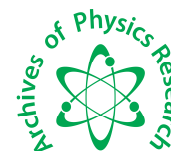




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Physical properties of nanocrystalline CdSe:FeSe thin films grown by chemical spray pyrolysis method

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ABSTRACT

Nanostructured thin films have attracted the attention of an increasing number of researchers from several disciplines during the last decade, due to their outstanding electronic and optical properties and extensively useful applications in various optoelectronic devices. Nanocrystalline CdSe:FeSe thin films were deposited onto glass substrate by spray pyrolysis method at 573K temperature. The structure and surface morphology of the CdSe:FeSe thin films were characterized by X-ray diffractometry (XRD) and scanning electron microscopy (SEM). The CdSe:FeSe thin films are nanocrystalline in nature with hexagonal lattice. The optical band gap of CdSe:FeSe thin film is of the order of 1.95 eV.

Keywords: Thin films; Nanocrystalline; XRD; SEM.

INTRODUCTION

The development of nano-science and nanotechnology depends on the preparation and study of new nanoscale materials of improved properties and functionalities that forms building blocks for new devices. The surfaces and interfaces play critical roles in nanostructured materials as they have very high specific surface areas. The fine grain size of the nanostructured material provides large number of atoms at edge and corner sites, which increases number of catalytically active sites. The chemical and physical properties of such materials are different as that of the bulk material. Among various metal selenides, iron selenide and cadmium selenide nanostructure has identified as a potential material for future applications in magneto electronics, spintronics and in optoelectronic devices [1–11]. A several techniques have been used for the synthesis of selenides thin films such as spray pyrolysis[12], electrodeposition[13], and SILAR method[14] etc. As spray pyrolysis method is simple and economical in comparison other methods, it has been employed to grow nanocrystalline CdSe:FeSe thin films onto glass substrates. In the present work CdSe:FeSe thin films were prepared and well characterized using different analytical techniques such as X-ray diffraction (XRD), scanning electron microscopy (SEM) and UV-VIS spectrophotometry.

MATERIALS AND METHODS

The spray pyrolysis technique has been applied to deposit a wide variety of thin films useful for various devices such as solar cells, sensors, and solid oxide fuel cells. The properties of deposited thin film highly depend on the preparation conditions [15,16]. In spray method the deposition temperature i.e substrate temperature is the most critical parameter as it influences film roughness, cracking, crystallinity, etc. Thus in the present work several trials were performed to optimized the various deposition parameter. It was observed that the films deposited at 573K are well adherent and uniform; however films deposited below were discontinuous and less adhesive. In addition, the optimized spray rate was found out to be 6 mL min⁻¹. The transparent white coloured spray solution of stable phase

was prepared by mixing 10 mL 0.1M ferric chloride, 0.1M CdCl₂ and 20mL 0.1M SeO₂ solution. The thickness of the film was measured by gravimetric weight difference method using the relation,

$$t = \frac{m}{\rho \times A} \quad (1)$$

where 'm' is the mass of the film deposited on the substrate in gram; 'A' is the area of the deposited film in cm² and 'ρ' is the density of the deposited material in bulk form. The structural studies were carried out using Philips PW 1710 diffractometer, with Cu-Kα radiation of wavelength 1.5405 Å. The film morphology was observed by Scanning Electron Microscopy (Model:JEOL 6380A).The optical characteristics were studied using Lambda 25 UV-VIS spectrophotometer (PerkinElmer) to find band gap energy of CdSe:FeSethin films.

RESULTS AND DISCUSSION

3.1. Structural studies

Figure 1 shows the XRD patterns of the as deposited CdSe:FeSe thin films in the range of 2θ between 20 to 90°. The observed 'd' values were compared with the standard data (JCPDS file CdSe: 80-459, 2-230, 77-2307 and FeSe:75-0608) to confirm the structure of the deposited material. The crystal structure and phases identification of CdSe:FeSethin films deposited by spray pyrolysis method has been carried out by means of X-ray diffraction analysis. A typical XRD peak pattern of CdSe:FeSethin films of thickness 210 nm deposited onto glass substrate is shown in Fig.1. The observed diffraction peaks at 2θ angles 35.64, 45.98, 72.58 and 82.49 degree (marked by *) corresponds to the lattice planes (102), (103), (212) and (006) due to hexagonal CdSe, however the diffraction peaks observed at 2θ angles 50.38, 61.41 and 67.82 degree (marked by #) corresponds to lattice planes (201), (202) and (212) due to hexagonal FeSe respectively. The average crystallite size of the film was determined by using Debye Scherrer formula,

$$d = \frac{0.9\lambda}{\beta \cos \theta} \quad (2)$$

where 'λ' is the wavelength used (1.5405 Å); 'β' is the angular line width at half maximum intensity in radians; 'θ' is the Bragg's angle.

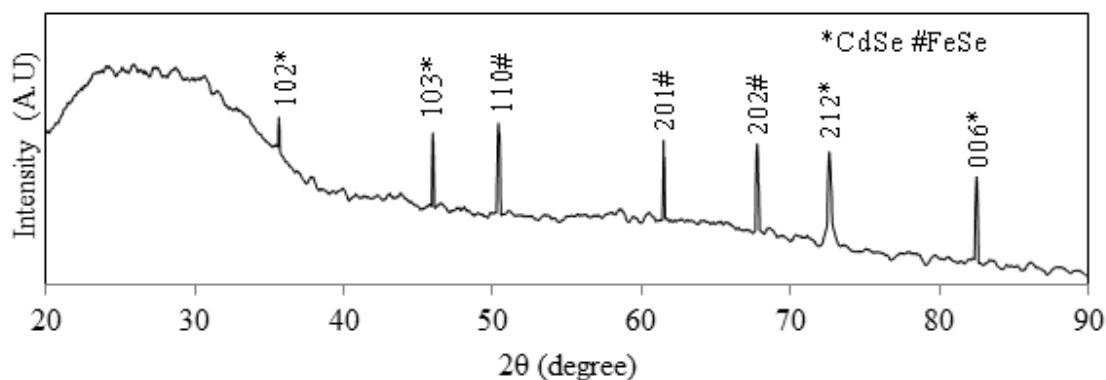


Figure 1.XRD patterns of composite spray deposited CdSe:FeSe thin films.

3.2. Surface morphology

Scanning electron microscopy (SEM) is a convenient method for studying the microstructure of thin films. Figure 2 shows, the SEM images of as deposited CdSe:FeSe thin films. From SEM, it is observed that as-deposited CdSe:FeSe thin film is uniform and porous in nature. The growth of well-developed network of nanotubes is observed in as deposited CdSe:FeSe thin films. This type of morphology can be utilized to improve the efficiency and quality of various optoelectric devices.

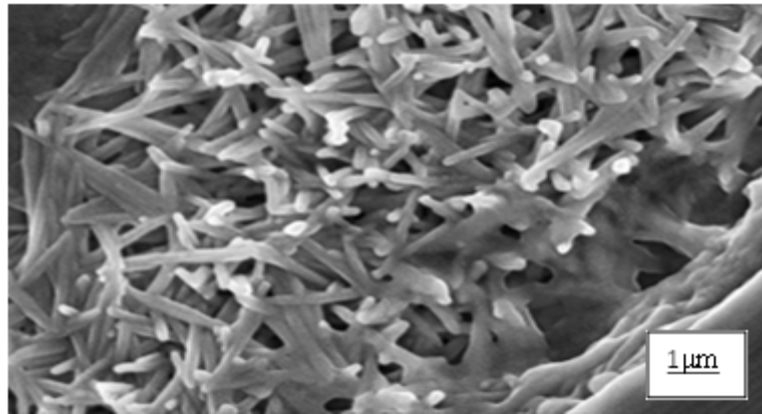


Figure 2. SEM images of spray deposited CdSe:FeSe thin films.

3.3. Optical properties

The optical absorption studies were carried out in the wavelength range of 350 to 1100 nm and the absorption spectra is analyzed to find band gap energy of CdSe:FeSe thin film. Figure 3 shows the variation of optical absorbance (α) of CdSe:FeSe thin film with wavelength deposited onto glass substrate, here 't' is film thickness and 'α' is the optical absorption coefficient. The nature of transition is determined by using the relation,

$$\alpha = \frac{A(h\nu - E_g)^n}{h\nu},$$

where $h\nu$ is the photon energy, E_g is the band gap energy, A and n are constants. For allowed direct transitions $n = 1/2$ for allowed indirect transitions $n = 2$.

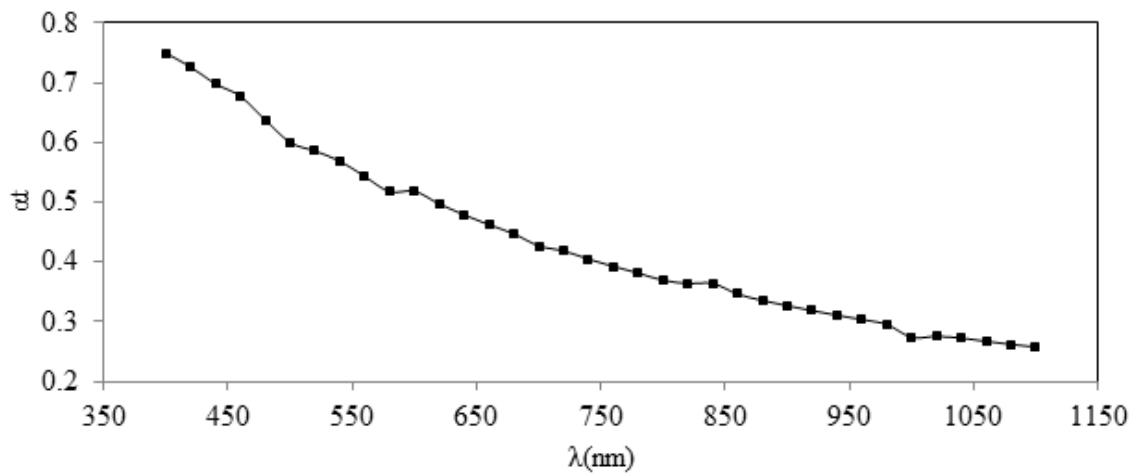


Figure 3. Variation of optical absorption vs. wavelength for CdSe:FeSe thin films

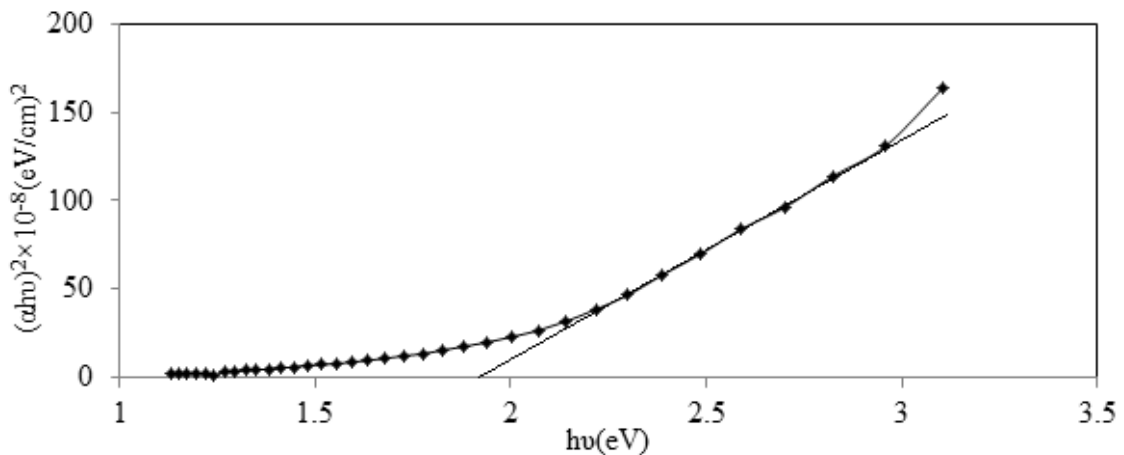


Figure 4. Variation of $(\alpha h\nu)^2$ verses $h\nu$ for CdSe:FeSe thin films

The plot of $(\alpha h\nu)^2$ versus $h\nu$ is shown in Figure 4. The nature of plot indicates the existence of direct transition. The optical band gap energy "Eg" is determined by extrapolating the straight line portion to the energy axis for zero absorption coefficient. The value of Eg for as deposited CdSe:FeSe thin film is found 1.95 eV.

CONCLUSION

In the present paper, synthesis of nanostructured n-type CdSe:FeSe thin films has been reported by chemical spray pyrolysis technique. XRD measurement confirms hexagonal structure and nanocrystalline nature of CdSe:FeSe thin films. SEM study reveals that the CdSe:FeSe film is uniform, crystalline and well covers the substrate surface. The optical band gap of CdSe:FeSe thin film is of the order of 1.95 eV.

REFERENCES

- [1] G.A. Prinz, *Science*.**1998**,282,1660.
- [2] Y. Ohno, D.K. Young, B. Besctoten, F. Matsukura, H.Otino, D.D.Awschalom, *Nature*.**1999**,402 790.
- [3]R. Fiederling, M. Keim, G. Reuscher, W. Ossau, G.Schmidt, A. Waag, L.W. Molenkamp, *Nature*. **1999**, 402-787.
- [4]A. Ennaoui, S. Fiechter, Ch. Pettenkofer, N. Alonoso-Vante, K. Buker, M. Bronold,Ch. Hopfner, H. Tribudou, *Sol. Energy Mater. Sol. Cells*.**1993** ,29,289.
- [5] N. Hamdadou, A. Khelil, J.C. Bernede, *Mater. Chem. Phys.***2003**,78,591.
- [6] A. Ennaoui, H. Tributch, *Sol. Energy Mater.***1986**,14,461.
- [7]V. Antonucci, A.S. Arico, N. Giordano, P.L. Antonucci, U. Russo, D.L. Cocke, F. Crea, *Sol. Cells*. **1991**, 31, 31.
- [8]A.S. Arico, V. Antonucci, P.L. Antonucci, D.L. Cocke, U. Russo, N. Giordano, *Sol.Energy Mater.* **1990**, 20, 323.
- [9] R.B. Kale, C.D. Lokhande ,*Applied Surface Science*.**2004**,223,343.
- [10] Sun-Ki Min, Oh-Shim Joo ,Rajaram S. Mane, Kwang-Deog Jung ,C.D. Lokhande , Sung-Hwan Han ,*Journal of Photochem. and Photobio. A: Chem.* **2007**,187,133.
- [11] Sachin K. Sharma, Lokendra Kumar, Sushil Kumar, T. P. Sharma, *Chalcogenide Letters***2008**,5(4),73.
- [12] A.U. Ubale , Y.S. Sakhare, M.R. Belkhedkar, *Materials Letters*.**2013**,92,111.
- [13]Y.G.Gudage,N.G.Deshpande, A.A.Sagade, R.P.Sharma, S.M.Pawar, C.H.Bhosale, *Bull. Mater. Sci.*, **2007**, 30, 321.
- [14] H.M. Pathan , B.R. Sankapal, J.D. Desai, C.D. Lokhande, *Materials Chemistry and Physics*.**2002**,78,11.
- [15] A.U.Ubale, S.G.Ibrahim, *J.Alloys.Comp*.**2011**,509,2364.
- [16]A.U.Ubale, V.P.Deshpande,*Optoelectro.Advan.Mater.Rap.Commun*.**2011**,5(2),119.