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Effective photocatalytic degradation of dye pollution in synthetic wastewater using nanocomposites of chromium and potassium oxides

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ABSTRACT

In the present work, chromium(III) oxide (Cr_2O_3) and potassium oxide (K_2O) nanoparticles (NPs) were synthesized using the combustion method. Mixed oxides of varying concentrations in the form of $(1–x)Cr_2O_3/xK_2O$ (x = 0.1, 0.3, 0.5, and 0.7) were prepared. X-ray diffraction (XRD), high-resolution transmission electron microscopy (HRTEM), and optical measurements were used to investigate the properties of NPs. XRD indicates that the grain size of the mixed oxides decreased as the K_2O content increased. Additionally, HRTEM revealed several types of shapes, such as hexagonally shaped NPs. The optical measurements showed a blue shift, indicating that the band structure was slightly modified during the Cr_2O_3/xK_2O mixing. The optical band gap obeys the direct allowed transition and varies from 2.29 to 2.59 eV as the K_2O ratio in the composites increases from x = 0.1 to 0.7. The $(1–x)Cr_2O_3/xK_2O$ NPs were used as catalysts in wastewater during a photocatalytic process. Orange G was chosen as an impurity in the water. The absorbance curves of Orange G in the water were measured at different times in the presence of the same quantity of Cr_2O_3/xK_2O NPs. It was found that after 120 min, the efficiency reached 11% and 33% for $(1–x)Cr_2O_3/xK_2O$ NPs with x = 0.1 and 0.7, respectively. Furthermore, the experimental results were analyzed by pseudo-first-order model. A first-order kinetic model had the best fit for the $(1–x)Cr_2O_3/xK_2O$ NPs. The strongest relationship occurred with a composition of $0.1Cr_2O_3/0.7K_2O$. The formed composites could be used to degrade organic dyes for water purification.

Keywords: Cr_2O_3; K_2O; High-resolution transmission electron microscopy; Photocatalysis; Optical properties; Dye pollution

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