ABSTRACT

Cadmium Sulphide (CdS) thin films play an important role in fulfilling the smaller and faster is the technological imperative of our times. Cadmium Sulphide is a II-VI compound semiconductor. Cadmium Sulphide compounds has a higher melting point and larger band gap than those of the covalent semiconductors of comparable atomic weights. CdS thin films can be prepared by vacuum evaporation deposition and chemical bath deposition. Deposition techniques and substrate temperature has a strong effect on the electrical and structural properties of CdS thin films.

One of the most important applications is the conversion of solar energy into electrical energy by the meaning of the photovoltaic effect. CdS thin films would produce small amounts of electric current when exposed to light.

CdS thin films of thickness 880 Å, 930 Å and 2550 Å have been fabricated by vacuum evaporation deposition. The CdS powder of purity 99% was evaporated using Tungsten conical basket (200 amps) under the pressure of 2 x 10⁻⁵ Torr on to a pre cleaned glass substrate (3.25 x 2.75 x 0.1 cm dimension). The pressure was obtained by diffusion pump backed by rotary pump in the coating unit and was measured using Pirani and Penning gauge. A constant rate of evaporation of the order of 1 Å / sec was maintained.
throughout the film fabrication. A rotary device was employed to maintain uniformity in film thickness.

A simple Chemical bath deposition (CBD) method was employed to deposit CdS thin films of thickness 560 Å, 1180 Å and 1700 Å on to glass substrates using thiourea as Sulphide ion source and cadmium sulphate as cadmium ion source in Ammonia bath. For the preparation of CdS thin films, 110ml of water heated upto 70°C and glass substrates was inserted and 0.0623M Cadmium sulphate was added with slow stirring of the precipitated solution. Ammonia solution (NH₃) was then added. When adding ammonia solution, the temperature of precipitated solution was reduced. Then 0.3284M Thiourea was added slowly in the solution. After adding thiourea, the precipitated solution became a yellowish colour which indicates the production of Cadmium Sulphide in the precipitated solution. Time taken for the growth of the Cadmium Sulphide on the glass substrates varied from 30 minutes to 45 minutes.

The properties of CdS thin films are strongly affected by the substrate material and the technique used to prepare the film. Some important techniques which can be used to characterize the structural, optical and electrical properties.

The vacuum evaporated CdS thin films of thickness 880 Å, 930 Å and 2550 Å are measured by quartz crystal digital thickness Monitor. The thickness of the Chemical bath deposited CdS thin films are calculated by gravimetric method and it is found to be 560 Å, 1180 Å and 1700 Å.
From the X-Ray diffraction pattern, it can be seen that the diffraction peak is sharp and well defined indicating that the film is polycrystalline in nature and shows cubic structure.

The SEM micrographs of Vacuum evaporated CdS thin films reveal that, the distributions of grains are not uniform throughout all the regions, which clearly indicates the glassy nature along with amorphous phase and the chemical bath deposition, reveals the presence of some amorphous phase in the films along with their predominant crystalline phase.

The AFM images of vacuum evaporated CdS thin films expose the high uniformity of the films with spherical shape particles and the AFM images of Chemical Bath Deposition expose well defined particle like features with granular morphology and indicate the presence of small crystalline grains.

Energy dispersive x-ray analysis of both techniques confirms the compositions of constituents in the CdS thin films and the concentrations are found to be varying with film thickness, but no systematic variation is observed.

From the Vacuum evaporation method, the slight decrease in the bandgap values as the film thickness increases. This decrease in the bandgap is due to the improvement in the film crystallinity and the films prepared by chemical bath deposition, the presence of a single slope in the curves suggests that the single phase in nature and the type of allowed transition is direct.
The Photoluminescence studies of CdS thin films prepared by both techniques at room temperature, the spectrum exhibits a high energy broad band centred around 2.30 eV whereas the low energy bands appear around 1.75 and 1.8 eV for the CdS thin films. The variation of resistivity and activation energy of CdS thin films at room temperature is too high. The activation energy increases with increase in film thickness.

The dark I-V plots are similar to the diode characteristics, the ideality factor (n) of CdS thin films prepared by both techniques are increases with increase in film thickness and it is used as temperature sensors in the semiconductor solar cells.

Capacitance-voltage is a technique for characterizing semiconductor materials and thin films. The interface states capacitance depends on the forward bias and thickness of the CdS thin films.

Hall Effect measurements by both techniques show that the CdS thin film saturation values of the Hall resistance decrease with decreasing thickness of the film because the measured signal is proportional to the out-of-plane component of the magnetic moment, which scales as the sine of angle. At lower thickness, the zero-field slope has strong temperature dependence and at higher thickness $R_{xy} (H)$ becomes linear and $R_{xy}/H$ is almost temperature independent, typical for the ordinary Hall effect in the paramagnetic state of thin films. With increasing the CdS film thickness, the coercivity rapidly decreases.