International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Effect of Substrate Temperature on Electric Properties of II-VI Solid Solution of ZnSe Thin Films Prepared By Spray Pyrolysis

Y. D. Tembhurkar

Department of Physics, S. K. Porwal College Kamptee (M.S) India-441002

Abstract: ***ZnSe thin films prepared by spray pyrolysis by using aqueous solution of zinc chloride and selenium dioxide of 0.1 M of each at different substrate temperature 300^{0}C, 325^{0}C, 350^{0}C, & 375^{0}C. From the Arrhenius plot, each curve shows two regions. Activation energy is found to be low at lower temperature and it is increasing for higher temperature for each prepared thin films of different temperature. This may be shallow trapping state due to interstial zinc or selenide vacancies are expected to dominates the extrinsic conductivity near room temperature where as higher temperature, deep traps state influence are probable appears.***

Keyword: ZnSe thin films, activation energy

1. Introduction

There has been growing interest in II-VI material because of their potential application in electronics and upto-electronic devices. CdSe, CdS, ZnS, ZnSe compound belongs to II-VI group and are used in the variety of semiconductor devices and recently in light activated values for large screen liquid crystal display and other opto-electronic devices such as, electroluminescent display, cathodo luminescent displace. Zinc selenide is a semiconductor that has been considered attractive for use in solar energy conversion because of its suitable band gap energy (Eg=1.68 eV). Thin films of ZnSe are prepared by variety of methods, such as screen-printing, vacuum evaporation, metal-organic chemical vapour deposition anodic and cathodic deposition, solution growth deposition, flash evaporation, r.f. sputtering evaporation and spray pyrolysis method. The polycrystalline ZnSe films have been prepared on glass substrate by spray pyrolysis method.

In the present investigation, we report the successful deposition of ZnSe thin films by spray pyrolysis method and study their electrical properties of ZnSe thin films at different deposition temperature. From this study the activation energy of each film calculated and are related to the grain size of the films.

2. Preparation of the sample

Aqueous solutions of zinc chloride and selenium dioxide are sprayed on the preheated glass substrate. Chemical were used as AR-grade. Molarity of the solution was taken 0.1 M. These two solutions was mixed in one then insert in the sprayer. Sprayer was mechanically moved to and fro to avoid the formation of droplets on the glass substrate and insure instant evaporation. Temperature of the substrate was measured by pre-calibrated copper constantan thermocouple. Thin films of ZnSe prepared at different substrate temperature 300^{0}C, 325^{0}C, 350^{0}C & 375^{0}C in theinterval of 25^{0}C.Zinc chloride and selenium dioxide are mixed in the proportion 1:2.2 by volume. The films show the selenium deficiency [1-3] if the ratio of the solution was taken as 1:1. The distance between the sprayer nozzle and substrate was kept at 30 cm. The spraying rate was maintained at 3.5 ml/min with pressure of 12 kg/cm^2. Thickness of the films was measured by Michelson interferometer. Conductivity of the films was tested by hot probe method. The resistivity of the films was calculated by four-probe method.

3. Electrical properties

The type of conductivity of the films was tested by hot probe method was of n-type semiconductor. Fig.1 shows the Arrhenius plot of conductivity with inverse temperature of as deposited thin films of ZnSe.

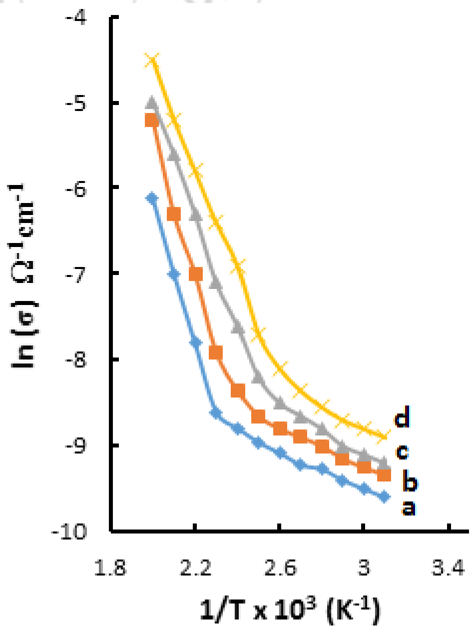

Figure 1: Arrhenius plot of conductivity with inverse temperature of as deposited thin films of ZnSe

The ZnSe films were prepared at different temperature 300^{0}C, 325^{0}C, 350^{0}C&375^{0}C range 300 K to 573 K at the atmospheric condition. Each graph has two segments corresponding to two values of the activation energy. The temperature dependence is weak at lower temperature confirming the low activation energy. On the other hand the temperature dependence becomes relatively stronger at higher temperature which reveals the possibility of conduction due to the extended state.

The temperature dependence of the electrical conductivity can be described by the following usual Arrhenius equation,

$\sigma = \sigma_0 \exp(-Ea/kT)$ (1)

Where σ_0 is the conductivity pre-exponential factor, Ea- the activation energy for conduction, k-Boltzman constant, T- be the absolute temperature.

The activation energies were calculated from each graph of the two region. It was observed that activation energy of each curve at low temperature are found to be slightly increases (low value), 30 meV, 33 meV, 40 meV& 45 meV for films prepared at different temperature 300^0C, 325^0C, 350^0C & 375^0C respectively. Activation energy are 70 meV, 80 meV , 86 meV and 98 meV at higher temperature region. This indicates that the conductivity becomes more thermally activated with increasing temperature, this strengthens the prediction of dominance [5] of high grain size of the films hence grain boundary effect of the films decreases. Sharma et al [6] have also observed the similar two region in the conductivity plot of zinc selenide films prepared by comical bath deposition technique. They also stated that activation energy at lower temperature is low and it is increases at higher temperature, may be attributed to the increase of band gap energy hence grain size of the films also increases. This affect the reduces the grain boundary effect of the ZnSe thin films. It is evident that the shallow trapping states preferably due to interstial zinc or selenide vacancies are expected to dominates the extrinsic conductivity near the room temperature whereas at higher temperature deep traps states influence are probable appears.

4. Conclusion

ZnSe thin films are a great use to prepare solar cell. Activation energy found to be low at the lower temperature and high at higher temperature indicates that increase of grain size of the films which reduces grain boundary effect. The shallow trapping state appears due to intestinal zinc or selenide vacancies.

Acknowledgement

Author would like to express his thanks to U.G.C for financial support in the form of major research project. Author also Thanks to principal of S.K. Porwal College Kamptee for provided the research facility in the physic department.

Reference

[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.”ActaCiencia India Volu 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] A.M. Ahemed, “Electrical conductivity and thermocouple power of $Ge_{40}Te_{60}$ and $Ge_{38}Sn_2Te_{60}$ alloys” Ind. J. of Pure and Appl. Phys. 43 (2005) 535-541.
[6] K.C.Sharma, R.P. Sharma and J.C.Garg, “Opto-electronic properties of chemical bath deposited polycrystalline non-stoichiometric Zinc Selenide films,” Ind. J. of Pure and Appl. Physic 28 (1990) 539-541