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Study of Optical Properties of Bilayer ZnTe: Al Film Grown on Glass Substrate by Thermal Evaporation Method

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***Abstract* - The Bilayer thin films of ZnTe/Al as well as ZnTe thin films were prepared onto glass substrate by thermal evaporation method under the vacuum of about 10^{-5} torr. All these films have been subjected to optical studies. It is observed that the transmittance and (optical) band gap value decrease with Al doping. The results of these studies will be presented in this paper.**

***Keywords* - Bilayer ZnTe, Al thin films, UV-Vis spectroscopy**

I. INTRODUCTION

Zinc telluride (ZnTe) is an important semiconductor material for the development of various modern technologies of solid state devices (blue light emitting diodes, laser diodes, solar cells, microwave devices, etc.) [1-3]. It is a direct band gap semiconductor having band gap 2.26 eV at 300 K and usually a p-type semiconductor.

A variety of methods have been developed for the preparation of ZnTe thin films such as thermal vapor deposition under vacuum, molecular beam epitaxy, organo-metallic chemical vapor deposition, solution growth, spray pyrolysis, etc. [3,5–7]. The choice of the deposition method may be based on quality of the films required for specific applications.

A well-defined composition of Zn–Te can be obtained in thin film form by thermal evaporation method under the vacuum of 10^{-5} torr. This method has been used for CdTe by Curz and de Avillez [8] and copper indium diselenide thin film by Carter et al. [9]. It is particularly suitable for deposition of compound semiconductor thin films, as it provides good control of composition. This method has been used as a promising method for producing highly efficient CdTe/CdS solar cells as reported by Ohshita [10]. It is also reported in the literature [11, 12] that ZnTe exhibits improved photorefractive response when it is doped with vanadium.

Although there have been a number of investigations on the ZnTe films by a number of researchers, no systematic study appears on the structural and optical properties of ZnTe thin films using aluminium as a dopant. We therefore have undertaken a systematic study, on structural and optical properties of Bilayer thin films of ZnTe/Al (ZnTe/Al) in this paper,.

II. EXPERIMENTAL WORK

Bilayer thin films of ZnTe/Al have been deposited layer-by-layer onto a glass substrate by thermal evaporation technique (Hind High Vacuum) under vacuum of 10^{-5} Torr. Zn (99.9 % pure), Te (99.9% pure) and aluminum foils (99.999 % pure) were used for the present study. Zn and Te were kept in tantalum boats separately and aluminium foil was wrapped over tungsten filament. The source to substrate distance was kept 15 cm in each case. Deposition of bilayer ZnTe/Al thin films has been performed by stacked layer method. First we have deposited ZnTe layer and later Al layers respectively to obtain ZnTe/Al bilayer thin film structures. The thickness of ZnTe/Al bilayer thin films was measured by quartz crystal thickness monitor (Hindhivac Thickness monitor model DTM-10).

III. RESULTS AND DISCUSSION

The optical transmittance spectra have been recorded using UV–vis Spectrophotometer (HITACHI U-2900) Fig. 1 shows the transmittance spectra of annealed ZnTe/Al thin films as a function of wavelength for 100, 150, 200 and 250 nm thicknesses, respectively. From this figure it is observed that the transmittance value decreases with the increase of film thickness for all investigated samples. For each sample of ZnTe/Al thin films, the reflectance data were measured as a function of wavelength. Fig. 2 shows the reflectance spectra of annealed ZnTe/Al thin films for different thicknesses as a function of wavelength in the range 300 < λ < 800 nm.

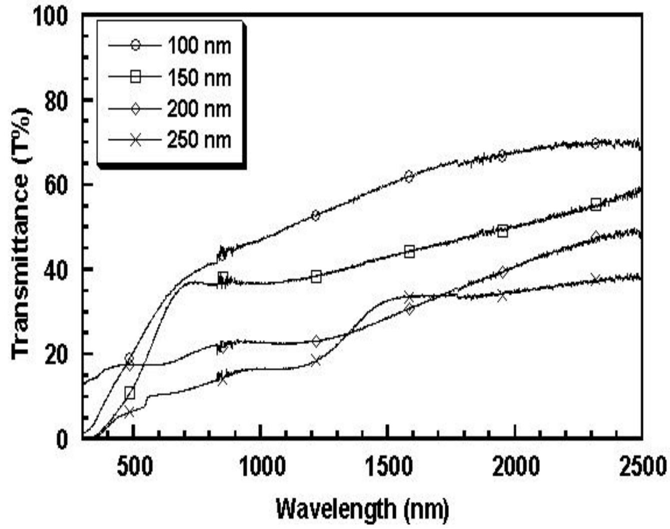

Fig. 1 Transmittance spectra of annealed ZnTe/Al thin films for 100, 150, 200 and 250 nm thicknesses.

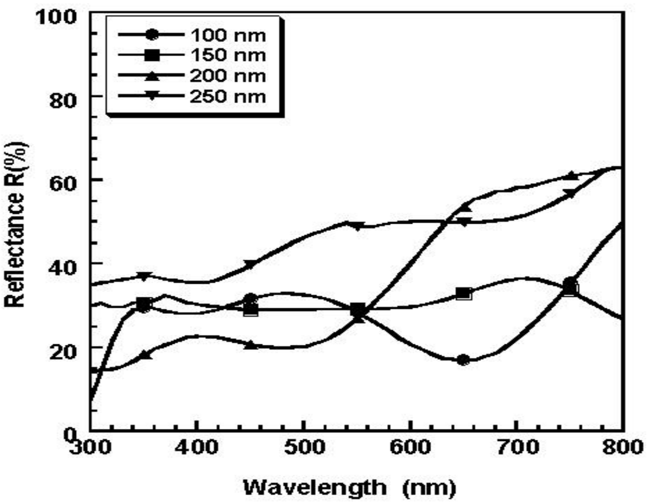

Fig. 2 Reflectance spectra of annealed ZnTe/Al thin films for 100, 150, 200 and 250 nm thicknesses.

The absorption coefficients α of the ZnTe/Al thin films for different thicknesses were calculated from the measured transmittance and reflectance data using the Tauc Relation. We have used the method for determining the value of the optical band gap Eg which involves plotting a graph of $(\alpha h\nu)^2$ versus photon energy (hν). The value of Eg will be given by the intercept on the (hν) axis. To apply this method for different samples under investigation, a number of curves based on, $(\alpha h\nu)^{1/2}$, $(\alpha h\nu)^2$, $(\alpha h\nu)^{1/3}$ and $(\alpha h\nu)^{2/3}$ as a function of hν are plotted and it is seen from all the plots that the best fit plot is the plot of $(\alpha h\nu)^2$- hν which covers the widest range of observed data points. The best fit plots $(\alpha h\nu)^2$ vs. hν of ZnTe/Al samples for different thicknesses are shown in Fig.-3. The band gaps Eg obtained by extrapolating the curves to $(\alpha h\nu)^2 = 0$ for direct allowed transition and their values for the samples of different thicknesses are given in the Table I.

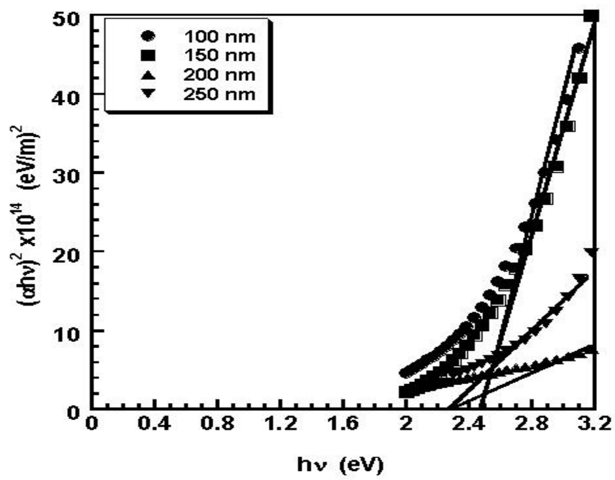

Fig.-3: Plot of $(\alpha h\nu)^2$ vs. hν for ZnTe/Al films of different thicknesses.

Table I

Optical Band Gap of Thin Films for Different Thicknesses

Thickness of films	Optical Band Gap
100 nm	2.40 eV
150 nm	2.39 eV
200 nm	2.30 eV
250 nm	2.28 eV

IV. CONCLUSION

ZnTe/Al thin films of different thicknesses have been prepared onto glass substrate at a pressure of 10^{-5}torr by thermal evaporation technique. The optical parameters of annealed ZnTe/Al films such as optical band gap were evaluated for 100 nm-250nm Eg varied from 2.40eV-2.28eV (for different film thicknesses). It is observed that the transmittance and band gap value decreases with the increase of film thickness for all investigated samples.

V. REFERENCES

[1]. K.C. Bhahada, B. Tripathi, N.K. Acharya, P.K. Kulriya, Y.K. Vijay, Applied Surface Science 255 (2008) 2143–2148.

[2]. G.I. Rusu, P. Prepelita, R.S. Rusu, N. Apetroaie, G. Oniciuc, A. Amariei, J. Optoelectron. Adv. Mater. 8 (2006) 922.

[3]. R. Bhargava (Ed.), Properties of Wide Bandgap II–VI Semiconductors, INSPEC, London, 1997.

[4]. S. Ignatowiczand, A. Kobendza, Semiconducting Thin Films of AIIBVI Compounds, Polish Scientific Publishers, Warsa, 1990.

[5]. A.N. Georgobiani, M.K. Sheinkman (Eds.), Physics of A2B6 Compounds, Nauka, Moscow, 1986 (in Russian).

[6]. K.L. Chopra, Thin Film Phenomena, McGraw-Hill, New York, 1969.

[7]. L.I. Massel, R. Glang (Eds.), Handbook of Thin Film Technology, McGraw-Hill, New York, 1980.

[8]. L.R. Curz, R.R. de Avillez, Thin Solid Films 373 (2000) 15.

[9]. M.J. Carter, I. I'Amson, A. Knowles, R. Hill, in: Proceedings of the 19th IEEE Conference of Photovoltaic Specialists, New Orlence, New York, (1987), p. 1275.

[10]. M. Ohshita, J. Appl. Phys. 10 (1971) 1365.

[11]. M. Ziari, W. H. Steier, P. M. Ranon, Appl. Phys. Lett. 60, 1052 (1992).

[12]. J. Kreissl, K. Irmscher, Phys. Rev. B53, 1917 (1996).