

Acalypha wilkesiana-Mediated Synthesis of $\text{TiO}_2/\text{PrCrO}_3$ Nanocomposites: Characterization and Photocatalytic Performance.

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Abstract:

The development of efficient photocatalysts with improved visible-light activity remains an important challenge in environmental catalysis. In this study, $\text{TiO}_2/\text{PrCrO}_3$ nanocomposites were synthesized via a green approach using *Acalypha wilkesiana* (Miana) leaf extract (AWLE) to enhance the photocatalytic performance of TiO_2 . The phytochemical constituents in AWLE act as a weak base and capping agents, promoting the formation of well-defined $\text{TiO}_2/\text{PrCrO}_3$ nanostructures. The structural, optical, and morphological properties of the nanocomposites were characterized using X-ray diffraction (XRD), Fourier-transform infrared (FT-IR) spectroscopy, scanning electron microscopy (SEM), UV-Vis diffuse reflectance spectroscopy (UV-Vis DRS), energy-dispersive X-ray spectroscopy (EDX), high-resolution transmission electron microscopy (HR-TEM), and X-ray photoelectron spectroscopy (XPS). The results confirmed the successful formation of $\text{TiO}_2/\text{PrCrO}_3$ nanocomposites with improved crystallinity and modified electronic structure. The incorporation of PrCrO_3 effectively reduced the band gap energy of TiO_2 , resulting in enhanced visible-light absorption and improved photocatalytic performance. Under visible-light irradiation, the $\text{TiO}_2/\text{PrCrO}_3$ nanocomposite achieved a degradation efficiency of 92.0% for malachite green (MG) within 120 min. The photodegradation process followed pseudo-first-order kinetics, indicating enhanced charge separation and faster reaction kinetics compared to pristine TiO_2 . Radical scavenging experiments revealed that superoxide radicals ($\cdot\text{O}_2^-$) are the dominant reactive species responsible for MG degradation. The enhanced photocatalytic activity is attributed to the synergistic interaction between TiO_2 and PrCrO_3 , which facilitates charge transfer and suppresses electron-hole recombination. This study demonstrates a sustainable strategy for the green synthesis of TiO_2 -based nanocomposites using plant extracts, providing an environmentally friendly approach for developing efficient visible-light photocatalysts for wastewater treatment.

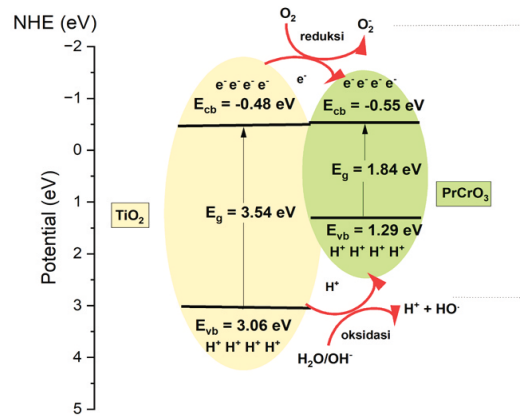


Figure 1. Proposed band structure and photocatalytic charge-transfer mechanism of the $\text{TiO}_2/\text{PrCrO}_3$ nanocomposite under visible-light irradiation.

Keywords:

Nanocomposite, $\text{TiO}_2/\text{PrCrO}_3$, *Acalypha wilkesiana*, Green synthesis, Photocatalysis, Malachite green degradation.