SYNTHESIS AND CHARACTERIZATION OF ZnO/g-C_3N_4 COMPOSITES FOR PHOTOCATALYTIC APPLICATIONS

Kolpachkova P.D., Moskalenko I.V., Skorb E.V.
ITMO University
191002, Saint Petersburg, Lomonosova st., 9

Low-temperature formation of carbon nitride from supramolecular precursors provides a model system for studying kinetically controlled structure formation and defect organization. In this work, ZnO/g-C_3N_4 composite materials were synthesized via thermal treatment of mechanically mixed precursors (melamine–thiobarbiturate supramolecular complexes[1] and zinc hydroxide) in an inert atmosphere using a low-temperature synthesis approach for g-C_3N_4[2].

Differential scanning calorimetry (DSC) analysis was performed to determine the optimal synthesis temperature. The results showed that the optimal synthesis temperature for the composite is 316 °C, which is higher than that of pure g-C_3N_4 (305 °C), indicating modification of the condensation pathway and effective energy landscape of condensation due to ZnO incorporation. The supramolecular structuring of the precursor system enables a preorganized condensation pathway leading to reduced structural randomness and non-random defect distribution, allowing a reduction of the synthesis temperature by approximately 200 °C compared to conventional g-C_3N_4 synthesis. The formation of the composite structure was confirmed by X-ray diffraction (XRD) and Fourier-transform infrared spectroscopy (FTIR), demonstrating the coexistence of both ZnO and g-C_3N_4 phases without formation of secondary phases.

Morphological analysis using scanning electron microscopy (SEM) revealed that at low ZnO content, ZnO particles are uniformly distributed on the layered g-C_3N_4 surface, forming a developed interface. With increasing ZnO content, particle agglomeration becomes dominant, leading to structural changes in the composite. Energy-dispersive X-ray spectroscopy (EDX) confirmed the presence of all key elements, including sulfur, indicating successful doping and preservation of the modified structure.

Optical properties were investigated using UV–Vis spectroscopy and Tauc plots. The obtained bandgap values lie between those of pure ZnO and g-C_3N_4.

Electron paramagnetic resonance (EPR) analysis revealed the presence of stable defect states. In addition to the characteristic signal of g-C_3N_4 ($g \approx 2.003$), an additional signal at $g \approx 2.01$ was detected, associated with sulfur-related defect centers stabilized at the ZnO/g-C_3N_4 interface.

It is shown that ZnO particles can serve as growth centers in g-C_3N_4 crystals, influencing defect formation and structural organization. The results indicate that the formation of ZnO/g-C_3N_4 composites is governed by supramolecular preorganization and kinetically controlled condensation, leading to structural inheritance and stabilization of sulfur-related defect centers at the heterointerface.

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