Enhancing Visible Light-Driven Photocatalysis for Water Treatment: Optimizing Fe_3O_4@SiO_2@Cr–TiO_2–S Nanocomposite Efficiency with Silver and Palladium Deposition

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Abstract

In this study, we developed a magnetically separable, visible light-responsive photocatalyst, Fe_3O_4@SiO_2@Cr–TiO_2–S, optimized via response surface methodology (RSM) for enhanced photodegradation of methyl orange in water. By doping with chromium and sulfur, and further surface modification with silver and palladium nanoparticles, we achieved significant improvement in photocatalytic efficiency under visible light. Our findings reveal that the optimal doping levels of Cr/TiO_2 at 2.88 mol% and S/TiO_2 at 3.02 mol%, coupled with noble metal deposition, notably enhance the degradation rates, leveraging the surface plasmon resonance effects of Ag nanoparticles for better light absorption and charge separation. This study presents a novel approach to synthesizing efficient photocatalysts for water treatment applications, highlighting the potential of magnetic nanocomposites in environmental remediation.