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Photocatalytic Degradation of Tetracycline using Graphitic Carbon Nitride coupled with TiO_2

Durrani Amri[a], Lim Ying Chin[ab*]

Structured Abstract

Background: Tetracycline, an antibiotic, poses significant threats to human health and ecosystems. Wastewater treatment methods such as photocatalysis, absorption, and filtration are employed to address this issue. Titanium dioxide (TiO_2) is valued for its non-toxicity and UV light activation, while graphitic carbon nitride (g-C_3N_4) is effective for long-term pollutant degradation. Researchers enhance TiO_2's visible light responsiveness by coupling it with g-C_3N_4, improving charge transfer and overall performance. Combining g-C_3N_4 with TiO_2 offers a promising solution for effectively removing tetracycline from wastewater.

Methods: Pure g-C_3N_4 was synthesized by pyrolyzing urea at 550°C for 3 hours. TiO_2 was made by autoclaving titanium tetrabutoxide at 120°C for 4 hours, filtering, drying, and calcining at 500°C for 2 hours. TiO_2/g-C_3N_4 composites (1:16 mass ratio) were mixed in anhydrous ethanol, sonicated, and tested at various catalyst mass loadings (0.1-0.4 g/L) in a 10 ppm tetracycline solution. Stability test was performed for 3 consecutive cycles and scavenger tests were conducted on the composites. The composites were characterized using XRD, UVDRS and BET.

Results: The hydrothermal method produced TiO_2/g-C_3N_4 composites achieving 88% tetracycline removal at 0.4 g/L in 180 minutes. Stability tests indicated initial efficiencies of 83% and 82%, declining to 76% in the third cycle, suggesting long-term stability. Scavenger tests highlighted the hole scavenger's role in enhancing photocatalytic efficiency. The XRD confirmed the presence of anatase TiO_2 and hexagonal g-C_3N_4. The UV-DRS analysis demonstrating TiO_2/g-C_3N_4 bandgap of 3.22 eV, and BET revealing a surface area of 65.12 m^2/g for the 1:16 composite.

Conclusion: In conclusion, this study has successfully synthesized TiO_2/g-C_3N_4 photocatalysts via hydrothermal methods and characterized them using XRD, UVDRS, and BET. The investigation of catalyst dosage (0.1-0.4 g/L) demonstrated its impact on enhancing tetracycline photodegradation efficiency. These findings highlight the potential of TiO_2/g-C_3N_4 composites as effective photocatalysts for environmental applications, particularly in treating wastewater contaminated with antibiotics such as tetracycline.

Keywords: TiO_2/g-C_3N_4, Tetracycline, Photocatalysis, Hydrothermal, Catalyst loading.

*Correspondence: limyi613@uitm.edu.my

[a] School of Chemistry & Environment, Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam, Malaysia

[b] Electrochemical Materials & Sensors Research Group (EMaS), Universiti Teknologi MARA, Shah Alam, Malaysia