CHAPTER 1

INTRODUCTION

1.1 Introduction:

II - VI group semicondutors are of interest, primarily because of their wide range of opto-electronic properties. The possibility of preparing these materials in multilayer form, not only alter the alloy composition of the materials but also the physical dimensions of the layers. This gives us opportunity for tailoring electronic and optical properties of II - VI group based compounds. In a typical molecular solid the intermolecular interactions are much weaker than the intermolecular bonding energies, so the bulk properties of molecular solid can usually be analyzed as the sum of individual molecular contributions, with small perturbations from the intermolecular forces. Such weak intermolecular interactions rarely extend beyond the nearest neighbours and the electronic properties of a molecular crystal are usually independent of the size of the crystal. As the diameter of the semiconductor crystallite approaches 'the exciton Bohr diameter' its electronic properties start to change. This is called the quantum size effect, which can be observed as a blue shift in the optical band gap or exciton energy.

The nano-structured materials are of much interest to the scientists from 1980 onwards. The ultra-small size (<100 nm) of the grains in the nano-crystalline materials can result in dramatically different properties from those of conventional grain size (>1μmetre) polycrystalline or single crystal materials of the same chemical composition. This stimulates the recent high interest in these materials. At present the very broad field of nano-structured materials includes nano-particles, nano-crystalline materials and nano-devices. The potential applications for the various kinds of nano-scale materials include dispersions and coatings, high surface area materials, functional nano-structures (such as, opto-electronic devices, bio-sensors, nano-machines) and bulk nano-structured materials for structural or magnetic applications.

The wide variety of processing methods of nanostructured materials can lead to similar, but not identical nano-crystalline structure. Thus, by changing the preparation method we might arrive at a different nano-crystalline structure, which may be different from its bulk, polycrystalline and amorphous forms. In the present work, Cadmium and Selenium are prepared in multilayer films to form CdSe compound. Their chemical composition as well as their structure may be different from the bulk single crystal CdSe compound. CdSe nano-structured materials can be synthesized in various hosts by different procedures. Recent researchers show much interest on CdSe, as it is a promising nano-structured material. CdSe compound is used as optical sensors and lasers and CdSe nanoclusters can be tuned to emit different wavelengths of light by changing the applied potential difference. Thus CdSe is a promising material that exhibits quantum size effect due to the presence of nanoclusters.

Chapter 2 of the thesis deals with the background theory needed for understanding the structural and the optical properties of CdSe thin films. These two properties are essential in understanding the behaviour of CdSe multilayer thin films because the crystal structure is connected to optical band gap, which can be detected using optical studies. The review of properties of CdSe prepared by various methods, their characteristic energies and optical band gap are also reported. Finally the recent developments in the preparation and characterization of CdSe quantum dots are added to the review on nanostructured CdSe films.

Chapter 3 gives the details of the various experimental techniques used for the physical investigation of the CdSe thin films. Details of the experimental set-up used for the preparation of thin films are reported. Basic working principle of various instruments handled during the course of work is also briefly summarized.

Chapter 4 deals with the preparation method of the multilayer thin films and the various analytical techniques used for characterizing the structural behaviour of thin films. The determination of the morphology of the films using SEM, the determination of crystal size and crystallite size using XRD and the quantitative analysis of atomic composition of samples using EDX are reported. These results are useful in inferring the behaviour of the films.

Chapter 5 summarizes the optical properties. UV-Vis-NIR spectrophotometer is used to acquire the optical transmission data of CdSe films. The transmission spectra obtained are used to determine the optical band gap energy of CdSe films. The characteristic energies are also determined to study the behaviour of the films. The structural and optical properties are useful in identifying nanostructure properties in CdSe multilayer films.

Consolidation of the conclusions drawn out from the present work is reported in Chapter 6. Suggestions in improving the quality of nanostructured CdSe films for future studies are also given. The correct choice of nanostructured materials and their preparation methods are important in improving the quality and performance of nano-devices.

1.2 Objective of the present work:

The objectives of this work is to prepare CdSe multilayer thin films with alternate layers of Cadmium and Selenium of different thickness, which may contain nanocrystallites, and to explore suitable evidence on these samples that show nanostructural properties, by carrying out structural and optical studies.