HALL EFFECT OF CDS THIN FILMS BY VACUUM EVAPORATION DEPOSITION

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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 Hall Effect and the electrical resistivity have been and continue to be the key parameters used in the investigations of the basic electrical conduction processes in semiconductor materials.

Keywords: CdS thin film, Electrical resistivity, Vacuum evaporation, Hall Effect.

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.
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. Hall Effect Measurement System- 7600 Series is designed to provide totally automatic measurements of resistivity, mobility and carrier concentration of a wide range of samples over a temperature range from 70K to 730K.

RESULT AND DISCUSSION

Hall Effect measurements have been valuable tools for material characterization essentially; the Hall Effect can be observed when the combination of a magnetic field through a sample and a current along the length of the sample creates an electrical current perpendicular to both the magnetic field and the current.

The Hall Effect is the characteristic property of semiconducting materials caused by spin-orbit interactions. It may have both extrinsic and intrinsic contributions, arising respectively from spin-dependent impurity scattering, or finite effective magnetic flux, associated with the charge carriers in different spin polarization. Hall voltage of thin films is described by

$$V_H = \left( \rho_H I \right) / d = \left( R_0H + R_1M \right) I / d \quad \text{-------- (1)}$$

where ‘$V_H$’ is the Hall voltage, ‘$\rho_H$’ is the Hall resistivity, ‘H’ is the magnetic field intensity, ‘M’ is the magnetization, ‘I’ is the applied current, ‘d’ is the film thickness, ‘$R_0$’ is the ordinary Hall effect (OHE) coefficient and ‘$R_1$’ is the extraordinary Hall effect (EHE) coefficient.

Figure 1. shows temperature dependencies of measured transverse resistances $R_{xy}$ for films with the CdS thin films of thickness 880 Å, 930 Å and 2550 Å, two opposite field directions perpendicular to the film. $R_{xy}$ contains both longitudinal and Hall contributions. It is seen that at higher thickness of the CdS thin film measured $R_{xy}$ is independent of the field direction, indicating that it is dominated by the even in field longitudinal resistance. However,
at lower thickness of the CdS thin film correlations become significant and the corresponding odd-in-field Hall contribution appears in $R_{xy}$.

![Graph of Hall resistance vs temperature for CdS thin films of different thicknesses.](image)

**Fig.1.** Hall resistance Vs temperature for the CdS thin films of thickness 880 Å, 930 Å, and 2550 Å.

Figure 2. shows, $R_{xy}(H)$ curves at $T \sim 2$ K for the CdS thin films of thickness 880 Å, 930 Å, and 2550 Å. The $R_{xy}(H)$ curves develop gradually with angle and collapse to $R_{xy}(H) \approx 0$ at field parallel to the film. In all cases saturation values of the Hall resistance decrease with decreasing thickness of the films because the measured signal is proportional to the out-of-plane component of the magnetic moment, which scales as the sine of angle. Similarly, the saturation occurs at approximately the same perpendicular component of the field. This leads to the seeming stretching of the $R_{xy}(H)$ curves along the H-axis, inversely proportional to the sine of the angle. The $-R_{xy}(H)$ curves, vary continuously with the angle until they practically collapse to $R_{xy}(H) = 0$ at $0^\circ$, field parallel to the film.
Figure 3 shows $-R_{xy}(H)$ curves at $T =1.8$ K for the CdS thin films of thickness 880 Å, 930 Å and 2550 Å between the field and the film surface. Orientation of the field is sketched in panels (a), (b) & (c). At the angle of 10° an abrupt switching of Hall resistance appears in the low thickness region 880 Å & 930 Å. As the angle decreases further, the values of $R_{xy}$ between switching slightly increase and reaches maximum at 0° at thickness 2550 Å. For parallel field orientation the saturation $R_{xy}$ at large fields becomes almost zero. In this case, the magnetic moment is oriented in-plane and does not produce a measurable Hall voltage.
CONCLUSIONS

CdS thin films prepared from Vacuum Evaporation deposition. However, at lower thickness of the CdS thin film correlations become significant and the corresponding odd-in-field Hall contribution appears in $R_{xy}$. In all cases of CdS thin films saturation values of the Hall resistance decrease with decreasing thickness of the films because the measured signal is proportional to the out-of-plain component of the magnetic moment, which scales as the sines of angle.
REFERENCES


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