CHAPTER 6

SUMMARY AND SUGGESTIONS FOR FUTURE WORK

6.1 SUMMARY OF THE PRESENT INVESTIGATIONS

The Present work deals with the preparation of thin films for solar cell application by photochemical and electrochemical deposition. The optimized film conditions were applied for the fabrication of the heterojunction solar cell structure. The solar cell structures of CdS/SnS and Cd\(_{1-x}Zn_x\)S/SnS were fabricated and their efficiencies were calculated.

Investigations have been carried out to understand the fundamental parameters like concentration, pH, temperature, stirring speed, deposition time and light intensity involved in the photochemical deposition (PCD) to deposit CdS, ZnS and Cd\(_{1-x}Zn_x\)S and the deposition conditions were optimized. It was confirmed that the solution concentration, pH, deposition time and intensity of the light play major role in the quality of the deposited film.

Cadmium sulphide and zinc sulphide thin films were deposited using drop and conventional PCD method. The films were deposited from the bath containing Cd\(^{2+}\), Zn\(^{2+}\) and S\(_2\)O\(_3^{2-}\) ions and the pH of the solution was adjusted to 3 by using diluted H\(_2\)SO\(_4\). The films were subjected to several characterization studies. The XRD studies show that the CdS and ZnS films deposited were in hexagonal and cubic structure, respectively. Raman studies confirm that the longitudinal optical (LO) phonon peak corresponds to the
CdS and ZnS. The surface morphology of the film shows improvement after annealing at 300°C in nitrogen atmosphere. The bandgap of the films was calculated as 2.42 and 3.3 eV for CdS and ZnS. The compositions of the deposited films are comparable with the standard and the conductivity type of the film was confirmed by using PEC measurement.

Cd\textsubscript{1-x}Zn\textsubscript{x}S alloys were successfully deposited by using (PCD) technique for different x values ranging from x = 0 to 1 from the aqueous solution containing Cd\textsuperscript{2+}, Zn\textsuperscript{2+} and S\textsubscript{2}O\textsubscript{3}\textsuperscript{2-} ions. The compositions of the alloys were calculated from Raman, XRD and AES data. Alloys having high Cd concentration show wurtzite structure and alloys having high Zn concentration show cubic structure. Change in surface morphology was observed when the Zn content increases in the Cd\textsubscript{1-x}Zn\textsubscript{x}S alloy.

The band gap values of CdS, Cd\textsubscript{1-x}Zn\textsubscript{x}S and ZnS were calculated from the transmittance measurements and found to vary from 2.42 eV to 3.3 eV. The resistivity values of the alloys were of the order of 10\textsuperscript{4} to 10\textsuperscript{3} Ω cm. The photosensitivity of the Cd\textsubscript{1-x}Zn\textsubscript{x}S alloys was confirmed by the PEC measurement and the films exhibit n-type behavior. Cd\textsubscript{1-x}Zn\textsubscript{x}S is well suited as a window layer material for solar cells, and the technique discussed in the present work is very cost-effective and promising for large-scale solar cell production.

Investigations on the deposition of SnS thin films using electrochemical deposition (ECD) with different applied potentials were carried out and the deposition conditions were optimized. The SnS thin films were deposited on ITO substrate from the aqueous solution containing SnSO\textsubscript{4} and Na\textsubscript{2}S\textsubscript{2}O\textsubscript{3} by pulsed electrochemical deposition. Films were deposited from different applied potentials and their properties were studied. XRD result indicates that the deposited SnS layer is polycrystalline and has
orthorhombic structure. The bandgap was estimated as 1.4 to 1.5 eV and the surface morphology of the deposited film is smooth and it has good adherence with the substrate. The SnS thin film exhibits photoconducting behaviour under the cathodic bias, which is the characteristic behaviour of p-type semiconductor.

CdS/SnS and CdZnS/SnS solar cells were successfully fabricated using ECD and PCD techniques. Both CdS/SnS and CdZnS/SnS heterostructures show good rectification property. The surface morphology of the SnS layers deposited on as deposited and 100°C annealed CdS window layers was analyzed. The SnS layer deposited on 100°C annealed CdS window layer shows better surface morphology. The AES measurement shows good surface coverage, since no elemental peak corresponding to window layer was observed.

SnS/CdS heterostructure fabricated using condition B shows maximum solar cell parameters. The solar cell fabricated on the annealed CdS window layer shows improvement in the solar cell parameter. The CdZnS/SnS solar cells fabricated using the 13% Zn concentration in the Cd$_{1-x}$Zn$_x$S window layer, shows maximum solar cell parameter. The solar cells fabricated on the CdZnS window layer show higher cell performance than the solar cells fabricated on CdS window layer. It is possible to obtain higher efficiencies using this structure in future.

6.2   SUGGESTIONS FOR FUTURE WORK

Further research work can be focused on the fabrication of CdS/SnS solar cell structure by considering its interface problem. The surface and the quality of the window layer can be improved by considering the
deposition parameters like concentration, pH and deposition time. In the \( \text{Cd}_{1-x}\text{Zn}_x\text{S}/\text{SnS} \) structure the window layer can be used for higher \( x \) values to see the effect on the efficiencies of the solar cells. The interface between window layer and absorber layer can be analyzed in detail to explain the cell performance. The cell performance upto 20% zinc in the \( \text{Cd}_{1-x}\text{Zn}_x\text{S} \) alloy has been studied and found that there is an increase in the cell efficiency. The \( x \) value in the \( \text{Cd}_{1-x}\text{Zn}_x\text{S} \) alloys can be varied from 0 to 1 to optimize the better \( x \) value for higher efficiencies. The SnS layer can be improved by considering the applied potential used for deposition. The deposition parameters like solution concentration, applied potential and deposition time can be varied to get better solar cell parameters.