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Photocatalytic degradation of organic dyes using ternary Ag nanoparticles/ZnO nanorods/PAN nanofibers under UV and natural sunlight irradiation

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Abstract

Ensuring access to clean water necessitates effective wastewater treatment strategies, particularly through advanced photocatalytic methods. In this study, polyacrylonitrile (PAN) nanofibers were fabricated by electrospinning as a low-cost and scalable substrate to support the growth of ZnO nanorods (NRs). Subsequently, silver nanoparticles (Ag NPs) were uniformly deposited onto the ZnO NRs/ PAN NFs to synthesize Ag NPs/ ZnO NRs/ PAN NFs composites with an optimized silver content. The photocatalytic performance of the prepared nanocomposites was evaluated by monitoring the degradation of Acid Orange 7 (AO7) dye and a mixture of methylene blue (MB) and rhodamine B (RhB) as model organic pollutants under UV and natural sunlight irradiation, respectively. The Ag NPs/ ZnO NRs/ PAN NFs exhibited a 1.7 times higher photocatalytic activity for AO7 photodegradation under UV light compared to the ZnO NRs/ PAN NFs. Additionally, under natural sunlight, this composite achieved photodegradation efficiencies of 83.5% and 60.4% for mixture of MB and RhB within 60 minutes, respectively. Mechanistic investigations using radical scavengers confirmed that the generation of hot plasmonic electrons on the Ag NPs under UV illumination plays a crucial role in enhancing photocatalytic performance. Owing to its flexibility and mechanical integrity, this photocatalyst presents a promising platform for future research and practical applications in efficient wastewater treatment.

Keywords: Electrospinning, Photocatalytic activity, Organic dyes, Plasmon resonance, Natural sunlight

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