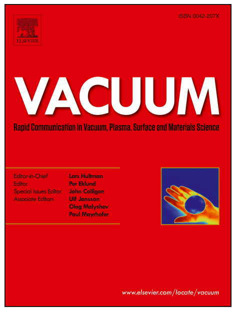
Accepted Manuscript



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PII: S0042-207X(17)30881-3

DOI: 10.1016/j.vacuum.2017.10.025

Reference: VAC 7654

To appear in: *Vacuum*

Received Date: 6 July 2017

Revised Date: 12 October 2017

Accepted Date: 17 October 2017

Please cite this article as: Pandian M, Matheswaran P, Gokul B, Sathyamoorthy R, Asokan K, Structural, optical and electrical properties of $In_2(Te_{1-x}Se_x)_3$ thin films, *Vacuum* (2017), doi: 10.1016/j.vacuum.2017.10.025.

Structural, optical and electrical properties of $In_2(Te_{1-x}Se_x)_3$ thin films

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Abstract

Indium chalcogenide $In_2(Te_{0.975}Se_{0.025})_3$, $In_2(Te_{0.95}Se_{0.05})_3$ and $In_2(Te_{0.9}Se_{0.1})$ thin films was prepared by thermal evaporation technique in Ar atmosphere. The samples were analyzed by XRD, transmittance spectra, FESEM, DSC and EDS in order to investigate the structural, optical properties, surface morphology, phase identification and elemental composition of the prepared films. XRD spectra reveal that the formation of compounds of both the ternary phase of $In_2(Te_{1-x}Se_x)_3$ and the binary phases of In_2Se_3 and In_2Te_3. Improvement in crystallite size is observed with increase in the elemental composition of Se concentration. The surface morphology of the as grown film shows spherical nature of the grains and it becomes denser with the increase in Se concentration. Band gap energy was estimated from optical spectra, which depends on the phases of In_2Se_3 and $In_2(Te_.Se)_3$. and found to be 1.50 eV, which can be used for maximum absorption of an effective layer in solar cell. The broad exothermic peaks at 675 K, 683 K and the sharp peak at 694 K, which clearly confirms the presence of crystalline $In_2(Te_{1-x}Se_x)_3$ phase. The resistivity of $In_2(Te_{1-x}Se_x)_3$ thin film was measured using four probe technique. The current increases progressively with temperature indicating the semiconducting nature of $In_2(Te_{1-x}Se_x)_3$ thin films.

Keywords: Indium chalcogenide, surface morphology, band gap energy and activation energy.

1. Introduction

The study of $In_2(Te_{1-x}Se_x)_3$ thin films have potential applications in phase change memory (PCM), optoelectronic devices, photovoltaic cells, solid state batteries [1][2] etc. Physical properties of these materials play an essential role in the fabrication of new memory devices. InSeTe have number of structural modifications which leads to have number of vacancy sites (i.e one-third or two-third of In sub- lattices remains vacant). This kind of impartial impurities plays a important role in determining the structural, optical and electrical properties of the film. Remarkable progress has been made over last two decades to understand the behavior of semiconducting metal chalcogenide thin films from the theoretical and experimental methods. However, a detailed research on In-Se-Te thin films is still necessary for choosing available materials for PCM and photovoltaic applications. Few researchers reported the structural, optical, photoconduction and phase change memory properties of $In_2(Te_{1-x}Se_x)_3$ thin films [1- 4]. More recently, A study of different selenium sources in the synthesis processes of chalcopyrite semiconductor [5], Influence of heating temperature of Se effusion cell on Cu(In, Ga)Se_2 thin films and solar cells [6] and The effect of selenium content on Cu(In, Ga)Se_2 thin film solar cells by sputtering from quaternary target with Se-free post annealing [7] have been studied. From the literature survey, the optical parameters of refractive index increases to 2.78, 3.24 with substitution of 1.5 at % and 27 at % Te for Se in In_2Se_3 respectively, the energy bad gap decreased with the substitution of 1.5 at % (1.58 eV to 1.52 eV) and 27 at % (1.58 eV to 1.22 eV) Te for Se in In_2Se_3. The decrease on the band gap energy explained by higher atomic weight of Te compared to Se atom. The photoconductivity increased by more than five orders of magnitude (higher than pure γ- In_2Se_3) in the presence of 8 at.% of Te in $In_2Se_{3-x}Te_{3x}$ thin film have been reported by H. El Maliki *et al.* On the switching behavior of $In_2(Se_{0.5}Te_{0.5})_3$ thin film at 80 °C, the threshold voltage of switching was observed at 2.25 V and explained on the basis of stoichiometric In_2Te_3 and In_2Se_3 phase transition by P. Matheswaran *et al.* From the earlier