

Development of BiFeO₃/ZnO Heterojunction Photocatalysts for Tetracycline Degradation: A Comparative Study of Different Ratios

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Structured Abstract

Background: Tetracycline, a widely used antibiotic, has become a persistent contaminant in water sources due to its resistance to natural degradation. Conventional treatment methods are often ineffective at removing such pharmaceutical pollutants. Photocatalysis has emerged as a promising approach, and the combination of BiFeO₃ and ZnO into a heterojunction photocatalyst offers enhanced degradation efficiency under visible light. This study focuses on developing BiFeO₃/ZnO composites to address tetracycline contamination through improved photocatalytic activity.

Methods: BiFeO₃/ZnO photocatalysts with different molar ratios (1:2, 1:1, 2:1) were synthesized using the hydrothermal method. The samples were characterized using XRD, FESEM-EDX, BET, and UV-Vis-NIR to determine their structural, morphological, and optical properties. Photocatalytic performance was evaluated by degrading 10 mg/L tetracycline solution under visible light (24-Watt LED), followed by control, scavenger, and recyclability tests.

Results: Among the synthesized samples, the BZ21 (2:1) ratio exhibited the highest photocatalytic efficiency in degrading tetracycline under visible light, attributed to its optimal band gap and surface properties. Characterization confirmed successful heterojunction formation, and reusability tests showed a gradual decline in efficiency over repeated cycles.

Conclusion: The BiFeO₃/ZnO heterojunction photocatalysts successfully enhanced tetracycline degradation under visible light, with BZ21 showing the highest efficiency. The improved performance was due to better charge separation and light absorption. This study demonstrates the potential of BiFeO₃/ZnO composites as effective and sustainable photocatalysts for removing pharmaceutical pollutants from water.

Keywords: Photocatalysts, BiFeO₃/ZnO, degradation, tetracycline, hydrothermal synthesis

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