

Synthesis of Zinc Oxide Nanoparticles from Spent Battery Wastes via Laser Ablation Technique for Photocatalytic Dye Degradation Application.

The recycling of waste materials into reusable resources plays a crucial role in environmental sustainability and waste reduction. Rapid industrialization and urbanization have led to the large-scale accumulation of electronic waste, among which spent batteries represent a valuable secondary source of functional materials [1]. In addition to that, among various forms of pollution, water pollution is regarded as the most hazardous to the environment due to large amount of effluents discharged from textile and dyeing industries that leads to a serious ecological threat. Production of efficient catalyst to degrade the dyes from waste materials reduces the environmental pollution, resources scarcity and production costs. In recent years, metal oxide nanoparticles (MO NPs) have emerged as promising candidate for dye degradation. Among MO NPs, zinc oxide nanoparticles (ZnO NPs) exhibit excellent photocatalytic activity, because of their physico-chemical properties, chemical & thermal stability and non-toxicity [2,3]. Conventional nanoparticle synthesis methods are often constrained by complex processing requirements and huge processing time. Laser ablation provides a straightforward and environmentally sustainable alternative for the one-step synthesis of high-purity nanoparticles without the use of chemical reagents or stabilizing agents. Compared to other laser ablation techniques, continuous wave fibre laser (CWFL) provides steady energy density, ensures rapid and controlled ablation [4]. Bearing this in mind, an attempt was made to synthesize ZnO NPs from spent battery waste using CWFL ablation technique. Structural, elemental, and functional group analyses evidenced the formation of ZnO NPs. The photocatalytic performance of the synthesized ZnO NPs was evaluated through the degradation of methylene blue (MB) and rhodamine B (RhB) dyes under UV and solar irradiation. The results demonstrated a progressive decrease in dye concentration with increasing irradiation time, achieving a maximum degradation efficiency of 99% under solar and UV light. These findings highlight the potential pathway for sustainable resource utilization by converting spent battery waste into high-purity ZnO NPs with superior photocatalytic activity.

References;

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