ABSTRACT

Water pollution caused by synthetic dye wastewater, particularly methylene blue (MB), has become a significant environmental concern due to its toxicity and resistance to natural degradation. Photocatalysis is considered a promising approach for addressing this issue; however, single photocatalyst materials such as TiO_2 and Zeolitic Imidazolate Framework-8 (ZIF-8) are still limited by high electron–hole recombination rates and restricted light-harvesting capabilities. This study aimed to synthesize ZIF-8/TiO_2/g-C_3N_4 composites with varying g-C_3N_4 contents and evaluate their effects on the photocatalytic degradation of methylene blue. TiO_2 was synthesized using a precipitation method, while g-C_3N_4 was prepared through the calcination of melamine at 550°C. ZIF-8 was synthesized at room temperature. The ZIF-8/TiO_2/g-C_3N_4 composites were prepared via a dispersion method with mass ratios of 1:1, 1:2, and 1:3. The synthesized materials were characterized using X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), UV–Visible Diffuse Reflectance Spectroscopy (UV-DRS), and Brunauer–Emmett–Teller (BET) analysis to determine their crystal structures, functional groups, optical properties, and surface characteristics. The characterization results confirmed the successful formation of the composites while preserving the distinctive properties of their constituent materials. UV-DRS analysis revealed that the ZIF-8/TiO_2/g-C_3N_4 composite with a 1:1 ratio exhibited the lowest band gap energy of 2.50 eV, compared to 2.59 eV for ZIF-8/TiO_2. Photocatalytic tests demonstrated that the composite with a 1:3 ratio showed the highest performance, achieving 87.46% methylene blue degradation, a photocatalytic efficiency of 72.72%, and a pseudo-first-order rate constant of 0.0097 min^{-1} after 180 minutes of UV-A irradiation. The enhanced photocatalytic activity was attributed to the formation of a heterojunction, which promoted efficient charge separation and electron transfer during the photocatalytic process.

Keywords: *Methylene blue*, *Photocatalysis*, ZIF-8, TiO_2, g-C_3N_4, *Heterojunction*.