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Photocatalytic Degradation of CitrusLemon-Capped CdO Nanocatalyst Synthesized via the Ceramic Method

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Abstract: *Cadmium oxide (CdO) nanoparticles are promising photocatalytic materials due to their narrow bandgap and high carrier mobility; however, their efficiency is often limited by rapid electron-hole recombination and particle agglomeration. In this study, lemon-capped CdO nanoparticles were synthesized via a conventional ceramic method integrated with green surface functionalization using lemon (Citrus limon) extract. The influence of lemon-derived biomolecules on structural, morphological, optical, and photocatalytic properties was systematically examined. X-ray diffraction analysis confirmed the formation of phase-pure cubic CdO with a substantial reduction in crystallite size from approximately 41 nm for uncapped CdO to 24 nm for lemon-capped CdO. Electron microscopy revealed improved particle dispersion and reduced agglomeration in capped samples. FTIR spectra verified the presence of hydroxyl and carboxyl functional groups on the nanoparticle surface. Optical analysis indicated enhanced visible-light absorption and bandgap narrowing from 2.42 eV to 2.21 eV. Photocatalytic degradation of methylene blue under UV-visible irradiation showed that lemon-capped CdO achieved ~95% degradation within 90 minutes, significantly outperforming uncapped CdO. Kinetic analysis followed pseudo-first-order behavior, demonstrating enhanced reaction rates due to improved charge separation and surface reactivity*

Keywords: Cadmium oxide nanoparticles; Lemon extract capping; Ceramic synthesis; Green photocatalysis; Dye degradation