INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Controlled Synthesis and Photo-Physical Properties of Graphene Quantum Dots and Its Heterostructures for Visible Light Photocatalysis and Bio-Imaging Applications

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SHORT ABSTRACT

Graphene quantum dot (GQD) is an interesting class of 0D materials that possesses interesting features, such as quantum confinement, edge sites and oxygenated functional groups. Interestingly, GQDs are considered to be a promising alternative over the conventional QDs owing to its excellent solubility, less toxicity, bright and tunable photoluminescence (PL). Controlling of the edge sites and oxygen functional group defect states of GQDs is the key to its ensuing applications ranging from sensing, bio-imaging, energy conversion and environmental cleaning etc.. PL emission is the one of the intriguing property of the GQDs that has drawn considerable attention of researchers worldwide. Despite sustained efforts, the exact origin of visible PL emission from GQDs is not well understood by the research community. There is considerable debate in understanding the PL from GQDs, as there are competing effects of intrinsic state and defect state PL emissions. The present thesis investigated on the origin of visible PL emission from GQDs and understanding the formation mechanism of circular shaped GQDs. Further, controlling the edge sites and oxygen functional groups defects through the solvent dependent synthesis of GQDs is very important for sensing, in particular in the field of bio-imaging applications. Moreover, achieving the high PL quantum yield from GQDs another challenging task. The thesis discussed the high PL quantum yield of GQDs and its confocal imaging on A-375 and HeLa cancer cell lines. Fabricating the efficient visible light photocatalysts based on the GQDs by using the low cost synthesis techniques is always desirable for industrial scale. The mechanism of hybrid formation between the GQDs with other graphitic materials, plasmonic nanoparticles and metal oxide semiconductors has been addressed in this thesis. The present thesis work extensively studied on the formation mechanism of GQDs based hybrid nanostructures with various experimental results in corroboration with DFT based simulations calculations. The exploration of the GQDs and GQDs based heterostructures for efficient dye degradation is also discussed. The free radical generation and the role of specific free involvement on the degradation of organic pollutant and elucidating the mechanism of dye degradation have been systematically studied.