The Influence of Gadolinium on the Photocatalytic Performance of ZrO_2-g-C_3N_4 Systems Towards the Degradation of an Organic Dye in Water

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Abstract

This research reveals the influence of gadolinium (Gd) on visible-light photocatalytic performance of ZrO_2-g-C_3N_4 systems for the decomposition of eosin yellow (EY) dye in simulated wastewater. Simple chemical coprecipitation method was used to synthesize the nanocomposites. The effect of Gd percentage concentration on the structural, optical and photocatalytic properties of the synthesized nanocomposites was studied. Characterization of the nanomaterials was done using various advanced techniques such as ultraviolet/visible (UV/Vis) spectrophotometry, X-ray powder diffraction (XRD), Fourier transform infrared (FT-IR) spectroscopy, scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDX). The EDX analysis revealed the presence of Gd, C, N, Zr and O ions in the nanocomposites. The monoclinic phase of zirconium oxide was observed for the synthesized pure ZrO_2, as per the XRD analysis. However, the mixed phases of monoclinic and cubic were observed for some of the composites, whereas some also revealed only the cubic phase of zirconium oxide. The average crystallite size was 26 nm. UV/Vis spectrophotometric studies showed that the Gd and g-C_3N_4 co-doping significantly extended the optical absorption range towards the visible region, which confirmed a reduction in the bandgap (redshift). It was observed from the photocatalytic activities that all the composites exhibited a higher degradation performance, with the 0.8%Gd-ZrO_2-g-C_3N_4 attaining a degradation efficiency of 97% within 180 min with a rate constant of $1.71 \times 10^{-2}\text{min}^{-1}$. The improved photocatalytic activity was ascribed to the collaborative effects of Gd ions and g-C_3N_4, which enhanced the charge

carrier separation and extended the light absorption range. The synthesized nanocomposites have the mammoth potential for producing cutting-edge photocatalytic materials for use in water purification applications.

Keywords: Photocatalysis, graphitic carbon nitride, zirconium oxide, gadolinium, eosin yellow.

References

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