

Improved Photocatalytic Activity of ZnO through Lanthanide Oxide Modification

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Abstract

This study presents the synthesis and evaluation of ZnO nanostructures modified with lanthanide oxides (CeO_2 , La_2O_3 , and Gd_2O_3) for the photocatalytic degradation of ceftriaxone in aqueous solutions. The materials were prepared via a sol-gel method to ensure homogeneous dopant dispersion, and their structural and functional properties were characterized. Photocatalytic activity under UV irradiation was assessed at an optimal catalyst loading of $0.05 \text{ g}\cdot\text{L}^{-1}$, with degradation following pseudo-first-order kinetics, indicating that the process is governed by surface-mediated reactions.

Among the investigated systems, CeO_2/ZnO showed the highest photocatalytic efficiency (91,3%), outperforming pure ZnO and the samples modified with La_2O_3 or Gd_2O_3 . This improvement is attributed to more effective charge-carrier separation, enhanced formation of reactive oxygen species, and the establishment of ZnO- CeO_2 heterojunctions that promote electron transfer.

These results show that modifying ZnO with f-block oxides—especially CeO_2 —offers an effective route to significantly enhance its photocatalytic efficiency for removing antibiotic contaminants from wastewater.

Keywords

Ceftriaxone removal, lanthanide-doped ZnO, photocatalytic degradation, sol-gel synthesis.