**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI**
**SHORT ABSTRACT OF THESIS**


Name of the Student : ABHILASHA BORA

Roll Number : 166121007

Programme of Study : Ph.D.


Thesis Title: Growth and Functionalization of Monolayer $WS_2$ Quantum Dots and Films for Photoluminescence Modulation and Photodetector application


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

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## SHORT ABSTRACT


The present thesis focuses on the top-down controlled synthesis of $WS_2$ quantum dots (QDs) by liquid exfoliation as well as the bottom-up controlled growth of large-area monolayer $WS_2$ by chemical vapour deposition (CVD). The effect of the growth of $WS_2$ via CVD technique has been extensively studied for a variety of substrates and different growth conditions. In particular, the salt-assisted growth gave rise to large area monolayer film. A detailed analysis of excitation wavelength-dependent photoluminescence (PL) spectra of the $WS_2$ QDs is carried out and the interaction of these QDs with single walled carbon nanotubes (SWCNTs) is carefully examined. The PL of the highly fluorescent $WS_2$ QDs is systematically quenched on complex formation with defective SWCNTs. We have fabricated self-biased p-n heterojunction photodetectors based on Si/$WS_2$ QDs heterostructure and Schottky Si/Au/$WS_2$ photodetectors by incorporation of Au nanoparticles in the system. The Au nanoparticle embedded Si/Au/$WS_2$ QD Schottky photodetector exhibits highly suppressed dark current and fast photo response. We investigated the evolution of the PL spectra of CVD grown monolayer $WS_2$ and the induced doping effect by decorating it with non-van der Waals $Bi_2O_2Se$ QDs through a four-energy level model involving coupled charged transfer-based rate equations. The doping effect is quantified by estimating the change in the net electron density on the formation of the $WS_2/Bi_2O_2Se$ heterostructure. Lastly, we have carried out a further comprehensive analysis of the PL emission of the CVD grown monolayer $WS_2$. We have encapsulated of the CVD grown $WS_2$ film with large band gap ZnO and investigated the accompanied modulation of the PL of monolayer $WS_2$ by the quantum well effect. The excitation power dependent studies enabled room temperature tuning of many-body effects, such as trion and bi-exciton populations in the quantum well. Thus, we have presented thorough investigative studies on the controlled synthesis of $WS_2$ QDs and monolayer $WS_2$ films and the fabrication of various heterostructures with SWCNTs, plasmonic Au NPs, non-van der Waals $Bi_2O_2Se$ QDs and large band-gap ZnO for applications in photoluminescence modulation and photodetection. There is a vast scope to extend the present work to understand the fundamentals of light-matter interactions in two-dimensional transition metal dichalcogenide systems and in turn, utilize them for a broad range of applications.