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Synthesis of TiO_2-C_3N_4 For Removal of Tetracycline

Nur Hannah Md Isa[a], Lim Ying Chin[ab*]

Structured Abstract

Background: The widespread use of antibiotics such as tetracycline has led to significant environmental contamination, necessitating the development of effective removal methods. TiO_2-C_3N_4 composites are promising photocatalysts due to their enhanced photocatalytic properties and stability. This study aims to synthesize TiO_2-C_3N_4 composites with varying mass ratios via a hydrothermal process, characterize their physicochemical properties, and evaluate their efficiency in degrading tetracycline.

Methods: The synthesis involved synthesis of TiO_2 using tetrabutyl titanate (TBOT) followed by combination of TiO_2 precursor with C_3N_4 powder via hydrothermal treatment. The product was calcined at 500°C for 2 hours to obtain TiO_2-C_3N_4 composites with mass ratios of TiO_2-C_3N_4 at 8:1, 16:1, 24:1, and 1:8. The physicochemical properties of the composites were characterized using X-ray diffraction (XRD), Brunauer–Emmett–Teller (BET), and UV-Vis Diffuse Reflectance Spectroscopy (UV-DRS). Photocatalytic performance was assessed by degrading a 10 ppm tetracycline solution under visible light.

Results: The study revealed that the TiO_2-C_3N_4 composites were successfully synthesized and XRD analysis confirmed the anatase phase for TiO_2 and the hexagonal crystal system for C_3N_4. The 8:1, 16:1, and 24:1 composite exhibited prominent anatase peaks, while the 1:8 composite showed peaks for both TiO_2 and C_3N_4, indicating the successful incorporation of both phases. BET analysis revealed that the 16:1 composite achieves a favourable balance, offering a higher surface area essential for catalytic processes, while maintaining efficient material use for effective catalysis. UV-DRS analysis showed band gaps of 3.35 eV for TiO_2, 2.88 eV for C_3N_4, and 3.22 eV for the 16:1 composite, suggesting improved visible light absorption. The photocatalytic performance demonstrated that the 16:1 TiO_2-C_3N_4 composite achieved the highest tetracycline degradation rate of 83.6%, significantly higher than other ratios. All composites displayed degradation process following the pseudo-first-order kinetics, highlighting the concentration-dependent nature of the photocatalytic reaction.

Conclusion: In conclusion, the 16:1 TiO_2-C_3N_4 composite exhibited superior photocatalytic performance and balanced physicochemical properties, making it a promising candidate for tetracycline removal from aqueous solutions. This study underscores the potential of TiO_2-C_3N_4 composites in environmental remediation applications.

Keywords: Composites, Hydrothermal, Photocatalysis, Tetracycline

*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