Variation of Band Gap Energy and Thickness with Temperature of Solid Solution II-VI CdZnSe Thin Films Prepared by Spray Pyrolysis

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Abstract: ***CdZnSe thin films were prepared by using aqueous solution of cadmium chloride, zinc chloride and selenium dioxide of 0.01 M of each. Optical band gap calculated from the graph $(\alpha h\nu)^2$ verses hν. This indicates that the optical band gap decreases as temperature increases uptooptimised temperature. If further increase of temperature the optical band gap increases and thickness decreases. This is due to higher evaporation the initial ingredient. The band gap energy decreases from 1.88 eV to 1.78 eV as temperature increases. CdZnSe thin films shows the direct allowed transition.***

Keywords: Spray pyrolysis, CdZnSe thin films, and Optical properties

1. Introduction

II-VI group of semiconductor compound is an important challenge for research in opto-electronic application. Cadmium zinc selenidethin films have great attention due to various opto-electronic applications. They have used as a wide –band gap window material for heterojunction solar cells due to band gap energy less than 2. II-VI semiconductor compounds are direct band gap materials. The band gap of values of CdZnSe ternary semiconductors can be varied from 1.86 eV (CdSe) to 2.68 (ZnSe) with composition parameter. CdSe is very promising candidate for photo-electrochmical cells and photoconductive cells, whereasZnSeis a very important material for luminescent and light-emitting devices. CdSe is found to undergo photo corrosion when used in photo electrochemical cells, whereas asZnSe is more stable though less photo active due to its wide band gap. To overcome this short coming, CdSe [1] and ZnSe [2] can be mixed so as to provide $Cd_{1-x}Zn_xSe$ternary alloys.

$Cd_{1-x}Zn_xSe$ have attracted much attention in the field of opto electronic and photoelctrochemical solar cells devices because of its wide optical band gap and good stability in the environment. In fact zinc concentration in $Cd_{1-x}Zn_xSe$ thin films plays important role for the high performance of photoelectrochemical solar cells.

There are different method to prepare thin films of CdZnSe such as vacuum evaporation, molecular beam epitaxy, electron beam pumping, chemical bath deposition, r.f sputtering, flash evaporation and spray pyrolysis. We have chosen spray pyrolysis due to simple, inexpensive method to prepare a thin films on large substrate area.

In this paper we have reported effect of temperature on thickness and optical band gap energy of CdZnSe thin films by spray pyrolysis.

2. Experimental Details

Aqueous solution of zinc chloride, cadmium chloride and selenium dioxide of 0.01 M of each were prepared in double distilled water. Chemical were used as AR-grade. These solution are mixed in the proportion of 1:1:2.2 by volume and then solution sprayed on pre-heated glass substrate which was maintained at 250^0C to 325^0C in the interval of 25^0C. The films shows the selenium deficiency if the solution of the proportion was taken in ratio 1:1:1 by volume. Temperature of the substrate was measured by pre-calibrated copper constantan thermocouple. Transmission were taken on UV-1800 Shimadzu spectrophotometer. Thickness of the films were measured by weighting difference method on unipan micro balance.

3. Transmission Study

Figure.1 shows the transmission verses wavelength of as deposited thin films prepared at different substrate temperature a) 250^0C b) 275^0C c) 300^0C and d) 325^0C.

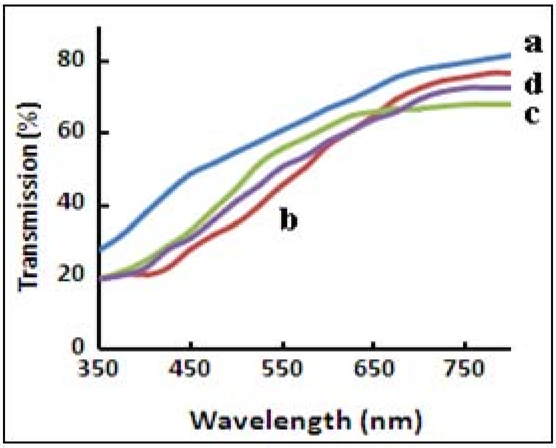

Figure 1: Transmission verses wavelength of as deposited thin films prepared at different substrate temperature a) 250^0C b) 275^0C c) 300^0C and d) 325^0C

From the transmission curve the optical absorption coefficient 'α' were calculated for each wavelength of each curve and it is given by relation,

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

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

The relationship between absorption coefficient and optical band gap is expressed to calculate the band gap of the semiconductor compounds by the following relationship (3),

$$\alpha = A/h\upsilon \, (h\upsilon - E_g)^n \quad (2)$$

Where A - an energy independent constant and E_g- the optical band gap, n-the constant which determined the type of optical transition. To calculate the exact value of band gap, plotting the graph between $(\alpha h\upsilon)^2$verses hʋ shown in fig.2.

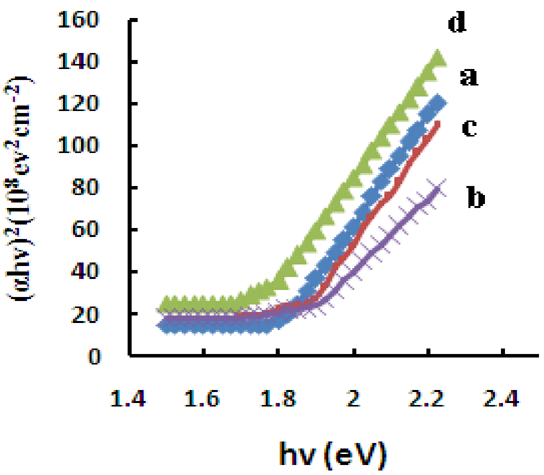

Figure 2: The graph between $(\alpha h\upsilon)^2$ verses hʋ of as deposited thin films prepared at different substrate temperature a) 250^0C b) 275^0C c) 300^0C and d) 325^0C

Each graph has linear portion which intercept on hʋ axis gives the value of band gap. Calculated band gap with different temperature is shown in table.1.

Table 1

Temperature T(^{0}C)	Band gap energy Eg (hʋ)	Thickness of the films t (μm)
250	1.88	0.1450
275	1.83	0.1695
300	1.78	0.1835
325	1.80	0.1785

Our calculated value of optical band gap are well agree with mahalingam etal [4] who have studied electrodeposited CdZnSe thin films at various bath temperature. They have reported the value of band gap increases from 1.67 eV & 1.72 eV with the increase of bath temperature from 30^0C to 90^0C. But in our case if the temperature increases the optical band gap decreases upto the optimised temperature 300^0C. After further increases the temperature, the band gap value slightly increases. This results of variation of band gap with temperature are similar to the sprayed $CdZn_2S_4$ thin films [5]. Thickness of the films was calculated by weighing method and are listed in table.1 with different substrate temperature. It was observed that if the temperature increases, the thickness of the films also increases uptooptimised temperature (300^0C). If further increases the temperature (greater than 300^0C), the thickness of the films slightly decreases. This shows that the temperature less than 300^0C may not be sufficient to decompose the sprayed droplets from the solution and therefore the deposit results into a low thickness was estimated [6]. This is due to higher evaporation the initial ingredient [5]. CdZnSe thin films shows direct allowed transition. Similar results also reported by Tembhurkar [7,8] for CdSe, ZnSe, CdTe, thin films. Thus CdZnSe thin films shows a good stoichiometric in semiconducting nature.

4. Conclusion

Thin films of CdZnSe shows the band gap vary from 1.88 eV to 1.78 eV if the change of preparation temperature. CdZnSe thin films shows the direct allowed transition.

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