Abstract

The performance of different nano scale materials change when composite is formed by attaching with different 2 dimensional materials. In my thesis I have tried to synthesis different reduced graphene oxide (RGO) and molybdenum disulfide (MoS_2) based composite materials by simple low cost, solution processable and easy to achieve soft chemical route. All the synthesized composite materials were well characterized structurally and optically. The solar light induced photo current generation and photocatalytic activities of these materials were studied in detail.

Solution processable Reduced Graphene Oxide – Zinc Sulfide (RGO-ZnS) composite has been synthesized by a simple single-step one-pot solvothermal route and is reported in chapter 2. As- synthesized composite was characterized structurally and optically. The photo induced charge generation of RGO-ZnS in solid phase as well as in solution phase has been investigated under simulated solar light illumination. RGO-ZnS thin film photo detector shows an excellent photocurrent generation with a high degree of reproducibility. The photosensitivity (ratio of photo to dark current) of the detector varies linearly with the light intensity. A remarkable increase of photo-reduction efficiency of RGO-ZnS compare to controlled-ZnS or controlled-RGO towards the reduction of 4-Nitrophenol was observed.

Chapter 3 reports the solvothermal synthesis of Reduced Graphene Oxide – Cadmium Sulfide (RGO-CdS) nanorod composite. The as synthesized composite was characterized structurally and optically by XRD, TEM, XPS, Raman, UV-Vis and PL spectroscopy. The photocurrent generation in large area thin-film photodetector devise is also reported. The photo catalytic activity of the composite was examined by the degradation of tetracycline (TC) antibiotic under solar light illumination. An enhanced photocatalytic activity of CdS nanorods was observed after the incorporation of RGO in the composite. Here, RGO plays a key role towards efficient photo induced charge separation which subsequently decreases the electron-hole recombination possibility and improves the photocatalytic activity of the RGO-CdS composite.

Chapter 4 describes the one pot single step solvothermal synthesis of reduced graphene oxide - cadmium zinc sulfide (RGO-CdZnS) composite. The reduction of graphene oxide (GO), synthesis of $Cd_{0.5}Zn_{0.5}S$ nanorod and decoration of nanorods onto RGO sheet was done simultaneously. The structural, morphological and optical properties were studied thoroughly by different techniques, such as XRD, TEM, UV-Vis and PL. The PL intensity of CdZnS nanorods quench significantly after the attachment of RGO, confirms photo induced charge transformation from CdZnS nanorods to RGO sheet through the interface of RGO-CdZnS. An excellent photo current generation in RGO-CdZnS thin film device has been observed under simulated solar light irradiation. The photo current as well as photo sensitivity increases linearly with the solar light intensity. Our study establishes that, the synergistic effect

of RGO and CdZnS in the composite is capable of getting promising applications in the field of optoelectronic devising. The photocatalytic activity of the RGO-CdZnS composite was investigated towards the degradation of 4-Nitrophenol. A notable increase of photocatalytic efficiency of RGO-CdZnS compare to controlled CdZnS was observed. Here RGO plays a crucial role to efficient photo induced charge separation from the CdZnS, and decreases the electron-hole recombination probability and subsequently enhanced the photocatalytic activity of the RGO-CdZnS composite material under simulated solar light irradiation. This work highlights the potential application of RGO-based materials in the field of photocatalytic degradation of organic water pollutant.

In chapter 5, the synthesis of a molybdenum disulfide–zinc phthalocyanine (MoS_2-ZnTTBPc) composite is reported, where the scalable synthesis of MoS_2 was done by a simple solvothermal route followed by the sono-chemical attachment of ZnTTBPc. The as-synthesized material acquires a monolayer with an average thickness of 2 nm. Raman studies give sufficient evidence of the existence of monolayer MoS_2 in the MoS_2-ZnTTBPc composite. The highly exfoliated abundant active sites available on the 2D surface of MoS_2 efficiently act as photocatalytic reaction centres. Moreover, the high energy transfer efficiency, authenticated by steady-state photoluminescence and time-correlated single photon counting studies, makes the MoS_2-ZnTTBPc (3:1) composite a promising optoelectronic and photocatalytic material. The photo-generated electrons from the conduction

band of ZnTTBPc transfer to the conduction band of MoS_2 leaving holes at the valence band of ZnTTBPc and simultaneously the photo-generated holes from the valence band of MoS_2 transfer to the valence band of ZnTTBPc. These well-separated charges reduce the electron–hole recombination probability in the composite, subsequently offering a positive synergetic effect among ZnTTBPc and single-layered MoS_2 sheets. It could thus have promise as a new photo-catalyst towards removing different organic pollutants and for other optoelectronic devices.