Research Ambition
An International Multidisciplinary e-Journal
(Peer Reviewed & Opened Access Indexed)
www.researchinspiration.com Email: publish2017@gmail.com
Impact Factor: 2.102 (IIJIF)
ISSN: 2456-0146
Vol. 1, Issue-I
May 2016

BAND GAP MEASUREMENT OF SINTERED $Cd_{1-X}Zn_XTe$ SINTERED FILMS FROM REFLECTION SPECTRA

SEEMA TEOTIA
Department of Physics
G.R.P.G. College, Rampur-244901, U.P., India

Abstract

Sintered $Cd_{1-x}Zn_xTe$ films have been prepared in the entire composition range from CdTe to ZnTe by using the screen printing method. To deposit good quality films, optimum conditions have been determined. Wide band gap ternary films have wide applications in solar cells. The band gap of these films is determined by reflection spectra in the wavelength range of 500 nm to 870 nm using the Tauc relation. These films have a direct band gap, which varies from 1.48 eV for CdTe to 2.26 eV for ZnTe films.

Keywords: Band gap, Reflection spectra, Semiconductors, Screen printing.

Introduction

CdZnTe or CZT, is a compound of cadmium, zinc and tellurium or, more strictly speaking, an alloy of cadmium telluride and zinc telluride. It is a direct band gap semiconductor. It is used in a variety of applications, including semiconductor radiation detectors, photorefractive gratings, electro-optic modulators, solar cells, and terahertz generation and detection[1]. $Cd_{1-x}Zn_xTe$ is the most emerging material for various devices. CdZnTe is also used as the most suitable substrate for epitaxial growth of $Hg_{1-x}Cd_xTe$ because both these material have similar structure with lattice

Research Ambition
An International Multidisciplinary e-Journal
(Peer Reviewed & Opened Access Indexed)
www.researchinspiration.com Email: publish2017@gmail.com
Impact Factor: 2.102 (IIJIF)
ISSN: 2456-0146
Vol. 1, Issue-I
May 2016

parameter varying almost linearly with composition. $Cd_{1-x}Zn_xTe$ is one of the II-VI ternary semiconductor material whose band gap can be tailored to any value between 1.48 eV to 2.26 eV asx varies from 0 to 1. The II–VI compound semiconductor having a wide band gap is a promising material for use in photovoltaic devices, blue light emitting diodes and laser diodes[2–4]. Other workers prepared CdZnTe films in vacuum evaporation technique which is a costly technique, but none of them prepared these films by screen printing which is a cheaper technique than other techniques.

Experimental details

For the preparation of sintered films of $Cd_{1-x}Zn_xTe$ (X = 0, 0.8, 0.6, 0.4, 0.2, 1), an appropriate amount of CdTe, ZnTe powder, $ZnCl_2.H_2O$ as an adhesive and ethylene glycol as a binder were thoroughly mixed. The composition of materials were taken as

$$\text{Wt. of CdTe} = (1-X)\text{x } 240 = 240(1-X) \text{ mg}$$

$$\text{Wt. of ZnTe} = X \text{ x } 192.97 = 192.97X \text{ mg}$$

$$\text{Wt. of ZnCl2.H2O} = 10\% \text{ of Wt. of [CdTe + ZnTe] mg}$$

Since the weights are large, we can reduce the weights in the same proportion. All the three were mixed properly along with the weight of ethylene glycol. The paste thus prepared was screen printed on a glass substrate which has been cleaned properly. The samples thus prepared were dried at 120^{o}C for 4 hours and then sintered at 500^o C for 10 min in nitrogen atmosphere in a tube furnace to remove the organic materials left. For drying and sintering nitrogen atmosphere is used instead of open atmosphere because in open atmosphere formation of zinc oxide (ZnO) occurs. But in nitrogen atmosphere this problem does not exist. To minimize the problem of diffusion, the film was covered with a glass plate of substrate size. The thickness of these prepared films is of the order of a micron.

Characterization of samples

Reflection spectra of these sintered films were taken at room temperature with the help of a Hitachi Spectrophotometer Model U-3400. The energy band gaps of these films were calculated with the help of reflection spectra. To measure the energy band gap, we have used the Tauc relation [5] is used.

$$\alpha hv= A(hv-E_g)^{1/2}$$

Where

hv= Photon energy

α= Absorption Coeffcient

E_g= Bandgap

A= Constant

To measure the energy band gap from reflection spectra a graph $[\alpha hv]^2$ Vs hv is plotted. α is the absorption coefficient and is proportional to Ln [(Rmax- Rmin)/(R-Rmin)] where reflectance falls from Rmax to Rmindue to the absorption by the material, R is the reflectance for any intermediate

Research Ambition
An International Multidisciplinary e-Journal
(Peer Reviewed & Opened Access Indexed)
www.researchinspiration.com Email: publish2017@gmail.com
Impact Factor: 2.102 (IIJIF)
ISSN: 2456-0146
Vol. 1, Issue-I
May 2016

energy photon. So we have used α in terms of reflectance as Ln [(Rmax.- Rmin)/ (R- Rmin)][6,7,8] and computed the energy band gap for the film material.

Results and discussions

Fig. 1 represents the reflection spectra of $Cd_{1-x}Zn_xTe$ sintered films for different values of x. It was observed here that the crossing of the curves of reflection spectra is due to the thickness of films in which thicker films will have less separation between Rmax and Rmin and the thinner films will have more separation between Rmax and Rmin. The value of Rmax and R min depends

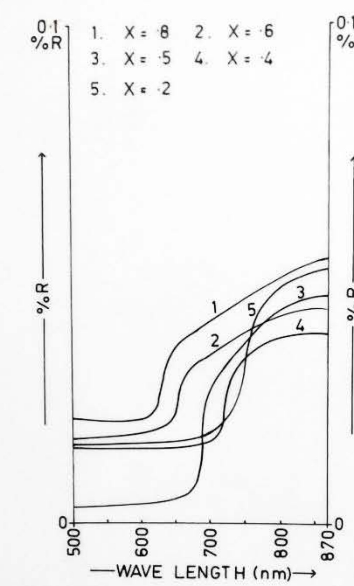

FIG. 1: REFLECTION SPECTRA OF $Cd_{1-x}Zn_xTe$ SINTERED FILMS FOR DIFFERENT VALUES OF X.

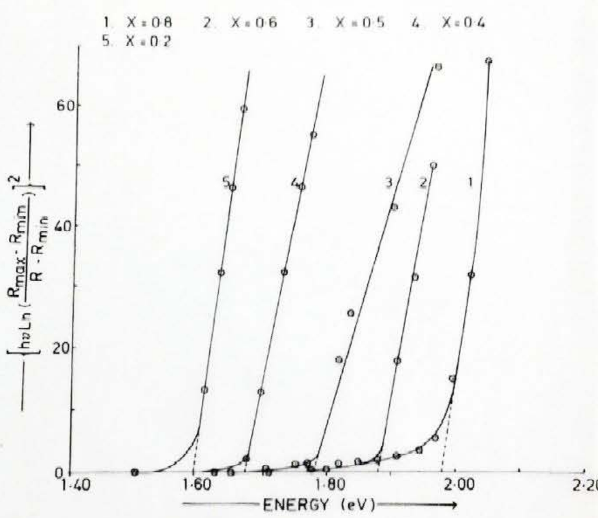

FIG 2: ENERGY BANDGAP DETERMINATION OF $Cd_{1-x}Zn_xTe$ SINTERED FILMS.

Research Ambition ISSN: 2456-0146
An International Multidisciplinary e-Journal
(Peer Reviewed & Opened Access Indexed)
www.researchinspiration.com Email: publish2017@gmail.com
Impact Factor: 2.102 (IIJIF)
Vol. 1, Issue-I
May 2016

on the grain size of the surface. The variation of R min may be attributed to the variation of grain size of the material. Fig. 2 is graph which is plotted Ln [(Rmax.- Rmin) / (R-R min)]^2 Vs hv for the sintered films of Cd_{1-x} Zn_x Te using different values of x. By extrapolating these cures, we can find out the value of energy band gap of sintered film of Cd_{1-x} Zn_x Te films using different values of x.

References

1. Seema Teotia, T.P. Sharma, S.C.K. Mishra, SPIE, 1999, Vol. 3903, 298-304.
2. R.J. Robinson, Z.K. Kun, Appl. Phys. Lett. 27 1975 74.
3. S. Fujita, H. Mimoto, T. Noguchi, J. Appl. Phys. 50 19791076.
4. G.F. Neumark, R.M. Park, J. Depuyat, Phys.Today, June1994, 26.
5. J. Tauc Ed. , Amorphous and Liquid Semiconductors, Plenum,New York, 1974, 159.
6. T.P. Sharma, S.K. Sharma, V. Singh, C.S.I.O. Communication, 19, July–December 1992, 63.
7. S.K. Sharma, V. Kumar, S. Sirohi, S.K. Kaushish, T.P.Sharma, C.S.I.O. Communication, 4, July–September 1996,
8. Vipin Kumar T.P.Sharma, Optical Materials 10 1998 253–256