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Photocatalytic Degradation of Nd_2O_3@SiO_2 Core-Shell Nanocomposites Under UV Irradiation Against Methylene Blue and Rhodamine B Dyes

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Abstract : Over the past years, industrial dyes have emerged as a significant threat to aquatic life, extensively detected in drinking water and groundwater, thus contributing to water pollution due to their improper and excessive use. To address this issue, the utilization of core-shell structures has been prioritized as it demonstrates remarkable efficiency in utilizing light energy for catalytic reactions and exhibiting excellent photocatalytic activity despite the availability of various photocatalysts. This work focuses on the photocatalytic degradation of Nd_2O_3@SiO_2 CSNs under UV light irradiation against MB and RhB dyes. Different characterization techniques, including XRD, FTIR, and TEM analyses, were employed to reveal the material's structure, functional groups, and morphological features. VSM and XPS analyses confirmed the soft, paramagnetic nature and chemical states with respective atomic percentages, respectively. Optical band gaps, determined using the Tauc plot model, indicated 4.24 eV and 4.13 eV for Nd_2O_3 NPs and Nd_2O_3@SiO_2 CSNs, respectively. The reduced bandgap energy of Nd_2O_3@SiO_2 CSNs enhances light absorption in the UV range, potentially leading to improved photocatalytic efficiency. The Nd_2O_3@SiO_2 CSNs exhibited greater degradation efficiency, reaching 95% and 96% against MB and RhB dyes, while Nd_2O_3 NPs showed 90% and 92%, respectively. The enhanced efficiency of Nd_2O_3@SiO_2 CSNs can be attributed to the larger specific surface area provided by the SiO_2 shell, as confirmed by surface area analysis using the BET surface area analyzer through N_2 adsorption-desorption.

Keywords : core shell nanocomposites, rare earth oxides, photocatalysis, advanced oxidation process
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