

ABSTRACT

Environmental pollution caused by synthetic dye waste from the textile industry, particularly methylene blue, has become a serious problem that demands effective and environmentally friendly solutions. Photocatalysis based on semiconductor heterojunctions is one of the widely developed alternatives, as it is capable of utilizing visible light energy to decompose organic pollutants into harmless products. This study aims to synthesize thin film heterojunctions of SiO₂/CdS and SiO₂/CdS/In₂S₃ on silica glass substrates and to evaluate their photocatalytic activity in degrading methylene blue.

The synthesis of thin films was carried out using the Chemical Bath Deposition (CBD) method with variations in deposition temperature and time to obtain optimal conditions. The silica glass substrate was first activated with silica powder prior to CdS deposition, followed by modification with In₂S₃. Material characterization was performed using X-Ray Diffraction (XRD), Scanning Electron Microscopy-Energy Dispersive X-Ray (SEM-EDX), UV-Visible Diffuse Reflectance Spectroscopy (UV-Vis DRS), Linear Sweep Voltammetry (LSV), and fluorescence spectroscopy.

XRD results confirmed the formation of CdS and In₂S₃ crystal phases, with the average crystallite size decreasing from 2.726 nm to 2.253 nm after modification. UV-Vis DRS analysis revealed a slight band gap widening from 2.39 eV to 2.41 eV, which is attributed to the quantum confinement effect resulting from the reduced crystallite size. LSV measurements showed approximately an 8-fold increase in current density after modification, and fluorescence spectroscopy confirmed that the photodegradation mechanism proceeds via hydroxyl radical (\cdot OH) pathway. Overall, the SiO₂/CdS/In₂S₃ thin film demonstrated higher methylene blue photodegradation efficiency compared to SiO₂/CdS, attributed to reduced electron-hole recombination through charge transfer mechanisms at the heterojunctions interface.

Keywords: methylene blue, photocatalysis, heterojunctions, CdS/In₂S₃, chemical bath deposition, thin film, band gap, hydroxyl radical