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Variation of activation energy and Instability in resistance with different thickness of $CdSe_{0.75}Te_{0.25}$ thin films by spray pyrolysis

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ABSTRACT

II-VI group of compound is a transparent semiconductor. In the study of $CdSe_{0.75}Te_{0.25}$ thin films prepared by spray pyrolysis at 350^0C. From the resistivity versus inverse temperature graph we conclude that activation energy value increases if the thickness of the films increases. This indicates grain boundary width decreases and depth of impurity levels reduced.

Keyword :- Thin films, $CdSe_{0.75}Te_{0.25,}$ electrical properties.

1.INTRODUCTION

II-VI compound is an important semiconductor group of compound due to their application in semiconductor device technology. Thin films of $CdSe_xTe_{1-x}$ are very promising ternary system in the category. Thin films of such group of compound has several application includes variable gas structures and photocondutors. Very few researchers have works on this thin films. There are several method to prepare thin films such as, r.f. sputtering, flash evaporation, vacuum evaporation, chemical vapour deposition and spray pyrolysis (1,3).

We have chosen spray pyrolysis method due simple inexpensive method to produce thin films on large substrate area. In this paper we have reported the change of activation energy and Instability in resistance with different thickness of the films. Thickness of the films was measured by Michelson interferometer. The temperature of the substrate was measured by pre-calibrated copper constantan thermocouple. Resistivity of films were calculated by four probe method.

2.PREPARATION OF THE SAMPLE

$CdSe_xTe_{1-x}$ thin films prepared by using aqueous solution of cadmium chloride, selenium dioxide and Tellurium tetrachloride 0.02 M of each. Chemical were used as AR grade. The temperature of the substrate was maintained at 350^0C. These solution are mixed and insert in the sprayer. Now sprayer move to and fro to avoid formation of droplets on the substrate and insure instant evaporation. The distance between the sprayer nozzle and substrate was kept at 30 cm and sprayer maintained at pressure of $12kg/cm^2$and spray rate was 3.5 ml/min. The solutions was taken 1:2.2 by volume to obtain good films.

3.ELECTRICAL PROPERTIES

The type of conductivity was tested by hot probe method was of n-type semiconductor. Electrical resistivity was measured by four probe method in the temperature range 300 K to 473 K by using the relation (4),

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

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

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, v-the voltage developed between the outer probes.

Fig.1. shows the resistivity verses inverse temperature for different films thickness.

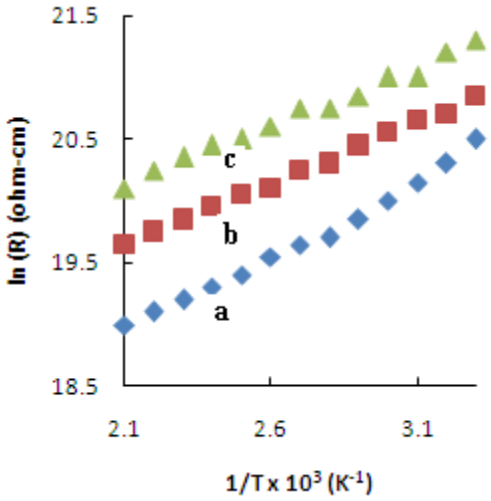

Fig. 1. Shows variation of resistivity verses inverse temperature for thickness a) t = 0.2530 µm, b) t = 0.2100 µm and c) t =0.1985 µm

It shows that the resistivity increases as temperature increased. This is due to the resistance of the $CdSe_{0.6}Te_{0.4}$ thin films when exposed to oxygen or atmosphere. Oxygen atoms adsorbed at the films surface capture the free electron from the conduction band and get chemically adsorbed as acceptor impurities with a finite activation energy of adsorption. This capturing of free electron from the conduction band will reduce the numbers of free electron available for electrical conduction. Hence the resistance of the films increases.

A depletion region is formed between the oxygen ions and donors atoms. The surface of the films becomes negatively charge with a positive region below, it is separated by the depletion region (5).The formation of this depletion region stops further capturing of free electrons by adsorbed oxygen atoms. Hence the resistances of the films get stabilized for all thickness of the films. The activation energy was calculated from each graph and was of 261 meV, 283 meV, 305 meV. This shows that activation energy increases when the thickness t=0.1985 µm, 0.2100 µm and 0.2530 µm respectively increases.

Hence we are able to say that this activation energy results from the excitation of electrons from the impurity oxygen level, which are very shallow and at the depth of 261 meV, 283 meV, 305meV from the conduction band. Belyaev, Kalinkin and Sanitarav (6) have reported that at temperature above 280 K, the process of conduction in $CdSe_xTe_{1-x}$solid solution films due to the activation of charge carriers from deep levels to conduction band. The grain size of the films increases if the thickness of the films increases. Hence impurity levels becomes less deep (7).

4.CONCLUSION

Spray pyrolysis is a simple and inexpensive method to produce a thin film on large substrate area. It was observed that activation energy increases if the thickness of the films increases. This indicates the grain boundary width decreases. The impurity level becomes less deep.

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