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HALL EFFECT OF CHEMICAL BATH DEPOSITED CdS THIN FILMS

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ABSTRACT

Thin films of CdS of different thickness have been prepared on glass substrates in various temperatures by Chemical bath deposition. 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: Electrical resistivity, Chemical bath deposition, CdS thin films, Hall Effect.

INTRODUCTION

Chemical bath deposition is a well known deposition process for Chalcogenides such as Cd, Zn, Co, Hg, Pb sulphides and selenides [1-2]. The Chemical Bath Deposition (CBD) method, being less expensive than other thin film deposition methods allows for the manufacture of relatively low cost devices especially light detectors, light energy conversion cells and thin films field effect transistor [3-5]. CdS in an important semiconductor material with very narrow band gap (2.10 to 2.40eV). The CdS material exhibits hexagonal structure with a preferred orientation along (002), (116,312) and (316,332) directions [6-9]. In this paper we present the results of our studies on Hall Effect of Chemical Bath Deposited CdS thin film.

EXPERIMENT

A simple Chemical bath deposition (CBD) method was employed to deposit CdS thin films on to glass substrates using thiourea as sulfide ion source and cadmium sulphate as cadmium ion source in Ammonia bath. For the preparation of CdS thin films, 110ml of water heated upto 70^0c and glass substrates was inserted and 0.0623M Cadmium sulphate was added with slow stirring of the precipitated solution. Ammonia solution (NH_3) 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 sulfide in the precipitated solution. Time taken for the growth of the Cadmium Sulfide on the glass substrates varied from 30 minutes to 45 minutes [10-11]. 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 Measurement (HMS) systems feature a moderate resistance range, high voltage capability, high magnetic field, and broad temperature range to provide very capable electronic transport measurement systems.

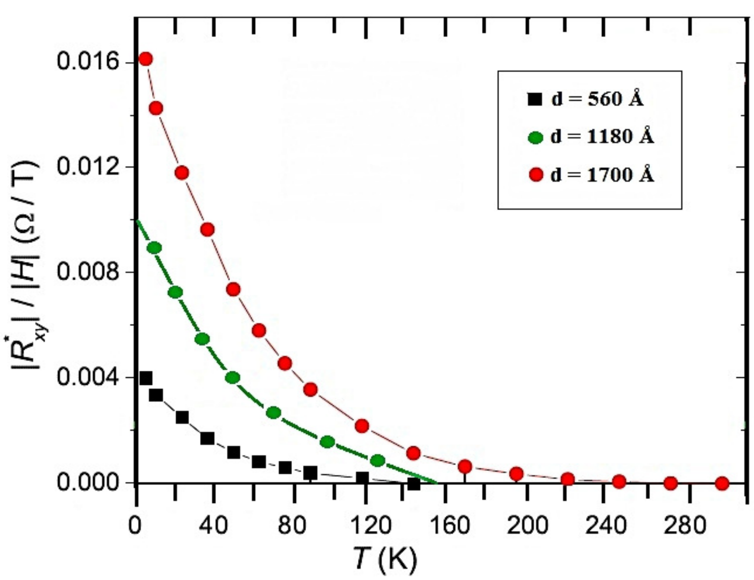

Fig.1. Hall resistance Vs temperature for the CdS thin films of thickness 560 Å, 1180 Å and 1700 Å

Figure 1. shows that, the temperature dependencies of absolute values of R_{xy} / H for the CdS thin films of thickness 560 Å, 1180 Å and 1700 Å. At low thickness 560 Å, the zero-field slope has strong temperature dependence.

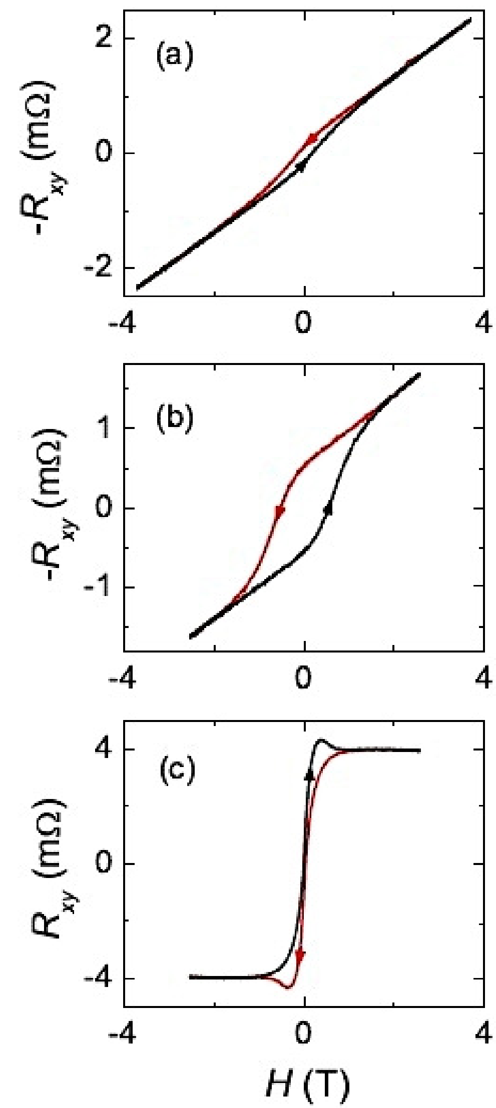

Fig.2. Hall resistances with Hall temperature for the CdS thin films of thickness (a) 560 Å, (b) 1180 Å and (c) 1700 Å.

The temperature rapidly decreases with increasing thickness of the films 1180 Å and 1700 Å. It becomes equal to the high field slope at $T \simeq 60$ K. Those temperatures represent the cluster glass-to-paramagnetic transition in the films. 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.

Main panels of Fig.2. shows, $-R_{xy}$ (H) at Hall temperature for the CdS thin films of thickness 560 Å, 1180 Å and 1700 Å. Low thickness films 560 Å show, a hysteresis at the lowest temperature with significant coercivity of 0.6 T, indicating the out-of-plane magnetic anisotropy. It is seen, how-ever, that R_{xy} (H) continues to grow at large fields. This is due to a weak magnetism in those strongly diluted, sub-critical CdS thin films. In this case the saturable extraordinary Hall Effect (EHE) is of the same order as the non-saturable OHE contribution. With increasing thickness 1180 Å and 1700 Å, the coercivity rapidly decreases 0.16 T and 0.06 T respectively. However, R_{xy} (H) remains nonlinear, curves with open circles in the main panels indicating presence of the residual cluster magnetism in the CdS thin films.

Figure 3. shows, The difference of R_{xy} / H at low and high thickness of the CdS thin films of thickness 560 Å, 1180 Å and 1700 Å, its provides an accurate measure of nonlinearity of the Hall effect. The switching of R_{xy} at small fields is associated with the planar Hall Effect (PHE). The PHE appears when there is a component of magnetization in the film plane. The contribution from the PHE is zero when the magnetization is parallel or perpendicular to the current. It is zero at high thickness (1700 Å) when the sample is magnetized perpendicular to the current flow direction Fig. 3. (c). Note that a similar non-monotonous R_{xy} (H) is observed for the film with thickness 1180 Å Fig.3.(b) , but not observed for more diluted film with thickness 560 Å, as seen from Fig.3.(a). This gain demonstrates different behavior of CdS thin films with low and high thickness.

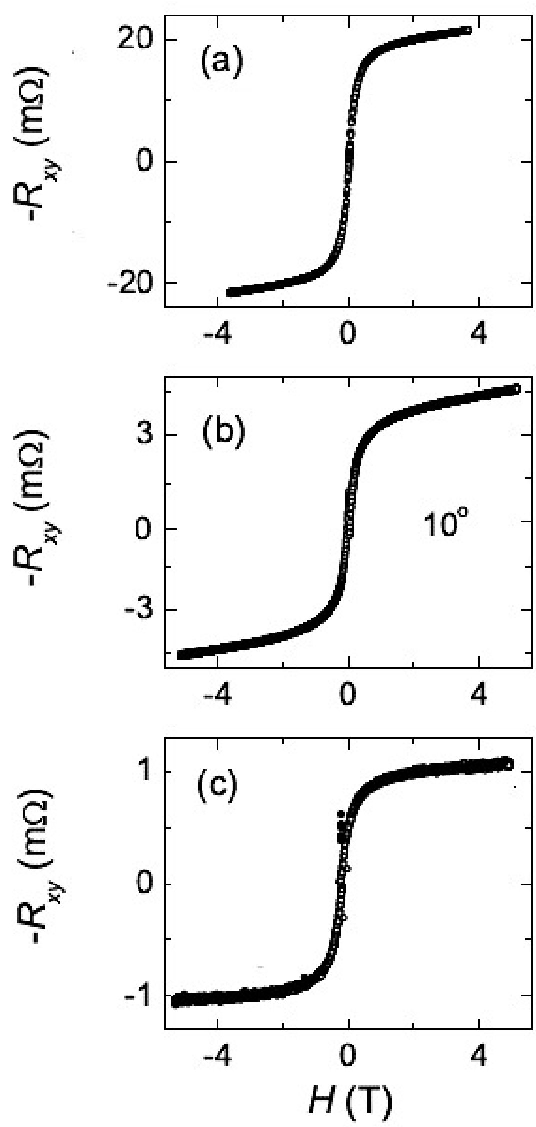

Fig. 3. Magnetic field dependencies of the Hall resistances for the CdS thin films of thickness (a) 560 Å, (b) 1180 Å and (c) 1700 Å.

CONCLUSION

CdS thin film has been deposited on a well cleaned glass substrate by chemical bath deposition technique. CdS shows n-type conductivity. Carrier concentration is found to improve with Cd concentration in bath. Conductivity is found to improve with dosage. 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 sine of angle.

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