

Study of Vacuum Evaporation Deposition of CDS Thin Films and its electrical properties

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Abstract: Cadmium Sulfide thin films have been deposited on to well cleaned glass substrate in a vacuum of 10-6 Torr. The thickness of the films has been determined by quartz crystal monitor method. The electrical resistivity measurements were performed at room temperature by four probe method and it shows CdS films with high resistivity. I-V characteristics analyzed with various thickness.

Key Word: CDS, Electrical Properties, Electrical Resistivity.

I. Introduction

The wide energy gap of CdS semiconductor is one of the most important properties leading to the great experimental interest in these materials. CdS is a suitable window layer for solar cells [1-2] and also finds applications as optical filters and multilayer light emitting diodes [3-4], photo detectors [5-7], TFETs [8-9], gas sensors and transparent conducting semiconductors for optoelectronic devices [10-11]. Various methods are used to deposit CdS thin films [12-14]. Among the vacuum evaporation is an attractive, effective method and the application at enables the deposition of thin films of larger area with good uniformity. The present study reveals the variation of electrical properties of CdS thin films.

II. Experimental Methods

Using the conventional 12A4 hind highvac coating unit pure (99.999%) aluminium was evaporated from tungsten filament on to well cleaned glass substrates through suitable masks to form to the base electrodes. Pure (99.99%) CdS (Alrich chemicals company, USA) was then evaporated from molybdenum boat to form the dielectric layer. A working pressure of 10-6 Torr was maintained in all the evaporation processes. Resistivity measurements are performed at room temperature by the two-probe method for high resistive films and four-probe method (van der pauw technique) for low-resistive films. Ohmic contacts are obtained using high-purity indium. The thickness dependent current-voltage behavior of Schottky devices was studied using Janis Liquid Nitrogen VPF Series Cryostat. Rotary pump was used to maintain desired vacuum inside the cryostat.

III. Result and Discussion

Electrical Resistivity

The electrical resistivity of CdS films with different thickness was measured using the d.c. four probe method in air. Fig. 1. – Fig. 3. shows the variation of (log ρ) with reciprocal of temperature (1000/T). For all films, it was seen that resistivity decreases with temperature indicating semiconducting nature of films. For all the films, resistivity follows the relation,

$$\rho = \rho_0 \exp(E_0 /KT) \quad (1)$$

Where ' ρ ' is resistivity at temperature 'T', ρ_0 is a constant, 'K' the Boltzmann constant (1.38×10^{-23} J/k) and 'E0' the activation energy required for conduction. Resistivity of CdS thin film decreases due to the improvement in crystallinity of the films as the film thickness increased. This observation is attributed to the size effect observed in semiconductor thin films.

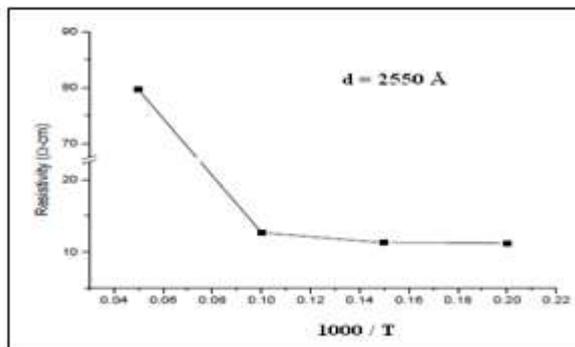


Fig. 1. Resistivity Vs (1000/T) of CdS thin film of thickness 2550 Å

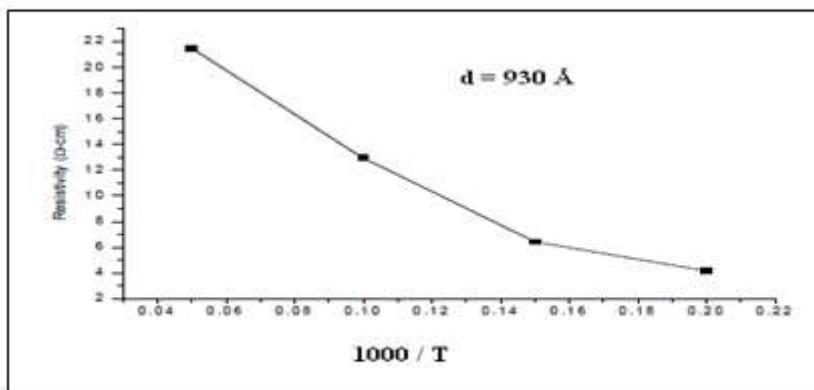


Fig. 2. Resistivity Vs (1000/T) of CdS thin film of thickness 930 Å

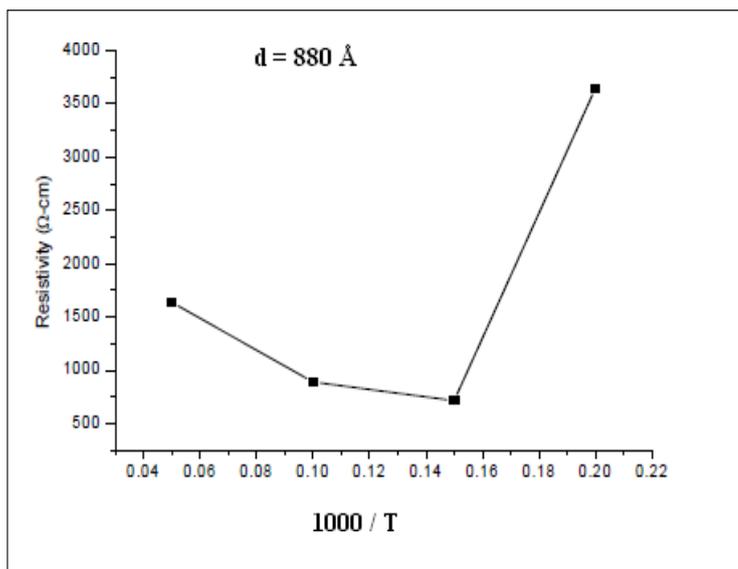


Fig. 3. Resistivity Vs (1000/T) of CdS thin film of thickness 880 Å

From the resistivity plot, the thermal activation energies were calculated using the formula (1). Table 1. Show activation energies at different thickness of CdS film. Activation energies are to the order of 0.7095 to 0.6345 eV as film thickness was decreased from 2550 Å to 880 Å.

Table 1. Variation of activation energy with film thickness

Film thickness (Å)	Activation energy (eV)
2550 Å	0.7095
930 Å	0.6547
880 Å	0.6345

I-V Characteristics Of Cds Thin Films Prepared By Vacuum Evaporation Method

The I-V characteristics without illumination (in dark), the forward current of the cell increases slowly with increasing voltage is shown in Fig.4. over the CdS thin films of thickness 880 Å, 930 Å and 2550 Å. From the Fig. 4, the heterojunction has rectification properties and the current increases with increasing thickness. Since the dark I - V plots are similar to the diode characteristics. The values of the series resistance (RS) in dark condition for the cell can be determined from the forward I-V characteristics at higher voltage. The results given are RS from 190 to 1200 Ω at different thickness of the films.

The current - voltage relation in heterojunction can be generally described by any of the diffusion model, the emission model or the recombination model from which the relation is represented by the standard diode equation:

$$I = I_0 \{ \exp (eV/nkT) - 1 \} \text{ ----- (2)}$$

Where ‘e’ is the electronic charge, n is the diode quality factor, ‘k’ is Boltzmann’s constant, ‘T’ is the absolute temperature and ‘I₀’ is the reverse saturation current.

From the I-V characteristics, the higher resistance may be responsible for decreasing the quality of the film.

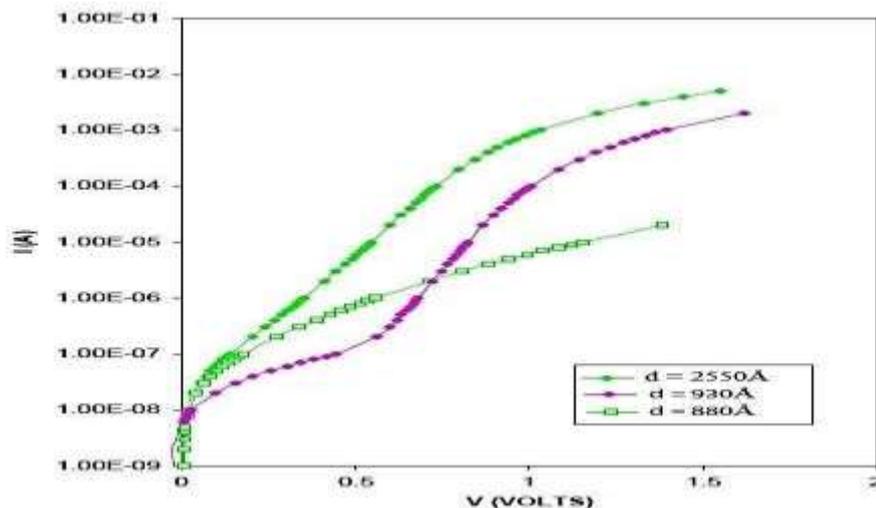


Fig. 4. I - V characteristics of CdS thin films in dark condition at different thickness by Vacuum evaporation method.

IV. Conclusion

CdS thin films prepared from Vacuum Evaporation deposition. The electrical resistivity measurements were performed at room temperature by four probe method and it shows CdS films with high resistivity. The higher resistance may be responsible for decreasing the quality of the film.

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