INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Water is our life and its quality degradation has imposed a major threat to the health and environment with the emerging contaminants. Photocatalytic advanced oxidation processes (AOP) using reactive oxygen species (OH^-, •OH, H_2O_2, HO_2•, O_2•$^-$, O_2^{2-}) provide complete degradation of these persistent pollutants by using nanomaterials triggered by light absorption. However, its real-time application is limited by the use of high-power light sources to trigger the reaction and its limited performance. Thus, this thesis focuses on understanding and addressing these bottlenecks by— (a) designing and developing a sunlight-responsive photocatalyst to harvest natural sunlight, (b) developing heterostructure photocatalysts for enhanced efficiency by developing interfacial charge transfer, and (c) studying and discovering ways to enhance charge transfer by manipulating heterostructure photocatalyst responsive to natural sunlight. To achieve efficient photocatalysis, different sunlight-responsive photocatalysts were synthesized by varying— synthesis mediums and methods introducing surface defects and producing different nanoparticle morphologies. The dependence of the charge transfer, charge carrier lifetimes, surface structures, induced defects, and morphologies on the photocatalytic efficiencies were discussed elaborately. Variable ZnO samples were synthesized using DMF or DEG solvents using solvothermal and chemical synthesis methods showing different properties— morphologies, surface, and chemical properties. The influence of the charge transfer pathways in the photocatalytic efficiencies is discussed and explored with different charge transfer methods— self-assembled ZnO nanoparticles on three electronically different SWCNTs (metallic-SWCNT/ZnO, semiconducting-SWCNT/ZnO, and pristine-SWCNT/ZnO); Type I ZnO/Fe_3O_4 and Type II ZnO/TiO_2 composite heterostructures; g-C_3N_4 & Z-scheme g-C_3N_4/ZnO composites, and other composites— g-C_3N_4/SWCNT, and g-C_3N_4/ZnO/SWCNT. By taking RhB as a model pollutant, these nanoparticles were used as the floating photocatalyst by coating on the face-mask fabric showing variable efficiencies up to 99% of 10 ppm RhB degradation within the 100 min natural sunlight exposure.