Visible-Light-Activated SPR-Enhanced Nanocatalyst for Simultaneous Water Disinfection and Organic Pollutant Removal

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With approximately 4.4 billion people worldwide lacking access to safe water, sustainable purification technologies that operate efficiently under natural sunlight are necessary. Industrial effluents and pathogenic microorganisms present challenges that have not been effectively met. In this project, a specially developed surface plasmon resonance (SPR)-enhanced g-C3N4/WO3/Ag3PO4 ternary nanocatalyst was introduced for simultaneous organic pollutant degradation and bacterial disinfection under visible light. A stable heterojunction nanocomposite integrating g-C3N4, WO3, and Ag3PO4 was synthesized through a stepwise approach to enable efficient charge separation and enhanced visible-light activity. Various characterization techniques were performed to examine visible-light absorption, absorption-edge shifts, and electron–hole recombination characteristics to assess charge separation efficiency. Subsequently, photocatalytic performance was examined under visible-light irradiation using single, binary, and ternary systems. The ternary nanocomposite exhibited the highest efficiency, achieving 99% degradation of Rhodamine B within 60 minutes, with an apparent rate constant of 0.03855 min?¹, demonstrating rapid photocatalytic activity. The antibacterial performance was evaluated and demonstrated significant bacterial inhibition, with 89%, 53%, and 82% reduction in S. flexnerii, E. faecalis, and C. albicans, respectively. This was attributed to enhanced reactive oxygen species generation. The catalyst demonstrated strong recyclability and self-regeneration, as confirmed through triple degradation cycles with no noticeable loss in performance. Overall, this work presents a potentially practical and sustainable solution for advanced water purification.

Awards Won:
Third Award of $1,200