PREFACE

Solar photovoltaic technology for conversion of solar energy into electrical energy is receiving considerable attention as a prospective source of bulk, electric utility power due to rapid depletion of our natural energy sources like oil, coal, gas etc. Also photovoltaic energy conversion is used today for both space and terrestrial solar energy conversion.

In addition, photoelectrochemical conversion of solar radiation into electrical energy has also recently received considerable attention as an attractive alternative to solid-solid junction photovoltaic cells. Their two basic advantages are (1) the easy attainment of the junction that allows for the separation of the photogenerated charges (by simply immersing the semiconductor in the electrolyte) and (2) the relatively small sacrifice in conversion efficiency when single crystals are replaced by polycrystals or polycrystalline films.

Number of compounds in the crystalline and polycrystalline family of materials have recently gained much attention and interest due to their enhanced performance,

potential for low cost manufacturability and good stability and reliability.

Of the many chalcopyrite compounds, $CuInS_2$ is particularly interesting for both applied and fundamental studies. $CuInS_2$ is a candidate for application in solar cells, because its energy gap (1.5 eV) is near the optimum value for solar energy conversion. In addition, the application of homojunctions is made possible by the fact that both n and p-type $CuInS_2$ can be prepared. Both the growth aspects in the form of single crystals and their films and the physical properties of $CuInS_2$ are treated in this thesis.

The thesis is composed of eleven chapters. **Chapter 1** emphasises the importance of $CuInS_2$. Review of the existing information and scope for the present work has been described.

Chapter 2 provides a description of the various experimental techniques employed for characterisation in the present investigation.

A description of vapour transport technique is given in **Chapter 3.** The salient features of chemical vapour transport method for the growth of $CuInS_2$ single crystals have been described in detail. Details of experimental set up,

temperature controlling system, construction of the furnace etc. have also been thoroughly described. A study of the microstructures of the grown faces of the as-grown crystals reveal the presence on layer growth mechanism.

Chapter 4 deals with characterisation of the as-grown CVT $CuInS_2$ single crystals. Synthesized $CuInS_2$ was characterised by XRD, TGA, DTA, EDAX etc. Semiconducting nature and type of the crystals were determined by high temperature resistivity measurement and hot probe technique respectively.

Since the as-grown crystals were highly resistive in nature, appropriate doping under controlled annealing condition was carried out. **Chapter 5** describes the details of doping conditions employed. The chapter also describes a comparative study of electrical transport properties such as low temperature electrical resistivity, Seebeck coefficient measurements, Hall measurements etc. on these doped $CuInS_2$ single crystals. The later part of this chapter deals with optical properties of the doped $CuInS_2$ crystals analysed for absorption properties in the visible and near infrared region.

Chapter 6 gives the growth and structural analysis of $CuInS_2$ thin films. It reports a detailed study on the role

of deposition parameters on the crystallinity and homogeneity of the film.

A necessary introduction to photoelectrochemical solar cells has been presented in **chapter 7.** Different types of solar cells have been described and discussed by giving their classification. The advantages and disadvantages of PEC solar cells over the solid state photovoltaic cells have also been discussed.

Chapter 8 deals with the fabrication of photoelectrochemical solar cells using $CuInS_2$ single crystal photoelectrodes. This chapter also includes the semiconductor--electrolyte interface characterisation in terms of location of valence band, conduction band edges and Fermi levels. The effect of light intensity and different doping concentration used in the fabrication of PEC solar cells have been thoroughly investigated.

Chapter 9 introduces and reviews the techniques for High Pressure generation and measurement. Whereas **chapter 10** describes the variation of electrical transport properties with pressure for $CuInS_2$ single crystals.

The thesis ends with the general conclusions drawn