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Improving Photocatalytic Efficiency of TiO2 Films Incorporated with Natural Geopolymer for Sunlight-Driven Water Purification

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Abstract : This research study presents a novel approach to harnessing the potential of natural geopolymer in conjunction with TiO_2 nanoparticles (TiO_2 NPs) for the development of highly efficient photocatalytic materials for water decontamination. The study begins with the formulation of a geopolymer paste derived from natural sources, which is subsequently applied as a coating on glass substrates and allowed to air-dry at room temperature. The result is a series of geopolymer-coated glass films, serving as the foundation for further experimentation. To enhance the photocatalytic capabilities of these films, a critical step involves immersing them in a suspension of TiO_2 nanoparticles (TiO_2 NPs) in water for varying durations. This immersion process yields geopolymer-loaded TiO_2 NPs films with varying concentrations, setting the stage for comprehensive characterization and analysis. A range of advanced analytical techniques, including UV-Vis spectroscopy, Fourier-transform infrared spectroscopy (FTIR), Raman spectroscopy, scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), and atomic force microscopy (AFM), were meticulously employed to assess the structural, morphological, and chemical properties of the geopolymer-based TiO_2 films. These analyses provided invaluable insights into the materials' composition and surface characteristics. The culmination of this research effort sees the geopolymer-based TiO_2 films being repurposed as immobilized photocatalytic reactors for water decontamination under natural sunlight irradiation. Remarkably, the results revealed exceptional photocatalytic performance that exceeded the capabilities of conventional TiO_2-based photocatalysts. This breakthrough underscores the significant potential of natural geopolymer as a versatile and highly effective matrix for enhancing the photocatalytic efficiency of TiO_2 nanoparticles in water treatment applications. In summary, this study represents a significant advancement in the quest for sustainable and efficient photocatalytic materials for environmental remediation. By harnessing the synergistic effects of natural geopolymer and TiO_2 nanoparticles, these geopolymer-based films exhibit outstanding promise in addressing water decontamination challenges and contribute to the development of eco-friendly solutions for a cleaner and healthier environment.

Keywords : geopolymer, TiO2 nanoparticles, photocatalytic materials, water decontamination, sustainable remediation
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