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Study of Optical Properties of Spray Pyrolytically Deposited II-VI Solid Solution of CdZnSe Thin Films

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Abstract: ***CdZnSe thin films prepared by using aqueous solution of cadmium chloride, zinc chloride and selenium dioxide of 0.01 M of each at 300^{0}C on pre-heated glass substrate. The optical band gap energy is found to be 1.78 eV which is close value to earlier reported workers. The optical study reveals that the CdZnSe thin films shows the direct allowed transition.***

Keywords: CdZnSe thin films, spray pyrolysis, optical properties.

1. Introduction

II-VI group of compound semiconductor are important in a wide spectrum of photoelectric application. Especially ternary group compound including cadmium zinc selenide (CdZnSe) have attracted much attension in the field of solar cell due to their interesting properties of band gap. The band gap values of CdZnSe semiconductors can be varied from 1.86 eV for CdSe and 2.68 eV ZnSe with composition (1,2). The development of low-cost solar cells depends on the exploitation of the films and thus CdS, CdSe, CdTe, ZnSe, ZnTe films prepared under various experimental condition. CdSe is found to undergo photo-corrosion, when used in photoelectro chemical cells. Whereas ZnSe is reported to be more stable though less photoactive due to its wide band gap. To overcome this shortcoming CdSe and ZnSe can be mixed to as to provide $Cd_{1-x}Zn_xSe$ ternary alloys. The importance of these material lies in the fact that their optical band gap energy and lattice parameter can be tailored independendly which can be lead to new semiconducting material that may be suitable task of increased absorption of solar spectrum and increase the resistance towards photo corrosion. In fact zinc concentration of $Cd_{1-x}Zn_xSe$thin films play an important role for the high performance of photo-electrochemical solar cells.

There are several method to prepare thin films of CdZnSe such as vacuum evaporation, molecular bean epitaxy, electronbeam pumping, chemical bath deposition, r.f. sputtering and spray pyrolysis.

We have chosen spray pyrolysis because it issimple, inexpensive and easy to handle for the production of thin solid films is a good method for the preparation of thin films suitable for scientific studies in for may technological and industrial application.This method was used for the preparation of thin films of the important II-VI group semiconductor compound. In this paper we have reported optical study of CdZnSe thin films.

2. Experiment Details

CdZnSe thin films were obtain by spraying the aqueous solution of cadmium chloride, zinc chloride and selenium dioxide of 0.01 M each. Chemical were used as AR grade. Biological glass plate used as a substrate. They are clean ultrasonically.The solution of each chemical were prepared in double distilled water. The temperature of the substrate was maintained at 300^{0}C and was measured by precalibrated copper constantan thermocouple. The spray rate was maintained at 3.5ml/min with pressure of 12kg/cm$^{2.}$ The sprayer was mechanically move to and fro to avoid the formation of droplets and insure instant evaporation. A continuous films is formed on the hot glass substrate by thermal decomposition of the material droplets (3). After decomposition, the films were allowed to cool at room temperature. Thickness of the films was measured by weight difference method using unipan sensitive semi-micro balance and also on Michelson interferometer. The results of measurement of thickness in above both method are same, only difference 0.002 µm were found.The thickness the films was calculated as 0.1680 µm.

3. Optical Properties

Transmission of the films were taken on UV-1800 Shimadzu Spectrophotometer in the wavelength range 350 nm-1100 nm as shown in figure.1.

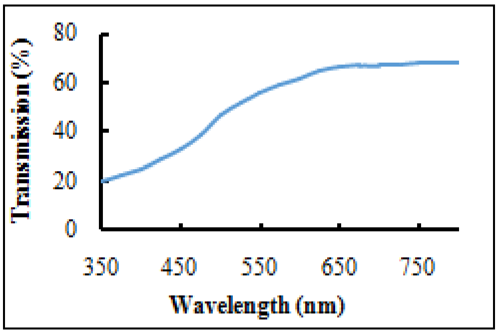

Figure 1: Transmission verses wavelength of as deposited CdZnSe thin films

It was observed that onset of decreases of transmission gives the optical absorption edge. The optical absorption coefficient were calculated for each wavelength given by the relation,

$$\alpha = 1/t \ln(I_0/I) \quad (1)$$

Where I_0 and I are the intensity of incident and transmitted radiation respectively, t-the thickness of the films.

An analysis of the spectrum showed that the absorption at the fundamental absorption edge can be described by relation,

$$\alpha = A/h\upsilon\,(h\upsilon - Eg)^n \qquad (2)$$

is probable responsible absorption edge. Where A-the parameter that depends on the transition probability, Eg-the optical band gap energy.

For direct allowed transition n=1/2 and for indirect allowed transition n=2. To calculate the exact value of band gap, plotting the graph between $(\alpha h\upsilon)^2$ verses hυ of as deposited thin films of CdZnSe as shown in figure.2.

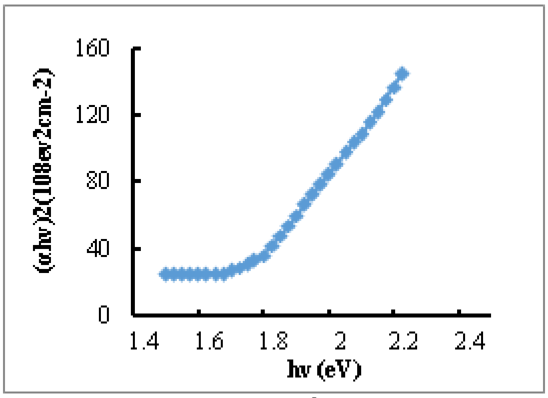

Figure: The graph between $(\alpha h\upsilon)^2$ verses hυ of as deposited thin films of CdZnSe

The linearity of the plot showed the direct allowed transition, indicating, semiconducting films. The linear portion of the plot was extrapolated to meet on hυ axis yield, the value of band gap energy and was found to be 1.78 eV.

This result are well agree with the mahalinganet (4). They have studied electron-deposited CdZnSe thin films at various bath temperature. They have stated that optical band gap of the films increased from 1.67 eV To 1.72 eV with the increase of bath temperature from 30^0C to 90^0C. They have also calculated optical constants (refractive index (n), extinction coefficient (k)).Several workers (4,6,7) have also reported the value of band gap energy of CdZnSe ternary semiconductor can be varied from 1.7 eV (CdSe) to 2.7 eV (ZnSe) with composition parameter. Thus CdZnSe thin films shows the semiconducting behavior.

4. Conclusion

The spray pyrolysis is asimple and inexpensive method to deposite thin films on large substrate area. The optical band gap of CdZnSe thin films obtained at 300^0C is found to be 1.78 eV which is quite closer to the other workers. The optical study reveals that the deposited films shows the direct allowed transition.

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