ABSTRACT

Thin films have got a great attention among the researchers because of their numerous applications. The main interest in thin films is due to the important properties differ from bulk. As the film becomes thinner, the properties are important in the miniaturization of elements such as resistors, transistors, capacitors and solar cells. The objective of this research is to develop a low cost method to fabricate the n - and p - type multilayer semiconducting films by chemical and physical methods.

Photochemical deposition technique was used for deposition of multilayer thin films on particular area of the substrate by the irradiation of photons. In the present investigation Ethylene Diamine Tetra Acetic Acid (EDTA) was used as a complexing agent to reduce the crystallite size, to enhance the properties of the films and to control the growth rate. The n - and p - type materials like cadmium selenide (CdSe), lead selenide (PbSe) and lead sulphide (PbS) were deposited on the glass substrate. The effects of annealing on structural, optical, morphological and electrical properties of the thin films were studied. In the physical method, the thermal evaporation was used and the source materials were synthesized by solvothermal and chemical methods. The CdSe, PbSe and PbS thin films were deposited employing vacuum evaporation technique. The first chapter deals with the introduction to semiconducting materials, importance of the present work and review of extensive literature survey.

A simple Chemical Bath Deposition (CBD) setup was fabricated in the present work for large area deposition of thin films. This is an inexpensive technique at low deposition temperatures (25-90°C). In addition, the process can be controlled simply by varying pH, time, temperature and concentration. In particular, chemical bath, photochemical and thermal evaporation methods were used to deposit thin films for present investigation. The second chapter discusses the deposition techniques and characterization.

The third chapter presents the synthesis, deposition and characterization of cadmium selenide (CdSe) thin films by chemical and physical methods. CdSe thin films were deposited on the glass substrates by CBD method at 80ºC using concentrations 0.025, 0.075 and 0.1 M. The deposited films were annealed at 350°C. The crystallite size of the film was estimated by Scherrer's formula and the dislocation density was evaluated. The phase change of CdSe from cubic to hexagonal after annealing at 350°C was confirmed. The thickness of the film is found to be 0.6 μm. The bandgaps are estimated to be 2.1 and 1.84 eV for as deposited and annealed films.

Nanocrystalline CdSe was synthesized by solvothermal method using $Cd(NO_3)_2.4H_2O$ and Se metal granules. The synthesized CdSe was annealed at 450ºC to maintain the hexagonal phase. The annealed CdSe was used to deposit films at Room Temperature (RT), 150, 250, 350 and 450ºC. The chemical and physical deposited CdSe films exhibit the hexagonal structure with n - type conductivity.

The fourth chapter deals with the deposition of PbSe thin films by CBD technique at room temperature. The lead nitrate ($Pb(NO_3)_2$), sodium selenosulphate and sodium hydroxide (NaOH) were used as the starting materials. The EDTA with concentrations of 0.05 and 0.1 M were added to the solution to enhance the crystalline perfection of the films. The absorbance band shifts towards the red region after annealing at 450°C. The surface morphology of the film was analyzed using HRSEM with EDX and AFM.

Nanocrystalline PbSe was synthesized by chemical method at 80°C using lead nitrate, 0.1 M of EDTA and sodium selenosulphate. Lead selenide thin films were deposited on the degreased glass substrates using synthesized powder by thermal evaporation. X-ray diffraction results show the synthesised powders and deposited PbSe films exhibit cubic structure. A gradual reduction in bandgap was observed with increasing substrate temperature. Changes in surface morphology of the films with respect to substrate temperature were studied by HRSEM and AFM. Electrical study infers the deposited films are of p - type semiconducting nature.

The fifth chapter deals with the synthesis and deposition of the PbS thin films by chemical and physical methods and its nonlinear behaviour. The X-ray diffraction studies reveal that the films deposited via chemical bath method are oriented in (200) with cubic phase. The photochemical deposited PbS thin films have tetragonal phase. The Raman spectral analysis of the films enumerates the presence of Longitudinal Optical (LO) modes. The High Resolution Scanning Electron Micrographs (HRSEM) of the deposited films exhibit the formation of plate like particles. The photochemical deposited films show the oval shape arrangement of particles. Bandgap values of the films were estimated which are higher than that of the bulk.

The PbS was synthesised via simple chemical method using EDTA and deposited thin films by thermal evaporation. The deposited films were studied using XRD, UV-Visible, Raman, HRSEM with EDX, AFM and Hall Effect measurement. The third order nonlinear optical behaviour of the thin films was studied by Z-Scan experimental setup. The Z-scan study with open aperture was carried out for the deposited films which shows nonlinear absorption, arises from saturable absorption process. The deposited PbS films exhibit p - type conductivity.

The sixth chapter deals with the summary and suggestion for future work. Cadmium Selenide (CdSe), Lead Selenide (PbSe) and Lead Sulphide (PbS) nanocrystalline thin films were deposited by physical and chemical methods. The deposition parameters were optimized to get good crystalline films. The synthesised and deposited films were characterized with various characterization tools for their structural, optical, morphological and electrical properties. The results presented in the thesis have been published in international journals.