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Synthesis and Structural Characterization of Cdse Thin Film by Homemade Spray Pyrolysis Technique

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Abstract:

The CdSe thin film prepared by homemade spray pyrolysis techniques at temperature 300^{0}C.Cadmiumselenide(CdSe)thinfilmswerepreparedhomemade spray pyrolysis technique usingammoniaand Triethanolamine (TEA)ascomplexingagents, cadmiumchlorideandselenium dioxide asthesourcesofCd^{2+} and Se^{2-} ions, respectively. The structural properties CdSe thin film were studied with help of XRD pattern and observed the hexagonal crystal structurewith crystalline size between 27.4nm to 61.1nm.

Keywords: Spray pyrolysis, structural, crystalline size.

Introduction:

The II-VI group compound semiconductors have the band gap between 1-3eV in the visible region and these semiconducting materials are used worldwide in optoelectronic devices.Cadmium selenide (CdSe) is one of such popular semiconductor materials in this group and its physical properties have been constantly investigated during recent years for both fundamental and practical aims [1-2].

CdSe is one of the most promising material for solar cell and other applications includingPECcells,opticalwaveguides,lasers,photodetectors, transistors,lightemittingdiodes,lightamplifiers, electro photography,gassensorsetc.Cadmium selenideisapromisingmaterialofII–VI compound semiconductors andusedinthin film devicesduetoitslarge absorption coefficient, opticalbandgapandhighphoto- sensitivity [4-7]. Thecadmiumselenideiscrystallizedinzinc- blende (cubic)andwurtzite(hexagonal)structure.Nowdays,CdSe thin films havepaidmoreattentionowingtotheirsizedependent physicalproperties.TheCdSethin films maybepreparedbyanumberofdepositiontechniqueslike molecularbeamepitaxy (MBE), thermal evaporation,sputtering,chemicalbathdeposition (CBD),pulsed laser deposition,spraypyrolysis,and successiveioniclayeradsorptionandreactionmethod(SILAR), isothermal closed space sublimation techniqueetc. [8–14].

Anuradha Purohit et al. [7]Effect of thickness on structural, optical, electrical and morphological properties of nanocrystalline CdSe thin films for optoelectronic applications. In this paper structure of film is cubic.T. Elangoe et al. [8]Characteristics of spray-deposited CdSe thin films.In this paper from XRD patterns indicated the presence of single-phase hexagonal CdSe.T. Logu et al. [9] Hydrophilic CdSe Thin Films by Low Cost Spray Pyrolysis Technique and Annealing Effects. In this paper structure of film is Hexagonal.

Experimental Work:

CdSe thin films prepared on glass substrate (7.5cm×2.5cm) using homemade spray pyrolysis technique at temperature 300^{0}C. Before deposition the glass substrate were boiled in

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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 thin films 0.025M equimolar solution of ($CdCl_2.H_2O$) and Selenium dioxide (SeO_2)in double distilled water. The ammoniaand Triethanolamine (TEA)ascomplexingagents. The 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 schematic used for deposition as shown in following Fig.1.

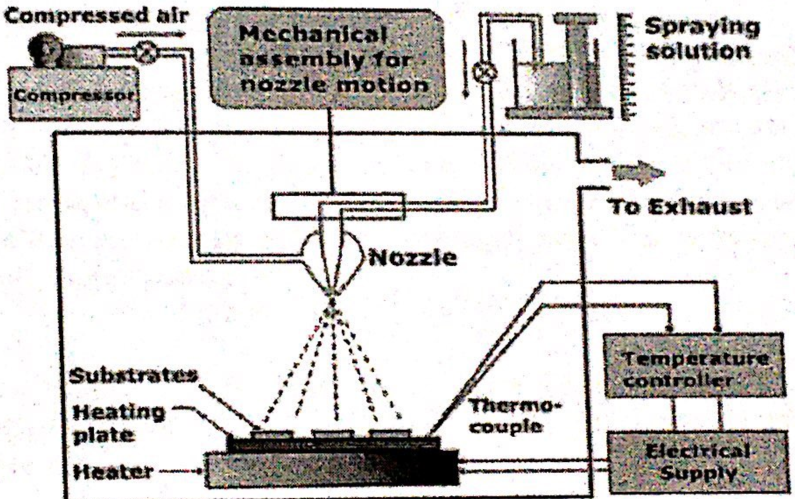

Fig.1: Schematic diagram of Spray Pyrolysis technique.

Result and discussion:

X-Ray Diffraction Analysis (XRD):

The crystallite size and phase of nanocrystalline CdSe thin films have been determined using X-ray diffraction measurements. Films exist in either cubic or hexagonal phase. Sometimes a mixture of the two phases is also reported [10]. X-Ray diffraction pattern of CdSe thin films prepared at temperature(T_s = 300^{0}C) with CuKα radiation (1.54060A^0). The XRD pattern (JCPDS card no.08-0459) obtained for the CdSe films grown on glass substrates were studied in 2θ ranges 20^0-80^0. Fig.2 shows the XRD pattern of the CdSe thin film deposited on to a glass substrate at substrate temperature 300^{0}C.

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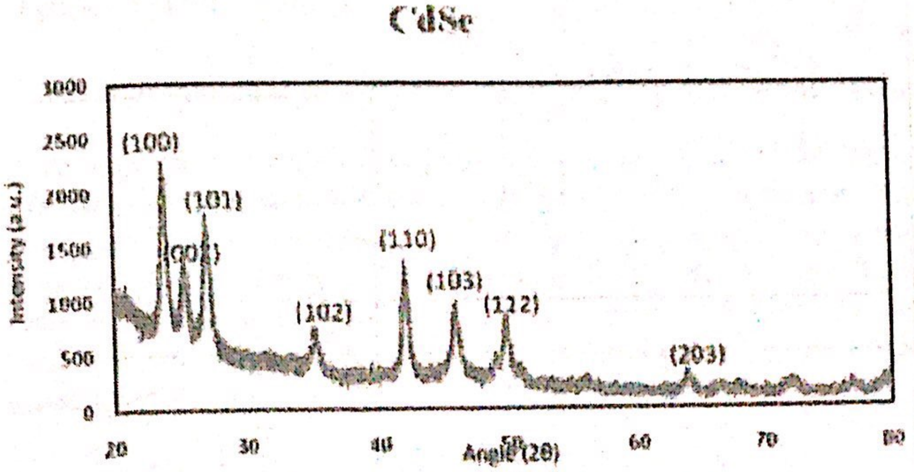

Fig. 2 XRD pattern of CdSe thin film deposited at 300°C substrate temperatures

From X-ray pattern found that at temperature 300°C, a well crystallized films was obtained. The peaks corresponds to the (100), (002), (101), (102), (110), (103), (112) and (203) lattice planes with 2θ values respectively. The maximum intensity peak of CdSe thin film is obtained at (100). As given JCPDS data revealed that only hexagonal crystal structure CdSe 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;

$$2d\sin\theta = n\lambda \quad \text{.........................(1)}$$

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

The value of average crystallite size of as deposited ZnS thin film estimated by using Scherrer's formula given as,

$$D = \frac{0.94\lambda}{\beta\cos\theta} \quad \text{.................. (2)}$$

Where, λ is the wavelength of X-ray, β is full width at half maximum in radian and θ is Bragg's angle.

The values of interplaner spacing (d), crystalline size (D), observed planes as shown in following table.1

Sr.No.	2θ(Calculated)	2θ(Standard)	d(Calculated)	D (nm)	Planes
1	23.9	23.901	3.7233	27.4	100
2	25.5	25.354	3.506	29.6	002
3	27.05	27.08	3.298	30.2	101
4	35.31	35.107	2.5425	32.9	102
5	41.99	41.988	2.1527	36.1	110
6	45.92	45.788	1.9771	38.6	103
7	49.75	49.669	1.8328	41.6	112
8	63.91	63.881	1.457	61.1	203

Table.1: X-ray diffraction data of spray deposited CdSe thin films at substrate temperature 300°C.

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Conclusion:

CdSe thin films were prepared by home-made chemical spray pyrolysis with temperature 300^{0}C. The precursor solutions were used for the deposition of CdSe thin films as Cadmium Chloride ($CdCl_2.H_2O$) and Selenium Dioxide (SeO_2)in double distilled water. We studied the structural properties of CdSe thin film. From Structural studies CdSe film form hexagonal crystal structure, and the crystalline size (D) of the film at (100) peak is 27.4nm to 61.1nm.This result held well with previous result.This makes ZnS thin films prepared by spray pyrolysis more appropriate materials for various applications.

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