SYNOPSIS

Over the centuries quite a few sustainable energy sources have been discovered and put to efficient use, such as, solar, wind, water, geothermal, tidal, and biomass. Solar energy being available for a considerable period of the day makes it a strong candidate for the present and future power generating resource. The solar panels can be installed anywhere with an open space and the shining sun, such as, rooftops, deserted lands, electric poles and so on. Solar cells have been around for over half a century now and have evolved from crystalline silicon solar cells (first generation), to semiconductor thin film based cells (second generation) to the present dye solar cells (third generation).

QDSC came into picture for replacing the expensive dyes used in DSSC with low cost and more efficient QD (Plass *et al.*, 2002). The third generation of solar cells dealing with quantum dots has attracted wide research interest owing to the excellent optical, electronic and size-tunable properties of QD (Zhu *et al.*, 2010; Raj *et al.*, 2013; Chuang *et al.*, 2014). The engineering or modifications of the solar cell electrodes, precisely the working electrode is vital as it shall facilitate efficient transfer of charges with minimal loss of the excited charges due to recombination or otherwise (Yu *et al.*, 2011; Zhu *et al.*, 2014; Man *et al.*, 2015).

This thesis embodies research on synthesis of cadmium chalcogenide quantum dots and their use as photoelectrodes. The band-alignment with conventional TiO_2 and other synthesized QD, consequent tuning of the working electrode has been the main focus, in order to achieve better solar cell characteristics.

The Thesis deals with the following chapters:

Chapter I start with basic introduction of the renewable energy resources available to mankind and why solar energy has a huge contribution in it. Further, a brief review is given on the various types of third generation solar cells while explaining their basic working principle. The importance is laid down on quantum dots which are promising candidates for replacing the expensive dye while increasing the efficiency due to multiple exciton generation property. Further the interest was narrowed down to the working electrode engineering of the cell.

Chapter II gives an insight on the working principle of major characterization tools and measurement techniques used in the study viz., UV-Vis Spectroscopy, Photoluminescence (PL) spectroscopy, X-Ray Diffraction (XRD), Transmission Electron Microscopy (TEM), I-V Characteristics, and Electrochemical Impedance Spectroscopy (EIS). Also the entire process for device fabrication and cell measurements has been detailed.

In chapter III, details about the synthesis of QD of CdSe via wet chemical method at temperatures of 40, 50, 60 and 70 °C has been presented. A prominent red shift in the absorption peaks in UV-Vis Spectroscopy and emission peaks in PL spectroscopy have been obtained along with a lowering in energy-gap with the rise in temperature. The QD were mixed in different ratios and coated directly onto the working electrode, leading to a high V_{oc} of 1.45 V with an efficiency of 0.69% and FF of 74%. The obtained V_{oc} value is a reflection upon the optimum band alignment on the working electrode of the cell.

In chapter IV, studies on core-shell CdSe-CdS QD prepared at 50 °C via wet chemical method has been presented. The core-shell QD was prepared both with and without the capping agent; the one without capping agent showed red shift in UV-Vis absorption pointing towards the existence of bigger sized particles. The capped QD had an average particle size of 4 nm as confirmed by TEM. XRD confirmed the core-shell QD to be of cubic structure having face-centered lattice. The core-shell QD was coated directly onto the working electrode which resulted in a V_{oc} of 1.27 V with an efficiency of 0.43%. The cell parameters were tested for a period of 60 days and were found to be stable.

In the final experimental chapter, i.e., chapter V, studies on CdSe and CdS QDs prepared with mixed solvent of water and methanol has been presented. In addition, the synthesis of rGO and its use as electrode has been studied. The combination of solvents has been shown to result in excellent luminescence under UV light. Crystalline natured rGO was prepared by microwave method and applied on the working electrode prior to TiO_2. CdS and CdSe QDs were deposited later along with a ZnS passivation layer resulting in an efficiency of 1.81% with J_{sc} of 4.50 mA/cm^2 and

V_{oc} of 0.92 V. The obtained results point towards the effective engineering of the working electrode and a significant possibility in further enhancement of the cell structure for achieving increased solar cell efficiency.

Chapter VI reflects upon the conclusion of the obtained results while exploring the future scope of the reported work. The prepared QDSCs were prepared effectively with entire emphasis on the working electrode engineering which resulted in cells with good band-alignment, improved charge transfer and consequent enhancement in efficiency compared the equivalent DSSCs.

References cited in the synopsis are listed at the end.