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Electrical Properties of CdSe Thin Films Prepared by Spray Pyrolysis

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Abstract: ***CdSe thin films prepared by spray pyrolysis method due to cheap and inexpensive method. Electrical properties studies in the temperature range 77 K to 473 K. From the Arrhenius plot of conductivity activation energy calculated was of 15 meV, which may be due cadmium interstitials or sulphur vacancies. From the conductivity plot it is also observeral that conductivity increase as temperature lower which was exactly the reverse of CdS thin films.***

Keyword: CdSe thin films, electrical properties, Spray pyrolysis.

1. Introduction

CdSe is an important II-VI group compound semiconductor material. The CdSe thin films has band gap < 2.0 eV used in the formation of heterojunction solar cells due to their greater open-circuit voltage and short circuit current and other opto-electronic devices. It is also used as photo detectors, electro-conductive electrode and super conductors.Measurement on CdSe thin films using deep-level transient spectroscopy have shown that the effect of annealing considerably increase the relative concentration of certain trap levels and these changes have been shown to strongly dependent on the grain size . Therefore we could expect that the effect of concentration would not also change in optical absorption, electrical properties of flash evaporated CdSe thin films are beyond control.There are several method to prepared CdSe thin films such as r.f. sputtering flash evaporation, vacuum, evaporation chemical vapour deposition and spray pyrolysis (1-3).

In this paper we have reported electrical properties of CdSe thin films by spray pyrolysis method. This method is a very simple, inexpensive and ruftuf method to prepared a high good quality of thin films. Anyone can setup the experiment and easily prepared thin films for different combination and different temperature etc. The study of activation energy was carried out from the conductivity versus inverse temperature using four probe method. The conducting type of the films was tested by hot probe method. The temperature of the substrate during the films deposition was measured by pre-calibrated thermocouple.

2. Preparation of the Sample

Aqueens solution of cadmium chloride, selenium dioxide were used for spraying the films on hot glass ,substrate at 350^0C. The Concentration of each solution was 0.02 M. These two solutions were mixed and insert in the sprayer. Now sprayer is move mechanically move to and fro to avoid the formation of droplets on the substrate. The substrate temperature was maintained at 350^0C and measured by pre-calibrated thermocouple. The distance between the sprayer and substrate was kept at distance 30 cm. Spray rate was maintained at 3.5 ml/min and spraying done in air at 12 kg/cm^2 .

3. Electrical Properties

Conductivity of the films, as determined by hot probe method, was of p-type. The resistivity was determined for two different ranges of temperature. Range (a) was from 300 K to 473 K and range (b) from 77 K to 300 K. The resistivity in the range (a) was measured at atmospheric pressure and in the range (b) at 10^{-2}Torr , for which a four probe arrangement together with sample films was enclosed in a specially prepared stainless steel container which was immersed in a liquid nitrogen bath. Resistivity was calculated for above temperature ranges using the relation (4),

$$\varrho = 2\pi S\ V/I\ /G_7(t/S) \qquad \text{.....(1)}$$

Where G_7 (t/S) = 2S/t ln(2), S-the distance between the probes, t-the thickness of the films I-the current generated from constant current source between the outer probe, V-the voltage between the inner probes.

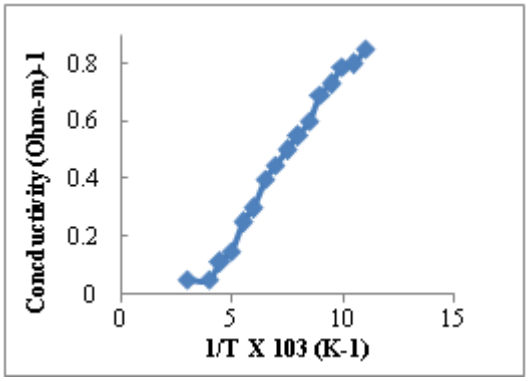

Figure 1: Conductivity v/s Inverse Temperature of as deposited CdSe thin films

Fig.1 shows the typical Arrhenius plot of conductivity versus inverse temperature of CdSe thin films of as deposited. The activation energy was calculated from this plot using relation,

$$\sigma = \sigma_0 \exp(-E_a/kT) \qquad (2)$$

Where σ_0– the pre-expontial conductivity, E_a- activation energy k-Boltzmann constant, T- absolute temperature. The value of activation energy calculated from the linear portion

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of the curve was of 15 meV. This results are well agree with results reported by Reddy et al. They have reported value of activation energy 10 meV for vopourphase grown CdS_xSe_{1-x} single crystal in the entire range of temperature 90 K-300 K. They also stated that activation energy shows a decreasing trend from CdS to CdSe. Wovdbury and Aven Showed that the donors in II-VI compounds are more hydrogen like and donor activation energy is given by,

$$E_a = 13.6\ m^*/m_e\ \varepsilon^2 \quad (3)$$

Where m^x/me is the effective mass ratio and ε is the static dielectric constant. Moreover the activation energy of a particular donor is known to vary with the energy gap of hot crystal. The energy gap (eV), effective mass ratio (m^*/m_o) and static dielectric constant (ε) of CdS and CdSe are 2.37, 0.204 9.3 and 1.2, 0.13, 9.63 respectively. Hence they observe decreasing trend in activation energy with increase in CdSe content is justified. As forein impurity were nor intentionally introduced these donors might be cadmium in terstitialsor sulphur vacancies.

In the study of electrical properties of CdS thin films by Tembhurkar (6) in the temperature 300^0K to 573^0K prepared by same method. We reported in CdS thin films, there are two district region are seen. The activation energy for these two region are 0.045 eV and 0.94 eV for the temperature ranges 313^0K 453^0K to 573^0K respectively. In CdS thin films conductivity of the films decreases as temperature decreases.

In the study of CdSe thin films it was observed that the conductivity increases as temperature decreases our results are well agreed with the results reported by Reddy et al for vapour phase grown CdS_xSe_{1-x} single crystal . This could be understand in terms of the rate of decrease of carrier concentration and the rate of increase of mobility as a temperature lowest. Hence former dominates a increase in conductivity of CdSe thin films.

4. Conclusion

Electrical study of CdSe thin films between the temperature 77 K to 473 K reveal that the activation energy 15 meV due to oxygen impurity level are very shallow from the conduction band .

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