Studies on Synthesis, Characterization, and Photocatalytic Activity of Pure Zinc Oxide and Nickel-Doped ZnO Nanoparticles for the Degradation of Eosin Yellow and Malachite Green

Sonchita Akter Shaila

University of Chittagong, Chittagong, Bangladesh

Abstract:

Nanotechnology focuses on creating and applying materials with nanoscale dimensions. Nanoparticles, Because of their large surface area to volume ratio, exhibit unique features. Zinc oxide (ZnO) nanoparticles, particularly in their pure and nickel-doped forms, are gaining interest for various applications.

Using the co-precipitation approach, both pure ZnO and Ni-doped ZnO nanoparticles were synthesized. Characterization with SEM, EDX, and FT-IR revealed sphere-like NPs in ZnO and rod-like NPs in Ni-doped ZnO. The dopant quantity was measured using EDX, and FT-IR spectra confirmed ZnO stretching bands.

Doping improved adsorption efficiency and photocatalytic activity, making these nanoparticles effective in removing Eosin Yellow (EY) and Malachite Green (MG) dyes from water. Under UV irradiation, degradation efficiencies for EY reached 86% with pure ZnO and 92% with Ni-doped ZnO. For MG, the efficiencies were 97% and 99%, respectively. Doping also enhanced the electrical conductivity by introducing more charge carriers.

The synthesized nanoparticles, particularly those doped with nickel, exhibited remarkable photocatalytic activity and adsorption efficiency. These attributes position Ni-doped ZnO nanoparticles as highly promising materials for environmental applications, particularly in the effective removal of harmful dyes from wastewater. The study underscores their potential to significantly enhance photocatalyst efficiency for dye degradation, advancing the field of wastewater treatment. Ultimately, these findings contribute to the development of greener and more sustainable solutions for pollution reduction.