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# Structural, Optical and Hall Effect Studies of Hot Wall Deposited Cdse$_{(0.7)}$ Te$_{(0.3)}$ Thin Films

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## 1. Introduction

Hall effect plays an important role in the study of conduction process in solids. In fact it is this effect which determines the nature, number and the mobility of charge carriers in materials.

Hall effect was discovered by E.H.Hall in 1879, during an investigation of the nature of the force acting on a conductor carrying a current in a magnetic field. Hall found that when a magnetic field is applied at right angles to the direction of the current flow, an electric field is set up in a direction perpendicular to both the direction of the current and the magnetic field. The Hall effect produces an electric field whose direction depends upon the sign of the charge in the conductor.

Hall effect makes possible the determination of the charge carrier mobility in semiconductors. The measurement of electrical conductivity. However it is possible to obtain this information from a combination of Hall effect and electrical conductivity measurements.

In general the properties of a material depend on its composition. In thin films it is seen that purely qualitative change in object size, at particular values of the thickness results in changes in the properties of the sample as a whole. Several physical properties of materials in thin form exhibit remarkable deviation from their behavior when they are in bulk form.

In this present work the Hall voltage in $CdSe_{0.7}$ $Te_{0.3}$ thin films coated at different substrate temperatures, are measured at different magnetic field strengths by varying currents through films, an their Hall mobility, conductivity, and carrier concentration are studied.

## 2. Theory of Hall Effect

A mathematical expression for the magnitude of Hall Voltage $V_H$ is derived and various parameters are determined using the relations given below.

The Hall constant $R_H = \frac{VH' t}{B' I_x}$ Ωm/Tesla

Where B is the magnetic field strength

$I_x$ is the current through specimen.

T is the thickness of the film

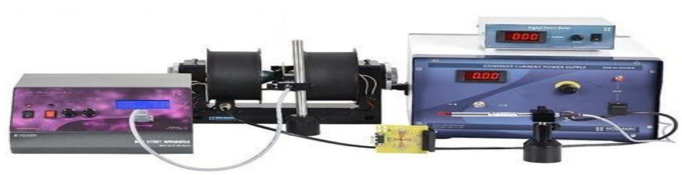
Electrical conductivity= $\frac{L}{R'b't}$ mho/m

Mobility $\mu = R_H ' \sigma$ $m^2$/Vs

Carrier concentration $= \frac{\sigma}{\mu e}$ Per $m^3$

## 3. Measurement of Hall Parameters

Hall effect was measured using vander Pahl's method. The experimental arrangement used for the measurement of Hall voltage is given in the **fig.(6.1**). Thin copper wires are used as leads for the probe. The obmic contact between the copper wire and the leads is obtained by employing a small amount of quick drying silver paint between the film and the lead. The whole substrate with the film and leads is mounted on a wooden scale for easy handling. Current $I_x$ is passed through two leads. Two more connection are taken from the different points, which are perpendicular, to the previous set, and are given to the digital multimeter for **Hall Voltage** measurements.



**Experiment arrangement for Hall Effect Study**

The contacts to measure Hall voltage must be exactly opposite to each other. Unless this condition is fulfilled, the two contacts will be on different equi potential planes when the current $I_x$ flows through specimen in the absence of the magnetic of this error voltage may be as large as, or even larger then, the Hall Voltage the measured with the magnetic field. Unless it can be eliminated by proper contact placement, it must be carefully measured in the absence of the magnetic field and corrected for in all subsequent measurements. The effect of this error voltage can be eliminated by determining the dc Hall voltage with the magnetic field in both the directions, successively and averaging the two results.

## 4. Experimental set up for Hall Voltage measurements

The circuit is set as shown in the **fig.(6.2)** Hall probe is placed in between the pole pieces of an electromagnet. A known current is passed through the film and the voltage across the other ends is measured. The current is measured using a Keethily digital milliammeter. Hall voltage across the leads is measured using digital multimeter. High input resistance meters are preferred in the Hall voltage and conductivity measurements to avoid loading error in the circuits.

The magnetic field is produced by an electromagnet with a DC power supply of 0-100 volts, capable of supplying current in the range of 0 to 6 amperes. A Gauss meter was used to measure the magnetic field strength.

## 5. Experiments Procedure

$CdSe_{0.7}$ $Te_{0.3}$ thin film is prepared by Hot Wall Deposition method and electrica contacts are made on the film for Hall effect Study. Electrical connections are made by using very thin copper wires. These copper wires are pasted on the film with the help of silver paste. Then the film and the wires set up is gently fixed on a scale and place between the pole pieces of the electromagnet.

A 0 – 30 V, 1 A, D.C. source is used to supply the current which passes through two opposite terminals made in the film. The magnetic field is set at three different values i.e. 6 KiloGauss, 9 KiloGauss, 12 KiloGauss. At each setting the current passing through the film is varied by adjusting the rheostat and the corresponding Hall voltage is measured between the other two opposite terminals in the film using digital multimeter. Such a kind of measurements are taken for the $CdSe_{0.7}$ $Te_{0.3}$ thin films which are deposited at 330K, 373K and 473K having the same thickness for 1950A$^o$. From the Hall voltage measurement, the Hall coefficient is calculated. From Hall coefficients, the Hall mobility and Carrier concentration are determined.

## 6. RESULT AND DISCUSSION

### 6.1 Structural Properties of $CdSe_{0.7}$ $Te_{0.3}$

X-ray diffraction measurements were made with X-ray diffractometer (Model-JOEL 8030) Japan with a nickel filtered Cu K radiation ( = 0.15418 nm). The X-Ray diffractogram observed for the bulk $CdSe_{0.7}$ $Te_{0.3}$ is shown in **fig.(7.1).** the calculated d values and the corresponding ASTM data values are tabulated below.

From this it is clear that the bulk $CdSe_{0.7}$ $Te_{0.3}$ compound formed is crystalline with hexagonal (wurtzite) structure. From the determined d values the lattice parameters a and c have been calculated and are 4.3 A$^o$ and 7.02 A$^o$ . The bulk $CdSe_{0.7}$ $Te_{0.3}$ material is found to exhibit Hexagonal wurtzite structure with preferred orientation and growth on some crystallographic planes of which (100), (101), (110), (103) and (201) were identified. The observed results are in good agreement with the reported results.

The structural analysis of $CdSe_{0.7}$ $Te_{0.3}$ thin films deposited by hot wall deposition technique has been carried out. X-ray diffractogram of films with the thickness in the neighborhood of 1950 A$^o$ deposited at 330K, 373K and 473K are as shown in fig.7.2, 7.3, 7.4 respectively. The thickness is measured by using multiple beam interferometric technique.

X-ray diffractogram of the films show that they are polycrystalline in nature. The crystallinity is found to increase with increase in substrate temperature.

X-ray diffractogram of films deposited at 330K show small peaks which may be due to the presence of small crystallites. X-ray diffractogram of films deposited at 373K and 473K are found to exhibit sharp peaks which confirm the polycrystalline in nature. The of the films. Films deposited at 373K and 473K have crystalline structure with hexagonal wurtzite phase. The films are found to have a preferred orientation and growth along 101 plane. The lattice parameter values have been determined which are found to be in agreement with the reported values by P.J.Sebastin etal {19}

From the X-ray diffractogram values grain size, strain and dislocation densities have been calculated for films deposited of 330K, 373K and 473K, and are as shown in Table 7.1. It is observed that grain size increases with increase of substrate temperature where as strain and dislocation density decreases with increase of substrate temperature. The variation of particle size and strain with substrate temperature is shown in fig.7.6 and fig.7.7 respectively. The variation of dislocation density and Full Width Half Maximum with substrate temperature is shown in fig.7.8 and fig.7.9 respectively.

Higher substrate temperature increases the surface mobility of atoms and cluster, during deposition which results in films with increased crystallite size. Decrease in strain and dislocation density indicates the formation of high quality films at higher substrate temperatures.

Thin films with thickness 1950 deposited at 330K was annealed at 473K for two hours. The X-ray diffractogram of the annealed film is shown in fig-7.5, and it exhibits sharp peaks. This may be due to increase in crystallite size as observed and decrease in lattice strain, dislocations and stacking faults. The annealed film is found to have preferred orientation along (100), (101), (110), (201) and (203) directions.

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