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Structural and optical properties of Z_{nx}/Te_{1-x} layered thin film on glass substrate

Abstract

This work, results on the Annealing effects, optical and structural study of Zn_x/Te_{1-x} thin films of 200 nm obtained by the vacuum evaporation technique. The layers are grown and then annealed for various temperatures and characterized by XRD, SEM and photo absorbance studies. Band gap of ~2.1eV has obtained by optical measurements. SEM micrographs clearly indicate cluster growth at the surface of a thin film of Zn_{50}:Te_{50} composition. However no prominent cluster growth has been observed at other stoichiometry ratios.

Keywords: ZnTe thin films, I–V characteristics, surface morphology, optical band gap

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Introduction

ZnTe is the most attractive semiconducting materials of II–VI group. The material has various applications in selection of devices optoelectronic and microelectronic devices.[1–5] Zn_x/Te_{1-x} thin films has analyzed and characterized for electrical, optical & structural properties because of above applications. Cluster growth at the surface of thin film of Zn_{50}:Te_{50} composition with annealing shows that the cluster growth becomes uniform with increase in temperature. Results carried out with systematic investigations on these properties of evaporated Zn_x/Te_{1-x} thin films.

Experimental

Thin films has deposited at vacuum of 10–5 torr on clean glass substrates by vacuum coating unit.[6] Stoichiometry ratio of pure Zn (99.99%) granules and Te (99.99%) powder has taken to prepare Zn_xTe_{1-x}, where x=0.5,0.2 and 0.8. electronic balance has used to weigh these materials and found resolution of ±0.0001g, in accordance with the percentage of composition used.[7] The material to be coated is placed in a tungsten boat. After reaching the high vacuum (10^{-5} mbar) in the chamber, the material is heated indirectly by passing the current slowly to the electrodes.[8] Thin Films has prepared at room temperature, thickness and evaporation rate of –deposited films measured by quartz crystal monitor which is fixed to the unit.[7] Initially deposited Zn layer then Te layers was deposited with x=0.5,0.2 and 0.8 respectively to obtain stacked layers, and thin film thickness has measured through "Hind Hivac" Digital Thickness Monitor Model–DTM–101.[6,8]

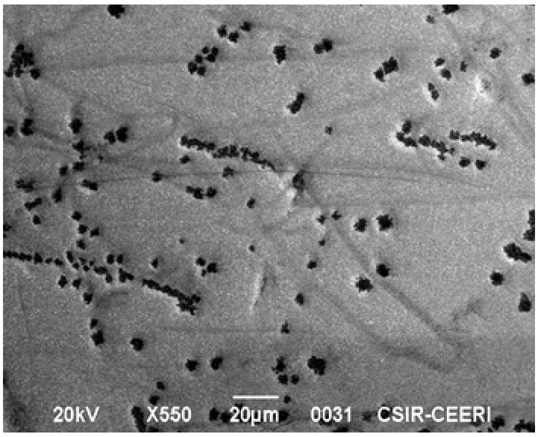
Results & discussion

Surface morphology

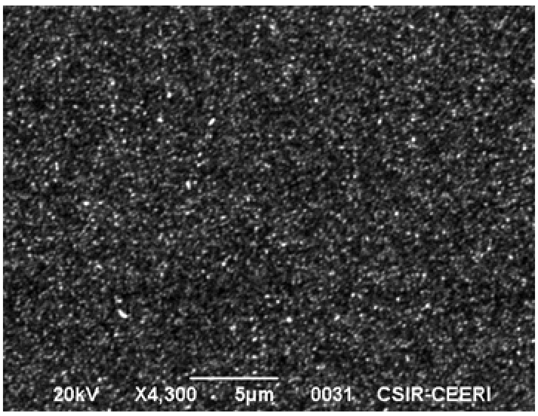
SEM micrographs shown clearly indicate cluster growth at the surface of thin film of Zn_{50}:Te_{50} composition in Figure 1(a) annealed at 373K. Figure 1(b) 423 K and Figure 1(c) 573 K shows that the cluster grown becomes uniform with increase in annealing temperature. However no prominent cluster growth has been observed at other stoichiometry ratios.

Optical properties

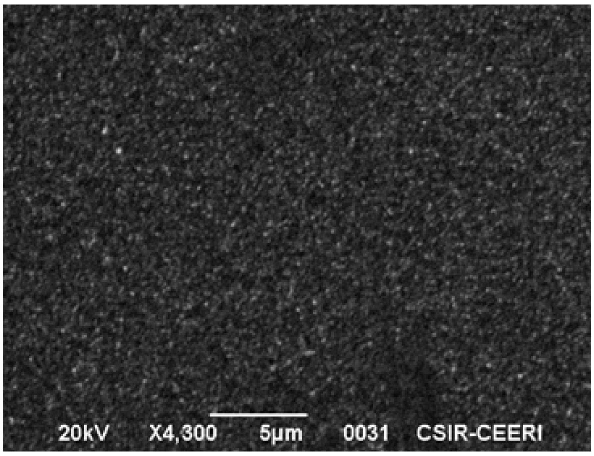
An absorbance spectrum of Zn_{50}:Te_{50} thin films has been taken at different temperatures through Systronics spectra photometer 117. Thin film material's energy band gaps has calculated by absorbance spectra, by means of relation $\alpha\, h\upsilon = A(h\upsilon - E_g)^n$, here hυ is energy of photon, α is the coefficient of absorption, E_g is band gap, A is constant is 0.5. Figure 2 shows spectral variation for Zn_x/Te_{1-x} deposited on glass substrate these extrapolating lines gives optical gap.[9] It is observer that annealing decreases the band gap and confirms the mixing of Zn and Te to form Zn_x/Te_{1-x} film. The band gap obtained for annealing temperature 573K is very close to reported values.



(a) At 373 K.



(b) At 423 K.



(c) At 573 K.

Figure 1 SEM of $Zn_{50/}Te_{50}$ at different temperatures.

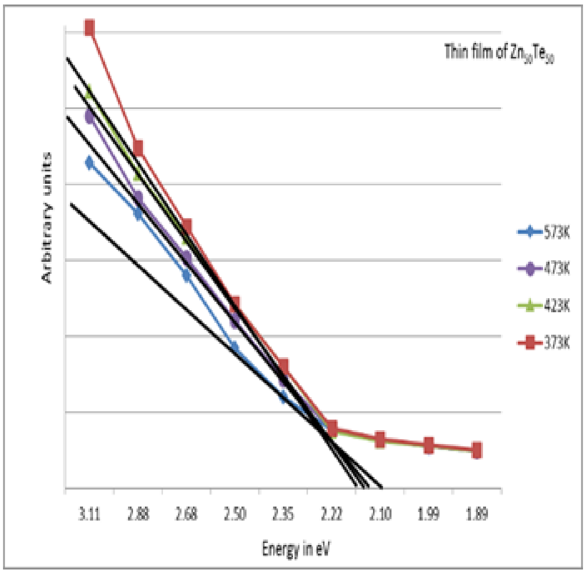
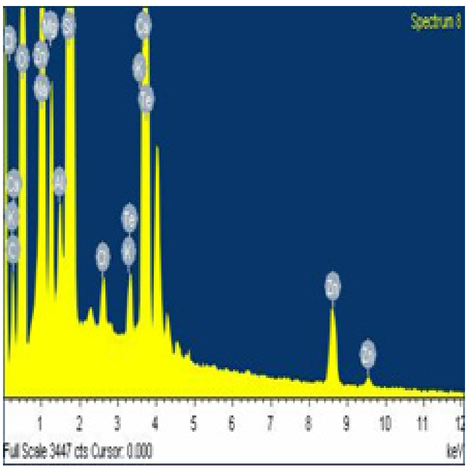
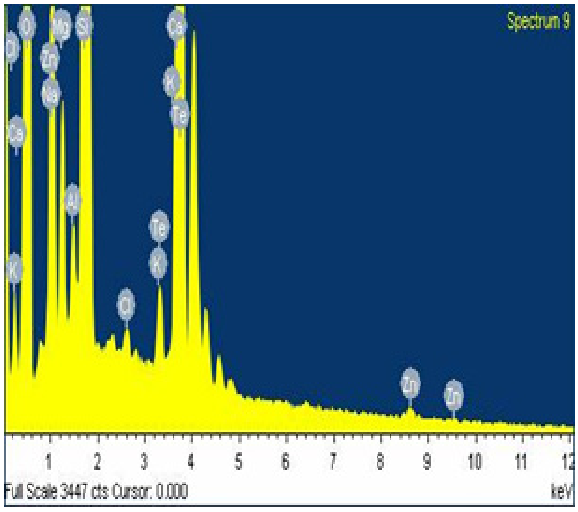


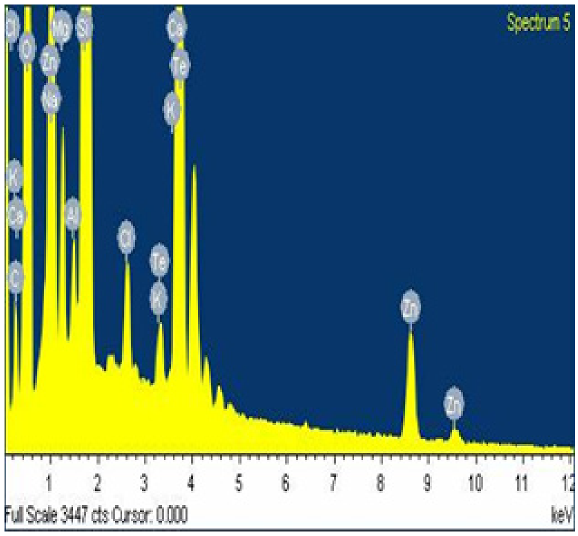
Figure 2 Spectral variation for Zn_{50}/Te_{50} thin films.



(a) Zn (50):Te (50).



(b) Zn (20):Te (80).



(c) Zn (80):Te (20).

Figure 3 Energy Dispersive X-ray Analysis graphs of Zn_{x}/Te_{1-x}.

Energy dispersive X–ray analysis (EDAX) graphs of Zn_x/Te_{1-x}

The EDAX values Figure 3 show the signatures of Zn_x/Te_{1-x} present in the glass substrate on which the films are grown. The photographs shown represent thin films of various stoichiometry ratios without annealing.

Conclusion

It is concluded that thin film of 200 nm Zn_x/Te_{1-x} for x=0.1 and 0.2 have prepared by thermal evaporation technique. The grown layers are annealed at different temperatures and then characterized by XRD, SEM and photo absorbance studies. Band gap of ~2.1eV has obtained using optical measurements. Optical band gap was calculated as 2.1ev from the absorption data which is close to the room temperature of 2.25ev or Zn_x/Te_{1-x}. EDAX of thin film reveal mix phase of Zn_x/Te_{1-x}. SEM micrographs clearly indicate cluster growth at the surface of thin film of Zn_{50}:Te_{50} composition. However no prominent cluster growth has been observed at other Stoichiometry ratios.

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Conflict of interest

No conflict of interest.

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