# CHAPTER VI

# CHAPTER-VI

## SUMMARY AND CONCLUSION

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In this investigation CdS films are prepared by chemical bath deposition technique. The CdS films are annealed in vacuum ($10^{-3}$ torr) at 200°C for one hour. The vacuum annealed and as prepared CdS films are studied for their electrical and optical properties. CdS-PbS hetero-junctions are formed by depositing PbS on CdS films by chemical bath deposition technique. Again the CdS-PbS heterojunction is used to study the electrical properties of semiconductor-semiconductor junction solar cell.

In the first chapter, subject of energy conversion is introduced, and summary of literature on CdS, PbS and CdS-PbS heterojunction is reported in brief. In the light of this, the problem has been selected and stated therein. Theoretical background of solar cell is given in Chapter II. Out of different methods for the preparation of films, the chemical bath deposition technique employed in the present study is described in Chapter III. To obtain uniform and good quality films following procedure was adopted: 20 ml, 1 M cadmium sulphate solution was taken in a solution container and sufficient amount of liquor ammonia (14 N) was added with continious stirring till the just redissolution of complex compound $Cd(OH)_2$ occured. The pH of the mixture was adjusted in between 10.5 to 11.0. The reaction mixture was controlled to 90°C. The substrates attached to the substrate holder were kept in the reaction mixture. 0.1 M thiourea solution was added at the rate of 0.7 ml/minute. Substrates were removed after half an hour and washed several times with double distilled water and dried. Exactly similar procedure was adopted for the preparation of PbS films. Initial ingradients used were lead acetate and thiourea. Deposition temperature was kept at 40°C.

Freshly prepared CdS films were annealed in vacuum ($10^3$ torr) at 200°C for 1 hour. The experimental procedure of the post preparative treatment i.e. vacuum annealing and characterisations of the film are described in chapter 3. The increase in grain size is observed for vacuum annealed CdS film, when studied for microstructure. The optical absorption measurement shows the increase in absorption after annealing CdS film. The intercepts of plots of $(\alpha h\nu)^2$ versus $h\nu$ for vacuum annealed and as prepared CdS films gives the values of band gaps 2.32 and 2.24 eV respectively. This increase in bandgap after annealing may be due to removal of extended states from forbidden gap. Chapter IV provides ECPV cell properties of CdS photoanode.

The ECPV cells with configuration $SnO_2$:F-CdS/.1 M NaOH-S-$Na_2S$/C have been prepared. Both as prepared and vacuum annealed CdS films are used as photoanodes in ECPV cells. The dynamic characteristics shows the rectifying nature of the junctions. The shifting of the I-V curves in fourth quadrent under illumination indicates that power can be extracted from the cells. For vacuum annealed CdS photoanode, the shift of I-V curve in fourth quadrent was more indicating that more power can be extracted from that cell. The increase in dark current Id for vacuum annealed CdS photoanode explains the formation of sulphur vacancies after annealing which gives rise to additional donor levels. The increase in short circuit current, $I_{sc}$ and open circuit voltage, $V_{oc}$ for vacuum annealed CdS photoanode, in photovoltaic output characteristics predicts the decrease in resistance and generation of sulphur vacancies in the film after annealing. The fill factors and efficiencies have been estimated for both photoanodes, it is found that the fill factor and efficiency of the as prepared CdS photoanode are 42% and .02% and for vacuum annealed CdS photoanode are 52% and .04% respectively.

Chapter V includes the study on CdS-PbS heterojunction. CdS-PbS heterojunction was studied for its electrical properties like dynamic characteristics, photovoltaic output characteristics and capacitance-voltage characteristics to find diode ideality factor (n) & flat band potential ($V_{fb}$). The dynamic characteristics of CdS/PbS heterojunction predict that junction has been formed between CdS and PbS. Junction ideality factor ($n_d$) was determined by plotting the graph of log I versus V. The slope of this graph gives the junction ideality factor ($n_d$) and it comes out to be n=3.75.The higher value can be attributed to the degree of recombination of chamge carriers in the depletion region and is indicative of non ideal junctions.

The flat band potential ($V_{fb}$) of CdS-PbS hetero-junction system was estimated by studying C-V measurements. The junction capacitance 'C' as a function of applied bias V in dark is measured. The linear variation of $C^{-2}$ as a function of applied voltage V, indicates that the Mott-Schotty relation is valid. The intercept of the plot $C^{-2}$ vs V, to the voltage axis yields the value of flat band potential - 1.5 V.