A Comparative Study on Band Gap of Vacuum Evaporated Semi-conductor compound Zinc Telluride (ZnTe) Thin Films at Various Thicknesses

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Abstract: Zinc Telluride (ZnTe) thin films for different thicknesses (191.3 nm, 209.6nm and 248.4nm) were prepared on clean glass substrate by vacuum evaporation technique. To measure the thickness of the deposited thin films optical method (Tolansky method) was employed. Band gap of ZnTe thin films of different thicknesses shows the band gap value decreases as thickness of the film increases.

***Index Terms* - Band gap, Vacuum evaporation, Zinc Telluride.**

I. INTRODUCTION:

Thin films are usually denoted as films with thickness ranging from fraction of nanometers to several micrometers. Thin films are formed by atom by atom or molecule by molecule condensation process which is generally achieved from vapour phase of a material. Zinc telluride is a binary chemical compound with the formula ZnTe, a solid semiconductor material with the direct band gap 2.26 eV (Haynes, William M., ed. (2011). It is usually a p-type semiconductor. ZnTe can be easily doped and for this reason it is one of the most common semiconducting materials used in optoelectronics. ZnTe is used in the manufacture of LEDs, laser diodes, solar cells and component of microwave generators.

The present investigation aims at comparing various band gap of Zinc Telluride thin film with the following specific objectives:

i) To compare band gap of ZnTe thin films of various thicknesses.

II. REVIEW OF LITERATURE:

Zinc telluride is a binary chemical compound with the formula ZnTe. This is a solid semiconductor material with the band gap 2.26 eV. It is usually a p-type semiconductor. Its crystal structure is cubic.

ZnTe can be easily doped and for this reason it is one of the most common semiconducting materials used in optoelectronics. ZnTe is used in the manufacture of LEDs, laser diodes, solar cells and component of microwave generators.

Various techniques are used for the fabrication of ZnTe thin films such as thermal vacuum evaporation (Ibrahim A.A. et al., 2004, Patel K.D. et al., 2010, Toma O. et al., 2014, Kalita P.K. et al., 1999, Pattar J. et al., 2009, Salem S.M. et al., 2011, Pal U. et al., 1989, Lbrahim A.A. et al., 2004), pulsed laser deposition technique (Bhumia S. et al., 1996, Erlacher A. et al., 2006), two source evaporation method (Syed W.A. et al., 2015), e-beam evaporation method (Nveen C.S. et al., 2014, Jeetandra S. et al., 2006), closed space sublimation technique(Mahmood W. et al., 2013), DC reactive magnetron sputtering(Kumar B.R. et al., 2014), Chemical Spray Pyrolysis (Mohammed S.M. 2008), Electro chemical deposition method(Mahalingam T. et al., 2002, Ikhioya I.L. 2015), Multiple Potential Step (Murilo F. G. et al., 2014), SILAR (Kale S.S. et al., 2007), Plasma immersion technique(Aboreia A.M. et al., 2015), rf sputtering method (Bellakhder H. et al., 2001) and Stacked Elemental Layer method(Shanmugam S. et al., 2012) etc. Among these techniques we take thermal evaporation technique because of its high deposition rate, large area scalability, and easy preparation of a large size as well as a high conductivity and visible transmittance. In our present work we studied about the optical and electrical properties of the ZnTe thin films as a function of thickness.

The optical and electrical properties of ZnTe thin film depends on the deposition methods and thickness of the deposited thin film. The vacuum deposited ZnTe thin film shows high absorbance in the UV region and high transmittance in the VIS-NIR region and the reflectance is much at UV region and decays in the visible and IR region.

III. METHODOLOGY:

- Material used: ZnTe powder supplied by Aldrich, Pure 99.99% was used for the deposition of ZnTe thin films were placed in a Mo boat.
- Thin film preparation techniques: Vacuum evaporation method
- Film thickness determination: Optical method (Tolansky method, 1948) was used to determine the film thickness.
- Vacuum pressure: During deposition the vacuum inside the chamber was maintained at $\approx 10^{-5}$ torr.

IV. RESULT AND DISCUSSION:

ZnTe thin films of different thicknesses (191.3nm, 209.6nm and 248.4nm) were prepared for the present study as shown in Chart no.1. Various band gap found with different thicknesses of the deposited thin films.

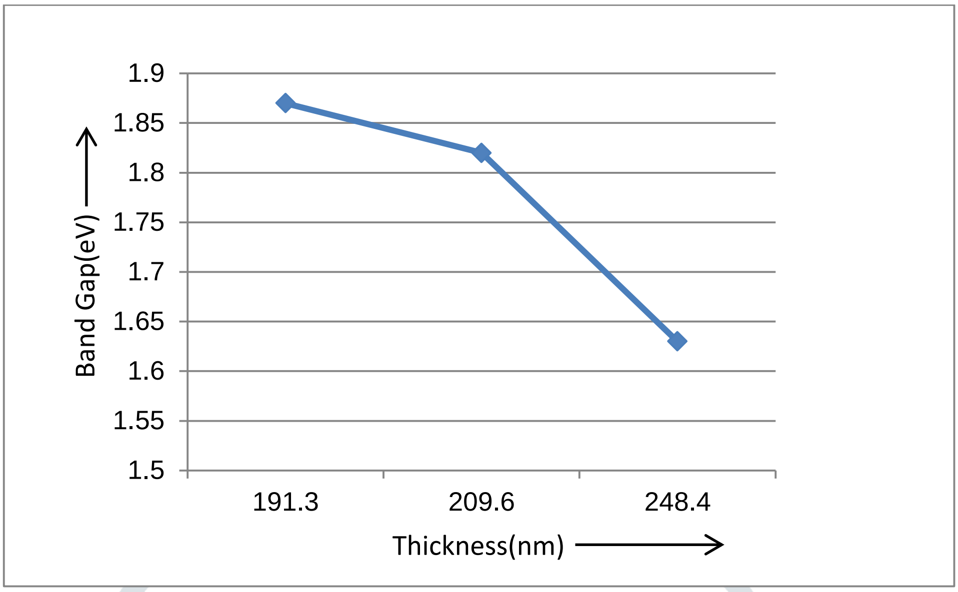

Chart no.1: ZnTe Band gap at various thicknesses

In the present investigation, it was observed that the band gap decreases with the increase in thickness of the thin film i.e. the band gaps of the ZnTe thin films are 1.87eV, 1.82eV and 1.64eV for the film of thickness 191.3nm, 209.6nm and 248.4nm respectively, also reported by Kiran M.S.R.N. et al., 2010. The decrease in band gap with the increase in thickness of the film is attributed to the increase in grain size of the higher films thickness [Pal U. et al. 1989, Amutha R. et al. 2006].

V. CONCLUSION:

ZnTe thin films have been deposited on glass substrate using vacuum evaporation method. The optical band gap of the ZnTe thin films were found to be in the range 1.64eV to 1.87eV because of this wide band gap. Band gap value obtained at different thicknesses show that band gap decreases with the thickness increase. These band gap values indicate that the films can be used as absorber layer in the photovoltaic cells and also used to fabricate LEDs.

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