

A Review of Synthesis Methods for FeTiO₂ and Its Photocatalytic Performance

Nur Nasuha Binti Jamaludin^a, Lim Ying Chin^{a,b*}

Structured Abstract

Background: Iron doped titanium dioxide (FeTiO₂) has emerged as a promising modification to enhance the photocatalytic performance of TiO₂, particularly under visible light. While pristine TiO₂ is widely used due to its stability and non-toxicity, its wide bandgap limits absorption to UV light. Doping with Fe introduces impurity energy levels within the bandgap, improving light absorption and charge separation. This review explores recent advances in FeTiO₂, focusing on its synthesis strategies, structural properties, and effectiveness in degrading organic pollutants under photocatalytic conditions.

Methods: For this review, reputable databases such as ScienceDirect, Scopus, and Google Scholar were utilized. Over 25 articles published within the last 10 years were selected using keywords such as “photocatalysis,” “Fe-doped TiO₂,” “metal doping,” and “synthesis methods.” Irrelevant materials and non-peer-reviewed sources were excluded from the analysis.

Results: Sol-gel and electrospinning techniques have demonstrated remarkable effectiveness in producing FeTiO₂ photocatalysts with enhanced performance for environmental remediation. These methods enable precise control over crystal structure, particle size, and surface area where all these are key factors in achieving high photocatalytic efficiency. For instance, FeTiO₂ synthesized via sol-gel has shown superior degradation of organic pollutants such as methylene blue and tetracycline under visible light, while electrospun nanofibers exhibited improved surface reactivity and stability during repeated use. In contrast, although co-precipitation and green synthesis approaches offer sustainability benefits, they often suffer from irregular morphologies and reduced photocatalyst durability. Therefore, sol-gel and electrospinning stand out as more reliable methods for developing high-performance Fe-TiO₂ photocatalysts for practical applications in water purification and environmental cleanup.

Conclusion: FeTiO₂ has demonstrated significant promise in enhancing photocatalytic activity through improved visible light absorption and better charge separation. The choice of synthesis method greatly influences the structure of material, optical properties, and overall degradation efficiency. However, challenges such as particle agglomeration, optimal doping levels, and insufficient long-term stability remain. Future research should prioritize green synthesis, advanced characterization, and mechanistic modelling to optimize performance and promote sustainable photocatalyst development.

Keywords: Titanium dioxide, Fe-doped TiO₂, synthesis, transition metals, photocatalysis

*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