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Qurtulen*

Department of Industrial Chemistry, Aligarh Muslim University, Aligarh,
India

Visible-Light Active CQDs/TiO₂ Nanocomposite for Dye Degradation

Abstract: A CQDs/TiO₂ nanocomposite was synthesized via a one-step hydrothermal process using kitchen waste, providing an eco-friendly solution for environmental applications. This composite was extensively characterized using several analytical techniques. Fourier-transform infrared (FTIR) spectroscopy helped identify functional groups, indicating the presence of surface functionalities essential for photocatalysis. X-ray diffraction (XRD) revealed the crystalline nature of TiO₂, confirming its structural integrity, while X-ray photoelectron spectroscopy (XPS) determined the composite's chemical composition and hybridization states, ensuring the effective incorporation of CQDs with TiO₂. Optical properties of the CQDs/TiO₂ composite were examined using ultraviolet-visible (UV-vis) spectroscopy and fluorescence studies, which verified its capacity to absorb visible light, essential for photocatalytic performance. When evaluated under visible light, the CQDs/TiO₂ nanocomposite achieved an impressive 98% degradation of Brilliant Green (BG) dye. This high photocatalytic efficiency is attributed to the synergy between CQDs and TiO₂: CQDs enhance TiO₂'s visible light absorption and improve charge separation, generating reactive species needed for efficient dye degradation. Consequently, the CQDs/TiO₂ composite offers a promising, sustainable solution for environmental remediation, particularly in breaking down hazardous organic pollutants under visible light.

Keywords: Carbon Quantum Dots, Hydrothermal, Fluorescence, Photocatalysis