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Effect of temperature on thickness and Resistivity of II-VI solid solution of $CdSe_{0.75}Te_{0.25}$ thin films by spray pyrolysis

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ABSTRACT

$CdSe_{0.75}Te_{0.25}$ thin films deposited by spray pyrolysis using aqueous solution of cadmium chloride, selenium dioxide and Tellurium tetrachloride of 0.02 M of each at different substrate temperature. From the resistivity against inverse temperature activation energy calculated. It was observed that activation energy decreases as temperature increases. But thickness of the films increases, if the temperature of the films increases upto the optomise temperature. It indicates the increases of grain size of the this films and grain boundary width decreases. This may due to the oxygen acceptor level are very shallow from the conduction band.

Keywords :- $CdSe_{0.75}Te_{0.25,}$Thin films, resistivity.

1.INTRODUCTION

Transport phenomenon in II-VI compound and their solid solutions are as important as their optical properties and they provide valuable information about the nature of carries and scattering mechanisms. This films of $CdSe_xTe_{1-x}$ are used in the fabrication of transistors, solar cells, and photocondutors. There are other application are variable gap structures and photodetectors. The very few workers works on $CdSe_xTe_{1-x}$ thin films deposited on glass substrate. The Hall mobilities of charge carriers in the binary compounds are known to be limited Piezoelectric/optical mode/ impurity scattering in different degree at low temperature (1). Belyaev etal have studied Hall mobility and resistivity by heat screen method. They have taken the measurement in the 100 K-300 K. Uthanna & Reddy (2) have reported the dependence of electrical resistivity and Hall mobility on the percentage of selenium present in the compounds. They states that resistivity decreases expontially with x and Hall mobility increased with x.

There are several method to prepare thin films,such as chemical vapour deposition flash evaporation vacuum evaporation, r.f. sputtering. We have chosen spray pyrolysis method due to simple, inexpensive, cheap and easy to handle to prepare thin films of $CdSe_xTe_{1-x}$ and study the effect of temperature on resistivity and thickness of the films.

The aim of the work is to prepare the $CdSe_{0.75}Te_{0.25}$ thin films at different temperature. The temperature response on resistivity measurements were carries out in the temperature 300 K to 473 K in atmosphere environment and also sees the effect on thickness of the films.

2.PREPARATION OF THE SAMPLE

Thin films of $CdSe_{0.75}Te_{0.25}$ prepared by using aqueous solution of cadmium chloride, selenium dioxide and Tellunium tetrachloride each of 0.02 M at 350^0C on the pre-heated glass substrate. Chemical were used as AR-Grade. These three solutions are mixed and insert in the sprayer. Now sprayer spray the mixed solution on pre-heated glass substrate. The sprayer was move to and fro to avoid the formation of the droplets on the substrate and insure the instant evaporation. The solution was taken in the ratio 1:2.2 by volume to obtain the desired $CdSe_{0.75}Te_{0.25}$ thin films. The films shows the selenium or Tellurium deficiency (2-4) if the ratio of the solutions was taken in the ratio 1:1. The spray rate was maintained at 3.5 ml/min and pressure also kept constant at 12 kg/cm^2 . The temperature of the substrate was calculated by pre-calibrated copper constantan thermocouple. Thicknesses of the films were calculated by Michelson interferometers. Electrical resistivity were measured by Four-Probe method (5). The temperature of the substrate vary from 300^0C to 375^0C in the interval of 25^0C.

3.MEASUREMENT OF THICKNESS

The thickness of the $CdSe_{0.75}Te_{0.25}$ thin films determined by Michelson interferometer. Table 1. shows the variation of thickness with substrate temperature. It was observed that if the temperature of the substrate is increases from 300^0C to 350^0C, thickness of the films also increases but if further increases of temperature say 375^0C, the thickness of the decreases. This is due to higher evaporate the initial ingredient (6-7).

4.ELECTRICAL PROPERTIES

The type of conductivity of all films tested by hot-Probe method was of n-type semiconductor. The resistivity was calculated of all the films for the temperature range 300 K to 375^0 K using the relation,

$$\varrho = 2\pi s\ V/I\ /G_7\ (t/s) \qquad (1)$$

and $G_7(t/s) = 2s/t \ln$ (2)

Where s-the distance between the probes, t-the thickness of the films. I-the current generated from constant current source between the inner probes from the constant current source ,v-the voltage developed between the outer probes.
Fig.2 shows the electrical resistivity verses inverse temperature of $CdSe_{0.75}Te_{0.25}$ thin films of different temperature of as deposited.

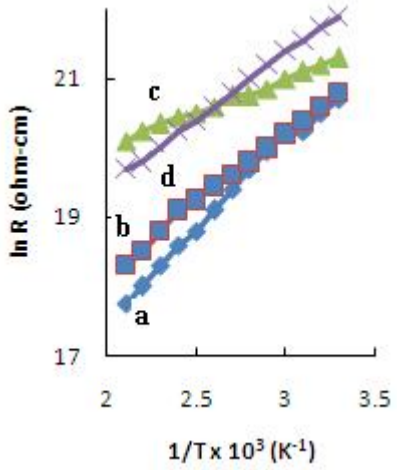

Fig. 1. Shows the resistivity verses inverse temperature of as deposited $CdSe_{0.75}Te_{0.25}$ thin films at different temperature a) 300 ^{0}C, b) 325 ^{0}C, c) 350 ^{0}C and d) 375 ^{0}C

It was observed that resistivity increases as if the temperature is lowered. The resistivity also increases if the deposition temperature increases. This is due to the capturing of the free electrons from the conduction band will reduce the number of free electrons available for the electrical conduction (8). Hence resistance of the films increases. From the graph of figure 2, activation energy also calculated .It was observed that the preparation temperature increases the activation energy also decreases. Table.1 shows the variation of activation energy, thickness with different deposition temperature.

Table .1.

Temperature ^{O}C	**Thickness t(μm)**	**Activation energy E_a(eV)**
300	**0.2018**	**283**
325	**0.2215**	**290**
350	**0.2530**	**305**
375	**0.2330**	**325**

The increase of temperature, the activation energy decreases. This is due to very shallow from the conduction band. Kalinkin etal have reported the films heated in vacuum at temperature above 280 K the process of conduction in $CdSe_xTe_{1-x}$ solid solution films is due to the activation energy of charge carriers from deep levels to the conduction band. When the thickness of the films increases, the grain size of the films increases and grain boundary width decreases. Hence also the impurity levels becomes less deep. The indicates the decrease in activation energy with an increase in the films thickness, the energy needed for the activation of charge carriers to the conduction band is reduced.

5.CONCLUSION

$CdSe_{0.75}Te_{0.25}$ thin films prepared by spray pyrolysis method. It was observed the thickness of the films increases if the temperature increases upto optimised temperature 350^0C. After this increase of temperature the thickness decreases. On the other hand activation energy continuously decreases if increase of temperature. This is due to increase of grain size of the films, which reduces grain boundary width.

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