean, low-cost, sustainable, and renewable energy generation. Photoelectrochemical (PEC) cells with zinc oxide nanorods (ZnO NRs)-based photoanodes are considered among the most promising approaches for solar-to-chemical energy conversion. The efficiency of the nanorods can be further enhanced by inorganic sensitisation using narrow-gap metal sulfides (such as Ag₂S, CdS, and Bi₂S₃). To showcase these capabilities, two stable novel ternary nanoheterostructured photoelectrodes, Ag₂S/CdS/ZnO NRs and Bi₂S₃/Ag₂S/ZnO NRs were fabricated using facile hydrothermal and successive ionic layer adsorption and reaction (SILAR) techniques. High-resolution transmission electron microscopy (HRTEM) revealed the formation of well-distributed and highly uniform nanosized metal sulfide particles along the ZnO nanorods. The materials' energy gaps exhibited a significant shift, with enhanced light absorption in the visible region. The photoelectrochemical efficiency increased dramatically, with a 15-fold enhancement for Ag₂S/CdS/ZnO NRs and a 13-fold enhancement for Bi₂S₃/Ag₂S/ZnO NRs compared to pristine ZnO NRs. These electrodes show great potential for use in photoelectrochemical solar cells and solar hydrogen generation.

Keywords: Nanoheterostructure; photoelectrochemical cell; zinc oxide; metal chalcogenides