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Composition and Electrical Characteristics of CDs Thin Films Vacuum Evaporation Process

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Abstract
Cadmium Sulphide 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 compositional analysis is carried out by Energy dispersive X-ray analysis (EDAX). The electrical resistivity measurements were performed at room temperature by four probe method and it shows CdS films with high resistivity in the order of 10^{-6} cm. Thermal activation energy is also calculated by varying the thickness of the films and no systematic variation of activation energy is observed.

Keywords: *Vacuum deposition CdS thin film, EDAX analysis, Electrical properties.*

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I. INTRODUCTION

The necessity and interest in the analysis of thin films have been greatly stimulated in recent years because it has been the subject of countless investigation [1-3]. CdS thin films have gained much attention during the past two decades due to their spectral properties such as high refractive index [4-6]. CdS is a suitable window layer for solar cells and also finds application as optical filters and multilayer light emitting diodes, photo detectors, thin film field effect transistors, gas sensors and transparent conducting semiconductor [7-8]. Semiconducting thin films have been extensively studied for a long time due to their significant role in modern science and technology. Among various methods the reliable, simple and cost effective route to synthesis CdS thin films in vacuum evaporation technique. This method is the most widely used technique for the deposition of metals, alloys and also many compounds. This involves the evaporation for sublimation of the material in vacuum by thermal energy and allowing the vapor stream of the charge to condense on a substrate so as to form continues and adherent deposit of desired thickness [9-10]. The objective of the paper is to study the compositional and electrical properties of CdS thin films.

II. EXPERIMENTAL DETAILS

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. The thickness of the film was controlled and measured by Quartz crystal monitor and the thickness monitor in a flat circular plate approximately 0.05 inch (1.4cm) in diameter and 0.011 inch (0.28 cm) thick. A substrate heater arrangement was employed to grow the thin film at different substrate temperature. The Copper – constant and thermocouple was employed to measure the temperature inside the champer. The specimen is mounted in the centre of the diffractometer and rotated by an angle around an axis in the film plane. Energy dispersive X-ray analyzer (LEICA.S44Oi) confirmed the composition of the constituents in CdS thin films. The most commonly used technique in the semiconductor industry for measuring resistivity is the four point probe method. The arrangement consists of PID controlled over (Model PID – 200, Scientific Equipment and services, Rookee, India) is combined to low current source, constant current source (Model LCS - 01) and digital micro voltmeter (Model DMV-001).

II. Electrical Properties

The electrical resistivity of CdS films with different thickness was measured using the d.c. four probe method in air. Fig. 4. Fig. 5 & Fig. 6, shows the variation of resistivity (cm) with reciprocal of temperature (1000/T). For all films, it was seen that resistivity decreases with temperature indicating semiconducting nature of films [11-14]. For all the films, resistivity follows the relation,

ρ = ρ0 exp (E0 /KT

Where 'ρ' is resistivity at temperature 'T', ρ0 is a constant, 'K' the Boltzmann constant (1.38 x 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.

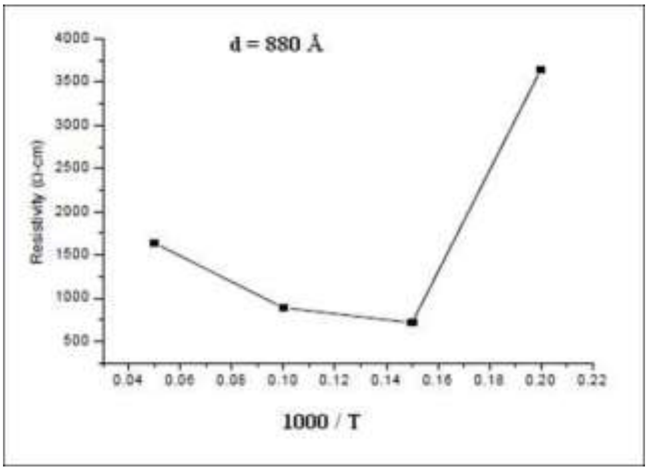

Fig. 4. Resistivity Vs (1000/T) of CdS thin film of thickness 880 Å.

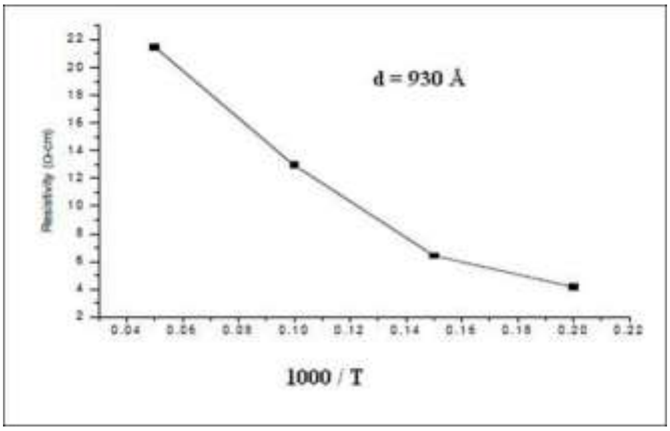

Fig. 5. Resistivity Vs (1000/T) of CdS thin film of thickness 930 Å.

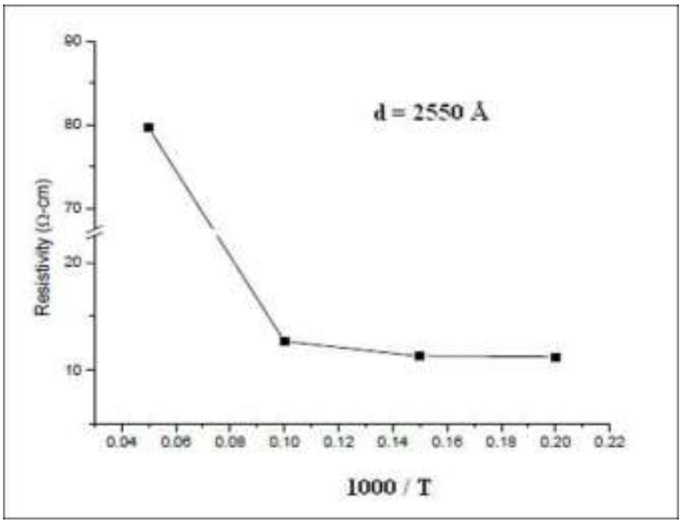

Fig. 6. Resistivity Vs (1000/T) of CdS thin film of thickness 2550 Å.

From the resistivity plot, the thermal activation energies were calculated using the formula (1). Table 2. Show the activation energies at different thickness of CdS film. Activation energies are to the order of 0.6345 to 0.7095 eV as film thickness was increased from 880 Å to 2550 Å.

Table 2. Variation of activation energy with film thickness.

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

IV. CONCLUSIONS

The CdS thin films have been deposited by vacuum evaporation and thickness of film was varied from 880 Å to 2550 Å, changing deposition time. Energy dispersive x-ray analyzer confirms the composition of constituent in the CdS thin films. The concentration is observed to be varying with film thickness, but systematic variation is not observed. The electrical resistivity measurements were performed at room temperature by four probe method and it shows CdS films with high resistivity. The activation energy is increases with increasing in film thickness.

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