PREFACE

Solar cells are devices in which sunlight releases electrical charges so that they can move freely in a semiconductor and ultimately flow through an electrical load, such as a bulb or meter. The phenomenon of producing voltages and currents in this way is known as Photovoltaic effect.

The fuel for solar cells - sunlight - is free and abundant. The intensity of sunlight at the surface of the earth is at most about one thousand watts per square meter. Thus, the area occupied by cells in a photovoltaic power system may be relatively large and its cost must be considered in calculating the cost of electricity produced. Therefore, the primary factor that determines whether solar cells will be used to supply electricity in a given situation is the cost per unit output, relative to that of alternative power sources of acquiring, installing and operating the photovoltaic systems.

In view of this, it is always essential to consider two important aspects viz. photoconversion efficiency and the stability related to the photovoltaic systems. Many materials like Silicon, Germanium, Cadmium Telluride, Copper Indium Diselenide etc. have shown potential towards their use as efficient photovoltaic materials. Amongst all these, Silicon has come up with the advancement of technology. Now-a-days, solar cells constructed using Silicon are already being used in terrestrial as well as extra terrestrial applications. Though the technology of producing / manufacturing Si solar cells is very well developed, it still proves to be expensive which ultimately restricts its applications in normal day to day life.

In above context, a new era of photovoltaic devices have come up in late 70's, viz. photoelectrochemical solar cells due to the ease of formation as well as flexibility of controlling various parameters of the devices. The main hindrance in the viability of these photovoltaic cells is their stability. The present thesis incorporates the investigations regarding
fabrication, characterization and stability aspects of MoSe₂ based photoelectrochemical solar cells. MoSe₂ - a member of group VI Transition Metal Dichalcogenides - acts as a semiconducting/photosensitive material in such cells. Since d → d transition photogenerated carriers are involved in this semiconductor, it is supposed to be very stable against photoconversion and photodecomposition.

Chapter - 1 of the present thesis begins with a general review of photoeffects in semiconductors. This is followed by a brief description of various types of solar cells. A short description of the photoconversion process in liquid junction solar cells has also been covered in this chapter along with a comparison of solid-solid junction and solid-liquid junction solar cells. This chapter ends up with the discussion about choice of the photosensitive semiconducting compound along with a brief review of the relevant literature.

Since MoSe₂ has been used in the form of crystals, the growth has been discussed in chapter-2. The construction of the furnace and the preparation of ampoules have been chosen in view of the requirements of the presently used direct vapour transport technique. Since growth of MoSe₂ crystals is the main theme of chapter-2, the literature survey of growth of this compound has also been given here. The preliminary characterization of the grown crystals is covered in the later part of this chapter.

Once the crystals are grown, it is very much essential to characterise them so that their potential towards any applications may be evaluated. With this view, complete electrical characterization of MoSe₂ crystals grown in present investigations (as discussed in chapter -2) has been given in chapter -3. This leads to the evaluation of some of the important parameters of the semiconducting compound like carrier concentration, mobility, electrical resistivity, energy gap etc. Besides this, the optical characterization of the grown MoSe₂ crystals also forms a component of this chapter.
Since the main emphasis of the present thesis has been on the photoelectrochemical solar cells, the chapter - 4 starts with the construction of photoelectrochemical solar cells using MoSe$_2$ crystals. The characterization of PEC solar cells has also been covered in detail in this chapter. The series resistance is one of the prime factors governing the photoelectrochemical behaviour of such cells. Therefore, various techniques have been adopted to evaluate this parameter in case of MoSe$_2$ based PEC solar cells. The results of these investigations have been discussed in this chapter. Also the monochromatic efficiency and the quantum efficiency of such cells have been evaluated and given in this chapter. The minority carrier diffusion length and absorption coefficient, which are two important factors controlling the generation and the transport of carriers under illumination, have also been measured and a discussion about it is also given here as a part of chapter - 4.

Chapter - 5 centers around the investigations on the stability of MoSe$_2$ based PEC solar cells. It has been very well known fact that since d $\rightarrow$ d transition of photogenerated carriers are involved in MoSe$_2$ crystals, this compound is expected to be highly stable against photocorrosion and photodecomposition. The corrosion resistance as well as the corrosion rate has also been investigated in case of the PEC solar cells under investigation using the potentiodynamic technique. The results of these experiments have been discussed in detail in this chapter. In addition to this, the variation of the solar cell parameters with time, which yields the aging effect of such cells, has also been reported in this chapter.

Finally, the general conclusions of the present investigation have been summarized in chapter -6. It also includes discussion about scope of further investigations, which may be carried out on such solar cells to increase their potentiality as viable solar cell devices.