INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study	:	Ph.D.

Thesis Title: Investigation of Metal and Semiconductor Nanoparticle/2D Layer Decorated TiO_2 Nanostructures for Visible Light Photo(electro)-catalysis and Optoelectronic Applications

Name of Thesis Supervisor(s)	:	Prof. P. K. Giri
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SHORT ABSTRACT

The PhD thesis focuses on the controlled fabrication, photo-(electro)catalytic and optoelectronic applications of heterojunction between shape tailored TiO_2 nanostructures and 2D materials/ plasmonic nanoparticles synthesized by a combination of hydrothermal and CVD techniques. Chapter 1 presents a brief account of the key properties, growth strategies for shape tailored TiO_2 nanostructures and their potential utilization in different technological applications. Recent progress and the lacunae on the fabrication of shape tailored TiO_2 nanostructure based hybrids for energy, environment and optoelectronic applications are presented. Chapter 2 presents a detailed investigation on the controlled growth of Ag_2O-nanoparticle (NP) decorated porous monoclinic B-phase TiO_2 (TiO_2(B)) nanorods (NRs) grown by a solvothermal route. Enhanced visible light absorption, band bending induced efficient charge separation and the Coulombic interaction between the dye molecules and catalyst surface are discussed in details to demonstrate the fast photocatalysis. Chapter 3 presents the origin of multi-step sequential degradation rate of organic dye, Rhodamine-B (RhB), under visible light illumination on Ag NPs decorated anatase TiO_2 NRs grown by a solvothermal route. Ultra-fast N-de-ethylation of RhB, photoreduction of Ag^+ ions into metallic Ag NPs during the photocatalysis demonstrate the faster rate constant in the 2nd degradation zone. Chapter 4 presents evidence of plasmonic hot electron injection and efficient interfacial charge transfer in ternary plasmonic photocatalyst of Ag-TiO_2(B)-C_3N_4 and Au-TiO_2(B)-C_3N_4 through the photoresponse study with plasmonic excitations and the resulting superior visible light photocatalytic activity. In Chapter 5, we achieved extraordinarily high visible light photoelectrocatalytic hydrogen evolution using a ternary heterostructure Pt@MoS_2/TiO_2 controlled by the edge-sites of few-layer MoS_2 on porous TiO_2 nanobelts support. Chapter 6 presents a new approach to achieve tunable and high PL quantum yield (QY) from the self-grown spherical TiO_2 quantum dots (QDs) on fluorine doped TiO_2 (F-TiO_2) nanoflowers, which are mesoporous in nature, synthesized by a simple solvothermal process followed by a post growth rapid thermal annealing (RTA) under vacuum. In Chapter 7, we showed the CVD growth of large area monolayer MoS_2 (p-doped) on n-type TiO_2 nanostructure on a metallic Ti substrate and the resulting heterojunction shows giant photoluminescence enhancement and broadband ultrafast photodetection with record high responsivity. Chapter 8 presents the summary and highlights of the contributions of the present thesis.