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$ZnO/g\text{-}C_3N_4$ Heterojunctions with Optimized Band Structure for Enhanced Photocatalytic Environmental Remediation

$ZnO/g\text{-}C_3N_4$ heterojunctions were synthesized by systematically varying the concentration of zinc nitrate hexahydrate, and the effect of this variation on the structural, optical, and photocatalytic properties was investigated using experimental techniques. The optical band gap energies were evaluated from UV–visible spectroscopy, revealing that the band gap of $ZnO/g\text{-}C_3N_4$ heterojunctions lies in the range of 2.55–2.70 eV, which is slightly narrower than that of pristine $g\text{-}C_3N_4$ (2.76 eV). This band gap narrowing indicates improved visible-light absorption upon heterojunction formation.

XPS analysis confirmed the presence of Zn, O, C, and N along with their respective oxidation states, validating the successful formation of the heterostructures. The $ZnO/g\text{-}C_3N_4$ heterojunctions exhibited significantly enhanced photocatalytic degradation of methylene blue (MB) dye compared to the individual components. Among all samples, the optimized heterojunction $ZnO/g\text{-}C_3N_4$ (ZCN4) demonstrated the highest degradation efficiency of 97%.

The superior photocatalytic performance of ZCN4 is attributed to the optimized ZnO content, improved charge separation efficiency, suppressed recombination of photo-generated charge carriers, and the reduced band gap.

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