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Effect of Concentrations of $AgNO_3$ on the Formation of Ag-TiO_2-gC_3N_4 Composite for Removal of Methyl Orange

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Structured Abstract

Background: Methyl orange, a common azo dye widely used in the textile industry, often contaminates water and requires effective treatment. Photocatalysis is an efficient method, with Ag-TiO_2-gC_3N_4 emerging as a promising photocatalyst due to its enhanced performance. This study aims to synthesize Ag-TiO_2-gC_3N_4 composites with varying $AgNO_3$ concentrations, characterize their physicochemical properties, and evaluate their efficiency in removing methyl orange.

Methods: The composite was synthesized by combining the TiO_2 precursor with C_3N_4 powder via a hydrothermal method, followed by deposition of Ag via photo deposition using different concentrations of $AgNO_3$ at 1%, 3%, and 5%$AgNO_3$ to obtain Ag-TiO_2-gC_3N_4 composite. The physicochemical properties of the composites were characterized using XRD, FESEM, and UV-DRS. Photocatalytic performance was evaluated by degrading a 20ppm methyl orange solution under visible light.

Results: This study confirmed the successful synthesis of the Ag-TiO_2-gC_3N_4 composite. XRD analysis showed that TiO_2 has an anatase phase peak, while C_3N_4 exhibits a hexagonal structure. However, when combined, the TiO_2 peak remains, yet the C_3N_4 peak disappears due to the low TiO_2:C_3N_4 ratio (16:1). The Ag peak at 44.2° confirms the successful deposition of Ag on the TiO_2-C_3N_4 composite, with its intensity increasing as $AgNO_3$ concentrations increase. FESEM analysis revealed that TiO_2 has a spherical structure, while C_3N_4 has a layered-sheet structure. When combined, the spherical TiO_2 embeds into the layered C_3N_4, with small, bright Ag particles successfully deposited on the composite. UV-DRS analysis revealed band gaps of 3.35 eV for TiO_2, 2.88 eV for C_3N_4, and 3.22 eV for both TiO_2-gC_3N_4 and Ag-TiO_2-gC_3N_4, Photocatalytic tests showed that the 3% Ag-TiO_2-gC_3N_4 composite achieved the highest methyl orange removal via adsorption, while TiO_2-gC_3N_4 had the highest removal efficiency via photocatalysis.

Conclusion: The 3% Ag-TiO_2-gC_3N_4 composite demonstrated the highest photocatalytic removal of methyl orange Its balanced physicochemical properties highlight its potential as an effective composite for the removal of methyl orange from the aqueous solution.

Keywords: Methyl Orange, Hydrothermal, Composite, Photodeposition, Photocatalysis

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