Charge Transfer Engineering in PhCN/ZnO Hybrid Thin Films for Photoactive Applications

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Phenyl-modified carbon nitride (PhCN)/ZnO hybrid thin films were fabricated to investigate the effect of hybrid loading on structural, optical, and charge-transfer properties. XRD confirmed that the wurtzite structure of ZnO was preserved after hybridization, while GIWAXS and SEM revealed that the intermediate-loading sample exhibited the highest structural ordering and most homogeneous morphology. AFM measurements showed increasing surface roughness with increasing organic part content.

Optical characterization demonstrated that the intermediate-loading film exhibited the lowest photoluminescence intensity and the highest apparent charge-transfer efficiency (56%) from time-resolved photoluminescence measurements, indicating efficient suppression of radiative recombination through interfacial charge transfer. UV–Vis measurements further revealed enhanced visible-light absorption after hybrid formation.

These results demonstrate that optimizing the hybrid loading provides an effective strategy to balance morphology, structural ordering, and interfacial charge transfer, making PhCN/ZnO hybrid thin films promising candidates for future photoactive and optoelectronic applications.