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Structural and Optical Properties of Thermally Evaporated CdSe Thin Films

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Abstract: *The polycrystalline CdSe thin films were deposited on amorphous glass substrate by the thermal evaporation technique under the pressure of 10^{-5} torr. The structural, surface morphological and optical properties of deposited films were studied by using X-ray diffraction (XRD), Scanning Electron Microscopy (SEM) and UV-VIS Spectroscopy respectively. The XRD diffraction spectrum shows that the grown thin films are of polycrystalline in nature having hexagonal structure. The SEM reveals that films have smooth surface area. The optical constant of grown CdSe thin films were determined by UV-VIS spectroscopy and it is found about 3.3 to 3.7 eV.*

Keywords: *CDSE thin Films, XRD, SEM, UV-VIS*

I. Introduction

The II–VI group semiconductor alloy has drawn attention due to their potential applications in electronics industries. The CdSe has been reported for potential applications in light-emitting devices [1], solar cells [2], photo detectors [3] and lasers [4]. There are several techniques available for the growth of CdSe thin films such as MBE [5], electro-deposition [6, 7], CBD [8], SILAR [9], vacuum deposition and spray pyrolysis [10]. Among these methods, the vacuum thermal evaporation has various advantages with other techniques such as uniform film deposition, control of thickness and maintenance of substrate temperature.

In the present study the CdSe thin films were deposited on glass substrate and structural, surface morphological and optical study of grown thin films have been done.

II. Experimental Detail

2.1 Alloy Preparation

The CdSe alloy was obtained by melt quench method. The direct mixture of extremely pure (99.999%) Cd and Se were kept in evacuated quarts ampoule with their atomic proportion. The ampoule was heated above 1000 °C for 12 hrs. Well mixed charges were then quenched in an ice bath. The CdSe ingot was taken out from the ampoule and used for film preparation.

2.2 Synthesis of Thin Films

The alloy of CdSe thin films have been deposited on cleaned glass substrate, by vacuum thermal evaporation technique with various thicknesses. The source to substrate distance was kept at 13cm. The thickness of the films was monitored on Digital Thickness Monitor (DTM-101) provided by Hind-Hi Vac. The deposition rate was maintained 8-10Å/sec throughout sample preparation. Before evaporation, the glass substrates were cleaned by using liquid detergent, distilled water, chromic acid and acetone.

III. Results and Discussion

3.1 XRD Analysis

The X-ray diffraction patterns are used to study the crystalline parameters. The grown thin films were scanned 2θ range of 20° - 80°. Figure 1 shows the XRD pattern of CdSe thin Films.

From XRD spectrum, 2θ peaks observed at 24.0° and 26.6° which belongs to the (100) and (101) planes of reflections respectively. The peaks are well matched with JCPDS data (02-0330). The crystal structure is found to be hexagonal in phase. The presence of multiple peaks indicates that the films are polycrystalline in nature. The crystalline size (D) was calculated by using the Scherrer formula and it was found to be 232.5 nm.

$$D = \frac{0.94\,\lambda}{\beta \cos\theta}$$

Where λ is wavelength of X-ray, β is FWHM and θ is angle of diffraction. The unit cell parameters a and c were found 4.30 and 7.02 respectively.

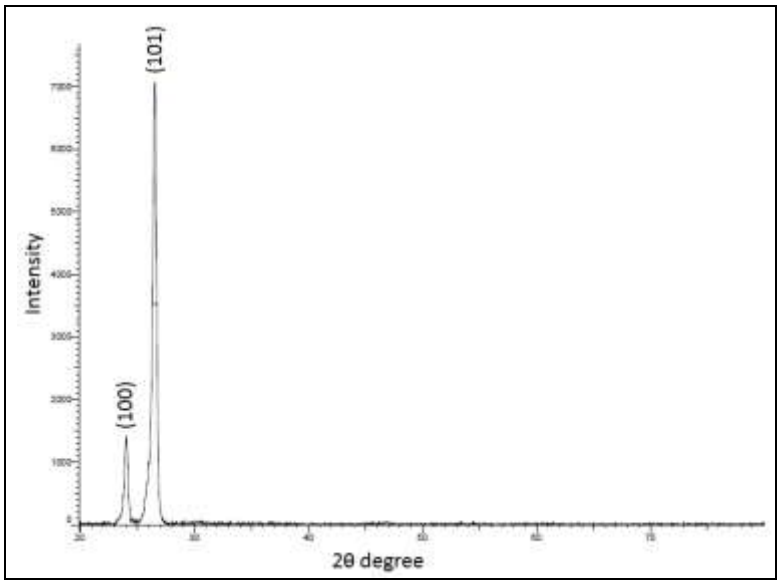

Figure 1: XRD Patterns of CdSe Thin Films

3.2 SEM Analysis

The surface morphology of grown CdSe thin films was studied by Scanning Electron Microscope. The figure 2 and 3 show the SEM images of CdSe thin films under the two different magnifications 18K and 120K respectively.

The SEM image reveals that the thin film is homogeneous. The particles are uniformly distributed all over substrate area and free from any microscopic defects like pinhole or cracks [11, 12]. The film has smooth surface area. The particles are granular shape and found near about 100 nm in size.

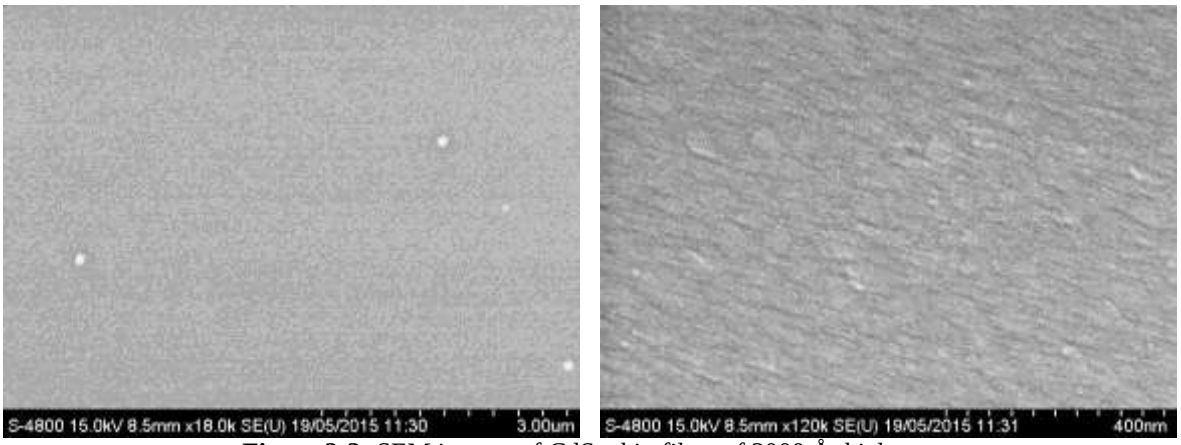

Figure 2-3: SEM images of CdSe thin films of 3000 Å thickness

3.3 EDAX Analysis

The elemental analysis is used to detect the present elements of sample. The figure 4 shows the EDAX pattern of grown CdSe thin film.

From the EDAX pattern it is cleared that the Cd and Se are determined near about at 1.4 and 3.1 KeV [11, 12]. The atomic percentage of Cd and Se was found 49.33 and 50.67 respectively which shows good stoichiometry. No impurity was found there which shows the purity of films. The presence of other peaks may be due to the glass substrate.

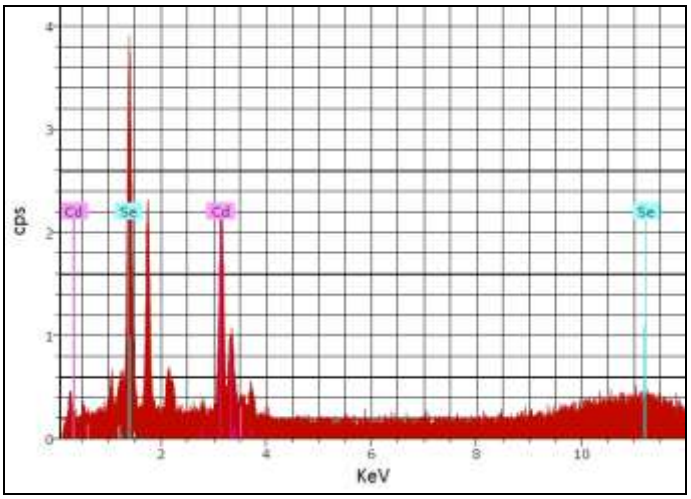

Figure 4: EDAX Pattern of CdSe Thin Film

3.4 UV-VIS Spectroscopy

The optical constant can be determined from UV-VIS spectroscopy. The figure 5 and 6 shows the absorbance and transmittance of grown CdSe thin film under different thickness. The samples were scanned within the range of 300-1000 nm wavelength.

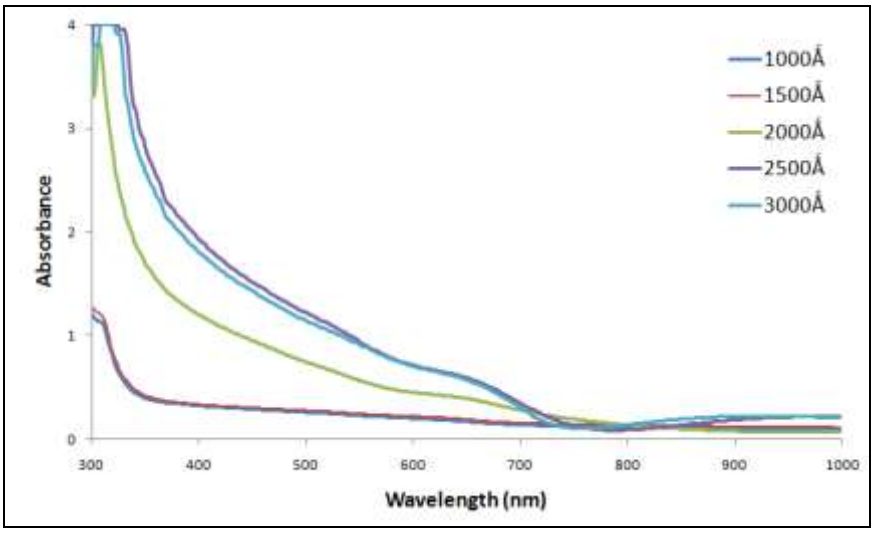

Figure 5: Absorbance Pattern of CdSe Thin Films

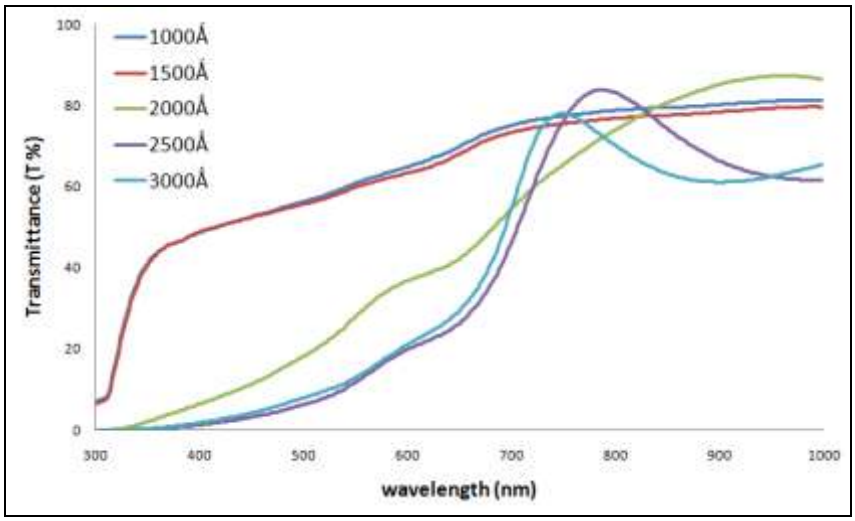

Figure 6: Transmittance Pattern of CdSe Thin Films

Figure 5 and 6 shows the absorbance and transmittance pattern of grown CdSe thin films respectively. The optical absorption was clearly increased with thicknesses for 1000 Å, 1500 Å and 3000 Å thickness. The transmittance of CdSe thin films is observed above as 70%. The CdSe has good optical properties and it can be used in optoelectronics devices. The optical band gap of grown thin films has been calculated using the Tauc relation:

$$\alpha h\nu = A\,(h\nu - Eg)^n$$

Where, α is the absorption coefficient, hν is the photon energy, Eg the band gap. The optical band gap of the grown CdSe thin films were determined from a plot of $(\alpha h\nu)^2$ Vs Eg as shown in Figure 7. The single slope in the straight part of the curve indicates that the film is a single phase with a direct band gap. The straight line portion is extrapolated to cut the x-axis, which gives the energy gap. The optical band gap was found within range of 3.3 to 3.7 eV.

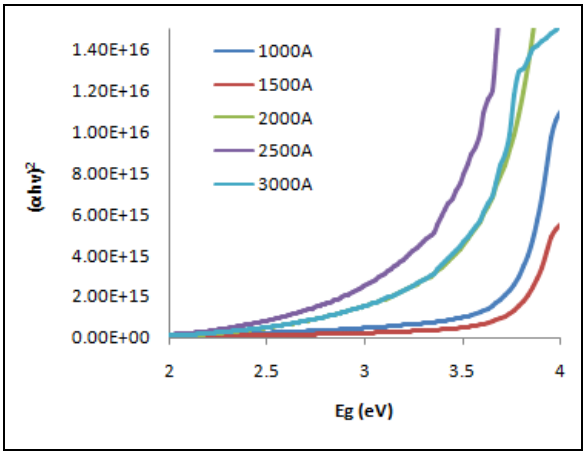

Figure 7: Optical Band Gap of CdSe Thin Films

IV. Conclusion

The CdSe thin films were deposited on glass substrate by thermal evaporation techniques. The XRD pattern and SEM images reveals that film is polycrystalline in nature, hexagonal in shape and homogeneous smooth surface. The EDAX pattern detects the presence of Cd and Se. The optical constant is found within range of 3.3 to 3.7 eV.

Reference

[1] Colvin, V. L., Schlamp, M. C.; Alivisatos, *A. P. Nature*, 370, 1994, 354–357.
[2] Yu, Y. H.; Kamat, P. V.; Kuno, M. A, *Adv. Funct. Mater.* 20, 2010, 1464–1472.
[3] Jiang, Y.; Zhang, W. J.; Jie, J. S.; Meng, X. M.; Fan, X.; Lee, S. T. *Adv. Funct. Mater.* 17, 2007, 1795–1800.
[4] Li, G. H.; Zhai, T. Y.; Jiang, Y.; Bando, Y.; Golberg, D. *J. Phys. Chem. C*, 115, 2011, 9740–9745.
[5] N. Samarth, H. Luo, J.K. Furdyna, S.B. Qadri, Y.R. Lee, A.K. Ramdas, N. Otsuka, *Appl. Phys. Lett.* 54, 1989, 2680
[6] K.R. Murali, V. Subramanian, N. Rangarajan, A.S. Lakshmanan, S.K. Rangarajan, *J. Electroanal. Chem.* 261, 1991, 303
[7] K.R. Murali, V. Subramanian, N. Rangarajan, A.S. Lakshmanan, S.K. Rangarajan, *J. Electroanal. Chem.* 95, 1995, 368
[8] S. Erat, H. Metin, M. Ari, *Materials Chemistry and Physics*, 111, 2008, 114
[9] C.D. Lokhande, B.D. Sankapal, S.R. Sartale, H.M. Pathan, M. Giersig, V. Ganesan, *Appl. Surf. Sci.* 413, 2001, 182
[10] T. Elango, S. Subramanian, K.R. Murali, *Surf. Coat. Technol.* 8, 2003, 123
[11] M.S.Kale, N.T.Talele, D.S.Bhavsar, *International Journal of Scientific and Research Publications*, Vol 4 (2), 2014, 1-4
[12] M.S. Kale, N.T.Talele, D.S.Bhavsar, *IOSR Journal of Applied Physics*, Vol 6 (1), 2014, 58-62