ABSTRACT

Synthetic dyes such as Rhodamine B are widely used in the textile industry. However, wastewater containing this compound is toxic, carcinogenic, and resistant to natural degradation. One promising solution for treating such wastewater is photoelectrocatalytic technology based on visible-light-active semiconductors. $BiVO_4$ is a semiconductor material with a narrow band gap (2.3–2.4 eV), but its performance is often limited by the rapid recombination of electron–hole pairs. This study aims to synthesize $BiVO_4$ thin films on Fluorine-doped Tin Oxide (FTO) substrates using the dip coating method and to evaluate their characteristics and performance as photoanodes for Rhodamine B degradation by photoelectrocatalysis. The FTO substrates were immersed in $BiVO_4$ precursor solution for varying durations 5, 20, and 60 minutes. After that, the annealing process was carried out at a temperature of 450°C for 2 hours. Characterization techniques included XRD, SEM-EDX, UV-Vis DRS, and fluorescence spectrophotometer. Photoelectrocatalytic activity was assessed by measuring photocurrent density and the degradation efficiency of 16 ppm Rhodamine B under visible light irradiation. The optimal result was achieved with a 5 minute immersion, yielding a photocurrent density of 0.101 mA/cm² and a degradation efficiency of 74.8% after 100 minutes of irradiation. The degradation followed pseudo second-order kinetics with a rate constant of 0.0015 min^{-1}. Characterization confirmed the formation of monoclinic $BiVO_4$ with a crystallite size of 16.88 nm and a uniform surface. The resulting morphology was smooth and homogeneous, indicating good thin-film formation. Fluorescence spectroscopy revealed lower emission intensity for the 5 minute sample, suggesting reduced charge recombination and enhanced photocatalytic performance. Hydroxyl radical (•OH) generation, confirmed using HTA as a probe, occurred significantly during the reaction and played a major role in Rhodamine B degradation. This study demonstrates that the dip coating method is a simple, effective, and environmentally friendly approach for producing efficient $BiVO_4$ photoanodes for the treatment of organic dye pollutants.

Keywords: $BiVO_4$, dip coating, photoelectrocatalysis, Rhodamine B, visible light