Evaluating MnO2 as a Transparent Photocatalytic Alternative to TiO2: A Comparative Study of PET Particulate Degradation and Real-Time Spectral Monitoring of Aromatic Byproducts via UV-Vis Spectroscopy

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This study evaluates the feasibility of MnO2 as a transparent, cost-effective alternative to TiO2, the industry standard, in photocatalytic remediation and degradation of PET microplastics. The research investigates if MnO2 can facilitate the cleavage of stable ester bonds into aromatic intermediates in basic conditions, while providing a clearer optical path for real-time absorbance monitoring than current standards. PET plastics were treated with 395nm UV-A light, as well as H2O2, and either acetic acid or NaOH depending on their designated pH environment. H2O2 facilitates the production of hydroxyl radicals, while alkali-enhanced environments weakened ester bonds, both expediting catalytic breakdown. Degradation was monitored via UV-Vis spectroscopy (380–400nm) to track the release of aromatic byproducts. High-pH environments across the board showed successful acceleration of polymer chain scission. Initial data analysis demonstrated extremely high absorbance for Basic TiO2 reactors, however this can be identified as a false signature caused by Mie scattering from its colloidal suspension. Conversely, basic MnO2 reactors successfully generated potential signatures of measurable degradation intermediates, like terephthalic acid, while also maintaining solution clarity to monitor these aromatic monomer releases through absorbance spectra. Its catalytic reactions with H2O2 also showed potential for catalytic micromotors in recovery of microplastics as well. MnO2 establishes high viability as a monitorable, cost-effective photocatalyst for PET chemical degradation and remediation through recovery efficiency. By providing spectral transparency, MnO2 provides a scalable, environmentally sustainable solution to global microplastic remediation overall.

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