ABSTRACT

Synthetic dyes are among the most prevalent organic pollutants found in textile industrial wastewater, known to be toxic and resistant to natural degradation. Methylene blue, one of the most widely used cationic synthetic dyes, poses a significant environmental threat if left untreated. Photocatalysis using CdS semiconductor materials active under visible light represents an effective alternative strategy for dye wastewater treatment. This study aims to synthesize CdS on silica-based thin layer chromatography (TLC) glass substrates via the chemical bath deposition (CBD) method with varying deposition temperatures, and to evaluate its application in methylene blue degradation. Cadmium sulfide (CdS) was synthesized using the CBD method with $CdSO_4$ as the Cd^{2+} ion source, thiourea as the S^{2-} ion source, and NH_4OH as the complexing agent, at deposition temperatures of 30, 40, and 50°C. Material characterization was subsequently performed using X-ray diffraction (XRD), scanning electron microscopy–energy dispersive X-ray spectroscopy (SEM-EDX), UV-Vis diffuse reflectance spectroscopy (UV-DRS), linear sweep voltammetry (LSV), and hydroxyl radical (•OH) formation confirmed via fluorescence measurement using sodium terephthalate as a molecular probe. Photodegradation testing was conducted using a 4 ppm methylene blue solution under 200-watt visible light irradiation for 120 minutes at neutral pH conditions. XRD characterization confirmed the formation of CdS with an average crystallite size of 5.62 nm and a band gap value of 2.43 eV based on UV-DRS characterization. The formation of •OH radicals as the primary active species was confirmed by the emergence of a characteristic fluorescence emission peak of 2-hydroxyterephthalate at wavelengths of 425–428 nm with increasing irradiation time. Photodegradation results demonstrated that the methylene blue decolorization percentage increased with rising deposition temperature, reaching a maximum of 41.96% at a deposition temperature of 50°C after 120 minutes of irradiation. Kinetic analysis revealed that the photodegradation process follows a pseudo-first-order kinetic model, with a reaction rate constant (k) of 4.267×10^{-3} min^{-1} at a deposition temperature of 50°C.

Keywords: CdS, photocatalysis, methylene blue, chemical bath deposition.