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Experimental Study on the Rapid Degradation of Volatile Organic Compounds (VOCs) Using Nano Photocatalytic Materials

Volatile Organic Compounds (VOCs) are a group of highly reactive and easily vaporized organic pollutants commonly found in industrial emissions, vehicle exhaust, building materials, and household products. As precursors to ozone and fine particulate matter ($PM_{2.5}$), VOCs pose serious threats to atmospheric environmental quality and public health. The rapid and efficient removal of VOCs has become a pressing challenge in the field of air pollution control.

Among various treatment technologies, photocatalytic oxidation (PCO) stands out due to its mild reaction conditions, high degradation efficiency, and environmentally friendly end products. With the advancement of nanomaterials science, nano-structured photocatalytic materials have demonstrated significant potential in VOCs removal, thanks to their high surface area, strong photo-reactivity, and efficient charge separation. Semiconductor-based materials such as TiO_2, ZnO, and g-C_3N_4 can generate electron-hole pairs under UV or visible light irradiation, which further produce reactive species like hydroxyl radicals (·OH) and superoxide anions ($\cdot O_2^-$) to achieve complete mineralization of organic pollutants.

This study focuses on constructing an experimental system for the rapid degradation of VOCs using nano-photocatalytic materials. The effects of different material types, light intensity, and reaction time on degradation efficiency are systematically investigated. Analytical tools such as gas chromatography (GC) and Fourier-transform infrared spectroscopy (FTIR) are employed to track intermediate products and clarify the degradation mechanisms. The feasibility and stability of these materials in practical applications are also evaluated.

The findings are expected to provide theoretical and technical support for indoor air purification and industrial VOCs abatement, and offer innovative solutions for the development of efficient and eco-friendly air pollution control technologies.