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Electrical Properties of Solid-Solution II-VI of CdTe Thin Films Prepared by Spray Pyrolysis

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Abstract: *Cadmium telluride thin films deposited by spray pyrolysis using aqueous solution of cadmium chloride and tellurium tetrachloride of each 0.02 M on pre-heated glass substrate at 350^0C. From the resistivity plot two activation energy calculated 380 m eV and 360 m eV at higher temperature and lower temperature region. This indicate that shallow trapping state due to the interstial of cadmium or telluride vacancies are dominates the extrinsic conductivity near the room temperature whereas at higher temperature higher temperature deep traps are appears to be operative. Chemical composition analysis reveals that CdTe thin films have good stoichiometric, n-type semiconductor.*
Keywords: *Spray pyrolysis, thin films, Electrical properties and chemical analysis.*

I. Introduction

Now a day a more focus on the solid solution II-VI group of semiconducting compounds due their application in upto-electronic devices. Cadmium telluride is an important member of group of binary compounds and it can be synthesized by using varies techniques. Cadmium telluride can also be used in heterojunction, IR detectors, switching devices and schottky barriers etc. The II-VI group compounds particularly CdTe are attracting a lot of attention due to their potential application in producing photovoltaic devices and wide use in the IR devices. The cadmium telluride is a semiconductor has been considered attractive for the use in solar energy conversion because it has optical band gap less than 2.00 eV. There are several method to prepare thin films of CdTe such as screen printing, vacuum evaporation metal-organic chemical vapour deposition, solution growth technique and spray pyrolysis (1-3).

Spray pyrolysis is a simple, inexpensive method to prepare thin films on large substrate area. In this paper report on electrical properties in the temperature range 300 K to 573 K was discussed.

II. Preparation Of The Sample

Thin films of CdTe were prepared by using aqueous solution of cadmium chloride and tellurium tetrachloride of 0.02 M of each solution. The chemical was used as AR-grade. Biological glass slide use as a substrate. The solution was mixed in one in proportion of 1:2.2 by volume then insert into the sprayer. Sprayer was mechanically move to and fro to avoid the formation of droplets on the substrate and insure the instant evaporation. Temperature of the substrate was maintained at 350^0C, which was measured by pre-calibrated copper constantan thermocouple. The distance between the sprayer nozzle and the substrate was kept at 30 cm. Spraying was done in air atmosphere at the pressure of 12 kg/cm^2 and spray rate was maintained at 3.5 ml/min.Thickness of the films was measured by Michelson interferometer. The electrical resistivity was measured by Four-Probe method. The conductivity of the films was tested by hot probe method.

III. Electrical Properties

Conductivity of the films was tested by hot probe method was of n-type semiconductor. The resistivity of the films measured by four probe method (4),

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

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

Where s-the distance between the probes, t-be the thickness of the films I be the current generated from constant current source between the inner probes, V-the voltage between outer probes.

Fig.1 shows the variation of resistivity with inverse temperature of as deposited CdTe thin films.

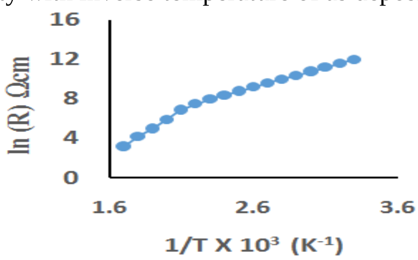

Fig. 1 The plot of resistivity with inverse temperature of as deposited CdTe thin films

It was observed that resistivity of the films decreases with increase of temperature. It was observed from the above plot it has two segments which corresponds to two values of the activation energy. The temperature dependence is weak at lower temperature confirming the low activation energy. The temperature dependence becomes relatively stronger at the higher temperature which reveals the possibility of conduction due to the extended state. This indicates the semiconducting nature of the films.

The polycrystalline films of cadmium telluride to do have electrical and optical properties similar to those of single crystal films. At the same time, the deposition condition have been found to have significant effect on the electrical properties [5,6]. The decrease in resistivity is due to the improvement in crystallinity of the films.

The thermal activation energies of the films were calculated by using the relation

$$\varrho = \varrho_0 \exp (E_a/kT) \qquad (2)$$

Where ϱ-resistivity at the temperature, ϱ_0- be the exponential constant, k-Boltmansconstant, E_a– the activation energy required for conduction. From the plot, activation energy calculated 380 meV and 360 meV respectively from the observed two segment of the plot. This shows that decrease of activation energy impure the grain size of the films. The activation energy of CdTe is also reported by the other worker by different method [7, 8] which was 200 meV, which may be due to the presence of shallow impurity level at 0.200 meV above the valence band. The higher the conductivity value at lower temperature is an evidence of the adsorption-desorption phenomena whereas the saturation of conductivity value at higher temperature is consequence of homogenous nucleation and diffusion controlled process. Similar two segment also observed in the same group of compound ofZnSe thin films prepared by the same method. They state that activation energy increases at higher temperature may be due to the attributed to the increase of band gap. Hence grain size of the films increases. This effect reduces the grain boundary effect. It is evident that in CdTe thin films the possibility of shallow trapping state due to the intestitial of cadmium or telluride vacancies are expected to dominates the extrinsic conductivity near the room temperature whereas at higher temperature deep traps states influence are probabley appears. Thus we conclude that spray pyrolysis is suitable method for the developing a good, stoichiometry semiconductor.

IV. Chemical Composition Analysis

The chemical analysis was taken on Inductivity coupled plasma atomic absorption at room temperature. For this thin film deposited on glass substrates scraped and collect the materials of thin films. Then this scrap material was used to analysis the chemical which are present in the films. The analysis of the composition of the films revealed the presence of 48.8 and 51.2 atomic percent of cadmium and tellurium in the films respectively which shows the good stoichiometric semiconductor.

V. Conclusion

Cadmium telluride thin films deposited by spray pyrolysis was of good stoichiometric semiconductor. In the resistivity plot the two segment observed with activation 380 meV and 360 meV show the possibility of shallow trapping state due to the interstitials of cadmium or tellurium deficiency. Chemical composition analysis show the films of CdTe have a good stoichiometric semiconductor.

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References

[1]. J. P.Hirde and Y.D. Tembhurkar, "Optical and structural properties of II-VI solid-solution thin films of $Cd_xZn_{1-x}S$deposited by spray pyrolysis."Indi. J. Pure and Appl. Phys28 oct (1990)pp 583-585.

[2]. Y.D. Tembhurkar and J.P.Hirde, "Structural, optical and electrical properties of spray pyrolytically deposited films of copper indium diselenide."Thin Solid Films 215(1992) 65-70.

[3]. Y.D. Tembhurkar and J.P.Hirde, "Electrical properties of spray pyrolytically deposited p-$CuInSe_{2(1-x)}S_{2x}$ solid-solution thin films."ActaCienciaIndiaca Vol. XVIII p4 (1992)239.

[4]. L.B. Valde, "Measurement of resistivity of germanium crystal by four probe method," Proceeding of I.R.E. 420 (1954).

[5]. K.N. Shreekanthan, Kasturi V. Bangera,G.K. Shivkumar& M.G. Mahesha, " Structure and properties of vacuum deposited cadmium telluride thin films." Ind. J. of pure and Appl. Phys. 44 (2006) 705-708.

[6]. M.Rusu, I.I Micolaescu and G.G. Rusu, J.Appl. Phys A, 70 (2000) 565.

[7]. A. Banerjee, H. Saha and R. Guha, Indian J. Appl. Phys. 63A (1989) 326.

[8]. G. Martin, E. Fogarassu and B.Fabre, J. Appl. Phys. 47 (1976) 264.

[9]. Y.D. Tembhurkar, "Effect of substrate temperature on electric properties of solid-solution of ZnSe thin films prepared by spray pyrolysis." Paper under consideration for publication International Journal of Science and Research Nov. (2016).