

Review of TiO₂-Graphitic Carbon Nitride Based Composites for the Degradation of Emerging Pollutants

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Structured Abstract

Background: Photocatalysis using semiconductor materials has gained attention for its potential in tackling environmental and energy-related challenges. Titanium dioxide (TiO₂) is widely used for its stability, low cost, and non-toxicity, though its photocatalytic activity is limited to the UV region due to its wide band gap and rapid electron-hole recombination. Concurrently, graphitic carbon nitride (g-C₃N₄), a visible-light-responsive, metal-free polymeric semiconductor, has emerged as a promising partner to form heterojunctions with TiO₂. The formation of these heterojunctions enhances charge separation, broadens visible-light absorption, and improves photocatalytic performance. This review explores and compares synthesis methods for TiO₂-g-C₃N₄ composites and their potential to degrade emerging pollutants.

Methods: This review was carried out by collecting journal articles related to the synthesis and photocatalytic performance of TiO₂-g-C₃N₄ composites, particularly those discussing heterojunction formation, visible-light response, and structural enhancement from ScienceDirect, Scopus and WoS. The literature primarily focused on studies involving hydrothermal, calcination, and chemical dipping techniques, with attention to articles exploring charge-transfer mechanisms and band-gap modification. Approximately 25 articles were reviewed to identify recent trends, evaluate synthesis strategies, and highlight areas requiring further investigation.

Results: The review found that the performance of TiO₂-g-C₃N₄ composites is strongly influenced by the synthesis route. Hydrothermal methods generally produce well-distributed heterojunctions, thereby improving charge separation and visible-light activity. Calcination enhances crystallinity and bonding but requires careful thermal control to avoid phase distortion or loss of active sites. Chemical dipping allows uniform surface coating, which is ideal for film-based applications, yet results vary due to inconsistent precursor concentrations and substrate compatibility. Furthermore, studies often differ in light sources, pollutant types, and degradation conditions, complicating performance comparison. Crucially, charge-transfer pathways remain insufficiently explored, limiting mechanistic insight and reproducibility.

Conclusion: TiO₂-g-C₃N₄ composites represent a promising direction in the design of visible-light-responsive photocatalysts. Continued research into synthesis control and mechanistic understanding will be essential to maximize their real-world environmental impact.

Keywords: Photocatalysis, TiO₂, g-C₃N₄, heterojunctions, environmental remediation

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