Synthesis, Structural & Optical Characterization of $CdSe_{0.3}Te_{0.7}$ Thin Films by Homemade Spray Pyrolysis Technique

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ABSTRACT

$CdSe_{0.3}Te_{0.7}$ thin film synthesized by homemade spray pyrolysis technique at 300^0C temperature. The film characterized through structural and optical by X-ray diffraction techniques and UV- visible spectroscopy. From XRD pattern film exhibits polycrystalline in nature with both mixture of cubic zinc blende and hexagonal wurtzite structure. The thickness of the films measured by weight difference method and is found that 355nm. From Uv-visible spectroscopy the bandgap of film is 1.53eV.

Keywords: *CdSeTe, thickness, XRD, Optical.*

Introduction:

The CdSe, CdTe & CdSeTe thin films were deposited by so many techniques such as Chemical Bath Deposition (CBD), Electro Chemical deposition, Slurry Painting, Screen Printing, Chemical Vapour Deposition (CVD), Molecular Beam epitaxy, Brush Electrodeposition, hot wall deposition spray pyrolysis technique, Sintering techniques,pulsed painting technique[1-9]

K.R. Murali [1] et.al studied CdSeTe thin film and found that film exhibits hexagonal Phase with 1.44 eV to 1.68eV varying band gaps. P.D. More [2] et.al studied $CdSe_{1-x}Te_x$ films with varying compositions and found that The films are crystalline in nature over whole range of the composition parameter with a homogeneous predominant wurtzite structure for $0 \leq x \leq 0.08$ and $0.7 \leq x \leq 1$ regions. For the middle range ($0.15 < x < 0.7$), the material tends towards a mixture of both the wurtzite and zinc blende phases rather than the homogenous solid solution. The cubic phase also under goes solid solution for $0 \leq x \leq 0.15$ range of composition parameter and the band gap varied nonlinearly, from 1.76 to 1.44 eV as x was increased from 0 to 1. S.K. Shinde [3] et.al studied $CdSe_{0.6}Te_{0.4}$ chemical bath deposition method and observed that film have hexagonal crystal structure. N. Muthukumarasamy [4] et.al studied $CdSe_xTe_{1-x}$ film with hot wall deposition method, in that observed film has polycrystalline in nature with cubic zinc blende or hexagonal structure or both depending on the composition.

V. Saaminathan [6] deposited $CdSe_xTe_{1-x}$ films and observed the film exhibited a cubic structure for as deposited films and a hexagonal structure for annealed films irrespective of the duty cycle. Lokendra Kumar [7] et.al deposited $CdSe_xTe_{1-x}$ and found that the band gap of the film 1.50 eV (for x =0.2) to 1.69 eV (for x = 0.8) by varying composition (x) and the structure found to be polycrystalline in nature and change the structure after x = 0.4 from zinc blend to wurtzite structure. R. Sathyamoorthy [8] et.al in his study XRD pattern of the $CdSe_xTe_{1-x}$ nano crystals revealed cubic, hexagonal and mixed phases depending on the ratio of Se:Te.A. Kathalingam [9] has been prepared $CdSe_xTe_{1-x}$ film by electrodeposition on SnO_2 coated glass substrates froman aqueous acid solution containing selenium and tellurium oxides in various amounts. From his study XRD pattern showed a hexagonal wurtzite structure. Also increase of selenium content in $CdSe_xTe_{1-x}$ films has increased band gap of the alloy $CdSe_xTe_{1-x}$ films from 1.48eV to 1.69 eV as the composition varied from 0.2 to 0.8.

In present investigation, we report synthesis of $CdSe_{0.3}Te_{0.7}$ by spray pyrolysis technique. Further, these $CdSe_{0.3}Te_{0.7}$ are characterized by means of structural and optical properties. The importance of choosing givencompositions is due to the fact that $CdSe_{0.3}Te_{0.7}$ shows a sharp transition from the properties of CdSe to those typical of CdTe inthe composition.

Experimental Work:

$CdSe_{0.3}Te_{0.7}$ thin films prepared on glass substrate (7.5cm×2.5cm) using homemade spray pyrolysis technique at temperature 300^0C. Before deposition the glass substrate were boiled in chromic acid for 15 min. & washed with lebalene. Then after substrate were ultrasonically cleaned for 10 min.

The precursor solutions were used for the deposition of $CdSe_{0.3}Te_{0.7}$thin films 0.025M equimolar 15ml solution of ($CdCl_2.H_2O$) in distilled water, 4.5ml solution of Selenium dioxide (SeO_2) &10.5ml solution of Tellurium dioxide (TeO_2)in double distilled water and ammonia. The Triethanolamine (TEA)ascomplexingagents and Hydrazine hydrate used for reduction agent. The total 30ml solution are mixed together and used for deposition with spray rate 4ml/sec. onto a glass substrate. Compressed air pressure is used as carrier gas to spraying a solution.The spray deposition films are, in general strong and adherent, mechanically hard, pin hole free and stable.

The film thickness of the deposited film was measured by a weight difference method.The films were characterized for their structural properties by using Philips X-ray diffractometer with CuKα radiation (1.54060A^0) in the span of angle between $20^0$and 80^0ranges.The films have also characterized by optical properties by using Uv-Visible spectrometer in the range 250nm to 1100 nm.

Result and discussion:

X-Ray Diffraction Analysis (XRD):

The crystallite size and phase of Polycrystalline $CdSe_{0.3}Te_{0.7}$ thin films have been determined using X-ray diffraction measurements. Films exhibits in either cubic or hexagonal phase. Sometimesa mixture of the two phases is also reported [2, 4]. X-Ray diffraction pattern of $CdSe_{0.3}Te_{0.7}$ thin films prepared at temperature($T_s = 300^0$C) with CuKα radiation (1.54060A^0). The XRD pattern obtained for the $CdSe_{0.3}Te_{0.7}$ films grown on glass substrates were studied in 2θ ranges 20^0-80^0. Fig.1 shows the XRD pattern of the $CdSe_{0.3}Te_{0.7}$ thin film deposited on to a glass substrate at substrate temperature 300^0C.

From X-ray pattern found that at temperature 300^0C, a well crystallized films was obtained. The maximum intensity peak of $CdSe_{0.3}Te_{0.7}$ thin film is obtained at (200). As given JCPDS data revealed that both Cubic & hexagonal crystal structure$CdSe_{0.3}Te_{0.7}$ was formed.The comparative intensities of the peaks are in good agreement with standard JCPDS data. Further d-values where calculated by calculating θ values from the peaks of the X-ray spectrum using Bragg's relation;

$$2d\sin\theta = n\lambda \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, n = 1 (first order), λ = wavelength of X-ray (1.54060 A^0)

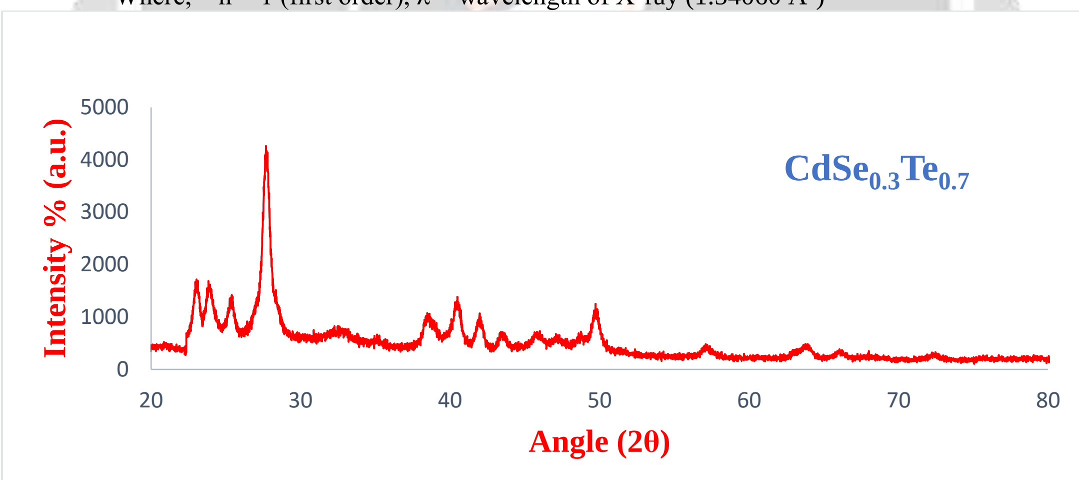

Fig. 1 XRD pattern of $CdSe_{0.3}Te_{0.7}$ thin film deposited at 300^0C substrate temperatures

Sr. No.	2θ(Calculated)	2θ(Standard)	d (A^0)	Plane (for CdSe)	Plane (for CdTe)	plane for (CdSeTe)
1	22.97	22.337	3.98		100	
2	23.95	23.72	3.81			100
3	25.4	25.35	3.51	111		
4	27.69	27.81	3.2		200	
5	40.5	39.74	2.26		220	
6	41.99	41.96	2.15	110		

7	49.84	49.45	1.84			201
8	63.96	63.58	1.46		211	

Table.1: X-ray diffraction data of spray deposited $CdSe_{0.3}Te_{0.7}$ thin films at substrate temperature 300^0C.

Uv-Visible Spectroscopy:

The optical properties of the $CdSe_{0.3}Te_{0.7}$ films were measured on UV–visible double beam spectrophotometer in the wavelength range 350 –1100 nm. A careful observation of the spectra revealed the presence of a broad absorption edge in the 500–800nm range as shown in Fig.2. The band gap energy (Eg) was determined by plotting a graph of hυ (eV) versus $(\alpha h\upsilon)^2$ x $(eV/cm)^2$ as shown in Fig. 3.

The linear nature of plot indicates the existence of the direct transition. Theband gap ‘Eg’was determined by extra plotting the straight line to the energyaxis whose intercept to the x-axis gives the optical band gap. The band gap of $CdSe_{0.3}Te_{0.7}$ film was found to be 1.53 eV.

The optical band gap of the thin films was calculated by using Tauc's equation

$$\alpha h\upsilon = B(h\upsilon - Eg)^n$$

Where: hv is photon energy and B is constant. n =1/2 for the direct transition.

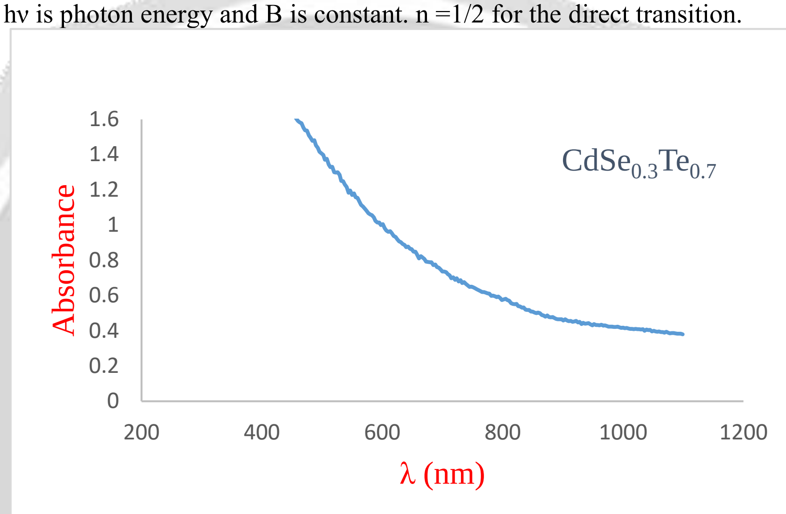

Fig.2 Variation of Absorbance Vs wavelength (nm)

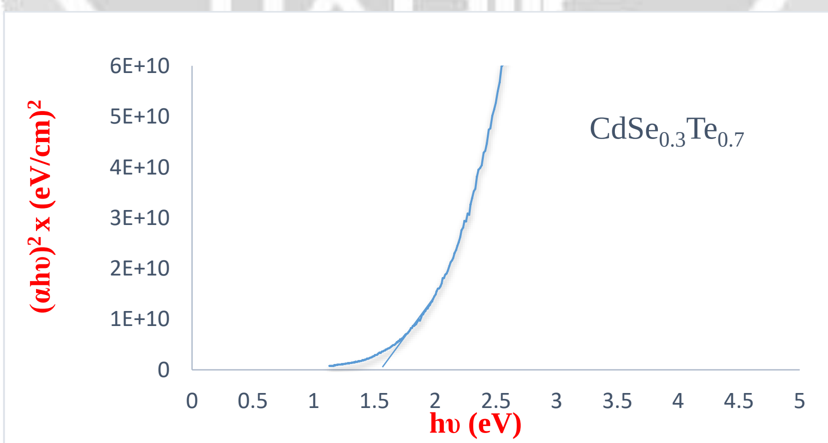

Fig.3. Variation of hv (eV) versus $(\alpha h\upsilon)^2$ x $(eV/cm)^2$

Conclusion:

The present study indicates that homemade spray pyrolysis techniquecan be successfully employed for the preparation of device quality CdSe, CdTe and $CdSe_{0.3}Te_{0.7}$thin films.The spray deposited$CdSe_{0.3}Te_{0.7}$ films are, in general strong and adherent, mechanically hard, pin hole free and stable at 300^0C temperature. The film have good absorbance in the wavelength in visible range. That's why film is good for solar cell applications.

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