Preface

Thin solid films are of great importance in the field of solid state electronics because, they are extensively accepted in photo voltaic cells, sensors, detectors, magnetic memories, gas detectors, reflecting surface as well as anti-reflecting materials, light dependent resistor, photo-switch and many more. In view of all these, we have decided to study Cadmium Telluride a member of semiconducting II-VI compounds, in thin film form for device application because semiconducting materials of this group are optically active in near-infrared (NIR) and infrared (IR) regions and they are of great interest for their applications in photo voltaic, near-infrared detectors, and biomedical applications such as hyperthermia where strong IR absorption is required. CdTe is the most suitable contender for the fabrication of thin film solar cells due to its optimum energy gap (1.44 eV) at room temperature and high absorption coefficient ($>10^5$ cm^{-1}) in visible range. Additionally, CdTe has the highest average atomic number, maximum iconicity, largest lattice parameter, least negative formation enthalpy and the lowest melting temperature among the II-VI semiconductor compounds. CdTe exhibits both n-type and p-type conductivity which permits the utilization of solar cells in both homojunction and heterojunction configurations.

During last several years, a research on CdTe has become attractive due to mainly its enormous potential applications particularly in the area of thin film solar cells and large area optoelectronic devices like photo detectors, light-emitting diodes (LEDs), field effect transistors, radiation detectors, X-ray detectors, optical filters, non-linear integrated optical devices, lasers, thermal and radio imaging devices etc. This has lead to the importance of this material and encouraged to investigate high efficiency and low cost CdTe thin film devices. The achieved efficiency of CdTe/CdS heterojunction solar cells is 16.5% in the laboratory and 11% in commercial modules. The theoretical conversion

efficiency of polycrystalline CdTe thin film solar cells is high (29%) and maximum reported experimental conversion efficiency is 20.4%. Polycrystalline CdTe thin film solar cells have shown long-term stable performance and efficiency as high as 16.5% under illumination (AM1.5). This application of CdTe films leads to the importance of research concerning the properties of the material.

The information about the understanding of growth kinetics during the preparation of these materials in thin film form is very insufficient. For proper evaluation and optimum utilization of these semiconductors in any electronic devices, the growth parameters and conditions need to be established and a systematic study of all properties is essential. Also CdTe is emerging out as highly photo responsive material. Thin films of such materials are essential elements of the high-performance optical sources and detectors, and are being employed increasingly in high-speed, high-frequency digital and analog devices.

The entire work to be presented in this thesis has been organized in seven different chapters. A brief idea about the work covered and presented in each chapter is given below.

Chapter 1

Chapter 1 begins with a brief overview of thin film technology for semiconducting materials and device physics. An essential description of development of thin film based electronic devices, as an introduction, is presented here. As the present work involves the use of II-VI compounds in thin film form, also an introduction of II-VI compounds in general and cadmium telluride (CdTe) in particular is presented in this chapter. Important properties of these materials and general conclusion for their applications in electronic devices are discussed in brief. The chapter ends with the choice of material and method for present investigations.

Chapter 2

As the present work is centered around the device application of group II-VI compounds, a brief review of different techniques used for thin film preparation of CdTe is presented here and finally a selection of suitable method for the present work is justified. As growth of these materials in different form depends on various growth conditions, it is essential to know about the chemical content of these grown materials as the properties of semiconductors, particularly electrical and photo electrical properties such as resistivity, carrier concentration, trap depth, rise and decay time etc. are a strong function of it. Energy Dispersive Analysis of X-ray (EDAX), a most suitable technique for this purpose is discussed in brief along with the analysis and conclusions of investigations made for the materials in different form used in the present case.

Chapter 3

It is evident that structure, shape and size of material e.g. CdTe thin films are important parameters to study and understand behavior of particles. It is a routine practice to characterize such materials by standard techniques e.g. X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and Atomic Force Microscopy (AFM). In the present study these techniques have been used to evaluate structural parameter such as preferred orientation, Crystallite size (t), Micro strain (ε), Dislocation density (ρ) and surface morphology.

Chapter 4

This chapter starts with the theoretical back ground of optical absorption by semiconductors. Various optical parameters like absorption (A), transmission (T), extinction coefficient (K), refractive index (n), optical energy gap (E_g) were calculated with detailed analysis of UV-VIS-IR spectra for as grown thin films and have been discussed in this chapter.

Chapter 5

The Dielectrical parameters of the deposited thin films have been investigated under the effect of temperature. Photo electrical properties of the deposited thin films have also been presented in this chapter. The space charge limited conduction (SCLC) parameters of the film were carried out under the dark and illumination environment. For increasing intensity of illumination, the effect of defects in sintered CdTe thin film is studied. In the last section of this chapter the effect of illumination on resistance of screen printed thin films has been discussed in detail.

Chapter 6

This chapter mainly discusses fabrication of gap type photo detector from screen printed CdTe thin films sintered at five different temperatures, which can be utilized as photo switch. In this section variation of photo current under dark as well as illuminated condition along with time appeared as pulse, which exhibits large difference of photo current between two conditions. This gives conformation about photo sensitivity of Cadmium telluride. In addition to this, the effect of sintering on rise and decay time of photo generated charge carriers is

also obtained from the rise and decay curves, which are considered as vital parameters for photo responsive device.

Chapter 7

Finally, the general conclusions of present investigations have been summarized in this chapter. It is concluded that Screen printed cadmium telluride thin films can be successfully used as photo-detector. It is also clear from the discussion that Gap type sintered CdTe thin films exhibit vast different in photoconductivity under dark as well illuminated conditions. This chapter also includes discussion about future scope for further investigations, which may be carried out on such screen printed thin films with necessary treatment given to the specimen for improvement in the I-V characteristics under both mentioned conditions.