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Effect of Samarium(Sm^{+3}) doping on the Structural and other Properties of CdSe films

Physics

KEYWORDS: Thin films, Morphology, II-VI semiconductors, Phonons.

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ABSTRACT

Samarium Oxide (Sm3+) doped Cadmium Selenide (CdSe) thin films were synthesized using Chemical Bath Deposition Method. The bath temperature was kept at 70^{0}C. The pH of the solution was maintained around 11. Samarium oxide (SmO_3) was used for doping. CdSe thin films so obtained were characterized using XRD, SEM and Raman spectroscopy, respectively. XRD spectrum reveals that the grown CdSe films are polycrystalline in nature and have hexagonal structure. On doping the diffraction peaks show slight shift toward lower diffraction angle. The Debye-Scherer formula was used to calculate average particle size in pure and doped CdSe film. The results show that they are of the order of 45nm and 39 nm, respectively. The FE-SEM images show spherical particles having uniform distribution. Raman spectra indicate characteristic peaks which provide confirmation to the nanocrystalline nature of grown CdSe films. The peak height decreases on doping which an indication of decreased crystalinity.

INTRODUCTION

The II-VI binary semiconducting compounds belonging to Cadmium chalcogenide family (CdS, CdSe, and CdTe) are considered to be important due to their potential use in photoconductive devices and solar cells. Semiconducting thin films have been widely used because of their superiority over conventional organic fluorophores due to their high luminescence quantum yield, good photochemical stability, broad excitation and narrow emission band, size-dependent emission wavelength and large effective Stokes shift. CBD, as compared to other technologies, has established its usefulness in the growth of thin films, particularly due to the ease of growth repeatability. The Doped semiconductor materials are interesting nanostructure materials because of their size dependent electronic and optical properties. Moreover they have practical applications such as in high brightness displays. Rare earth (RE) doped wide band gap II–VI semiconducting materials are intensively studied due to their possible application as multicolour cathode- (CL), electro- (EL) and photoluminescence (PL) displays. Compared to surface-modified semiconductors, RE-doped II–VI semiconductors exhibit very narrow emission line, a large excitation–emission separation and a long fluorescence lifetime.

EXPERIMENTAL DETAILS

As received, extra pure chemicals were used for the synthesis of thin films. High quality Sm^{3+} doped CdSe films were prepared by Chemical Bath deposition method using Cadmium Acetate ($Cd(CH_3COO)_2$) $2H_2O$, Samarium Nitrate ($Sm(NO_3)6H_2O$), Selenium ions (Se^{2-}) and Sodium Sulphide. Double distilled water was used as a solvent. Aqueous solution of 1 M $Cd(CH_3COO)_2\,2H_2O$, 0.1 M of $Sm(NO_3)_3\,6H_2O$ and 1 M Sodium Seleno sulphate was prepared separately . Selenium Selenosulphate solution was then added slowly into the mixture of Samarium nitrate and Cadmium Acetate solution with constant stirring till it turn in to yellowish orange solution. pH of the solution was maintained at 11 by adding 30% ammonia. Thereafter 5 ml. of Triethinoamine was added to this solution. The substrate was left in the bath for two hours to have substantial growth of the film. After the depositions was completed on the substrates- films were taken out and cleaned with double distilled water and dried in open atmosphere at room temperature.

RESULTS AND DISCUSSION

XRDs were recorded with Cu–K radiation having wavelength 1.54 Å at SAIF Chandigarh. The data were recorded by scanning 2 from 20° to 80°. Pure CdSe film peaks are detected at 2 values equal to 25.73°, 42.27° and 49.79°, respectively. Whereas in Sm doped films, the peaks are shifted to 24.80°, 41.83° respectively.

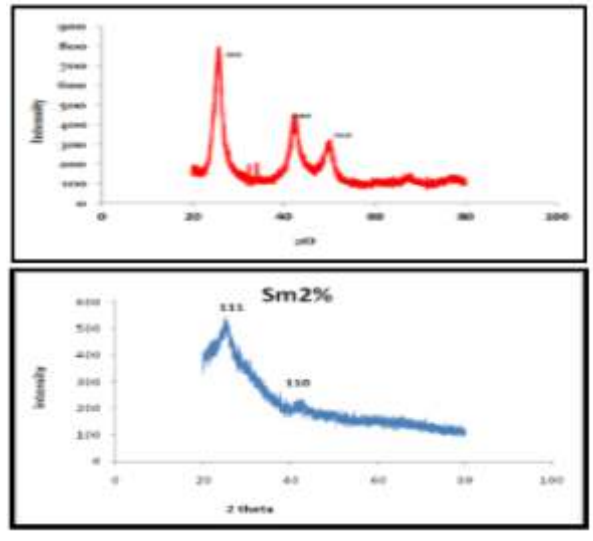

Figure : XRD pattern of CdSe and doped Sm thin films.

Scanning electron microscopy (SEM) is a convenient technique to study nanostructure of thin films. It is clearly observed from the surface morphological studies by SEM that the as-deposited CdSe films are nanocrystalline, homogenous, without cracks or holes and well covered to the glass substrate.

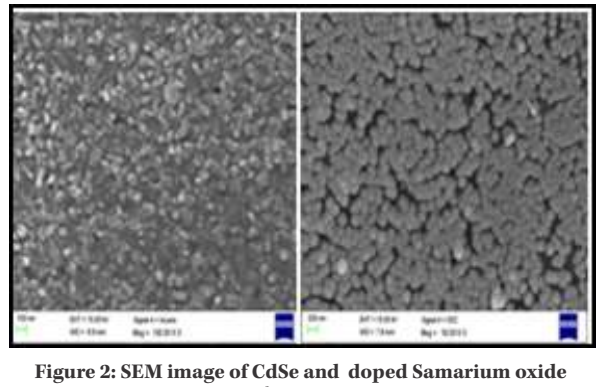

Figure 2: SEM image of CdSe and doped Samarium oxide (Sm^{3+}) thin film.

Raman spectra of annealed CdSe film show peak having highest intensity corresponding to dominating longitudinal optical (1LO) phonon peak at 206 cm–1. The observed (1LO) phonon peak is slightly below the bulk 1LO phonon frequency (211 cm–1). This might be due to the polycrystalline nature of the sample in nanocrystalline regime. Reported result shows that the Raman shift should decrease with an increase in nanocrystallite size. Multiphonon replicas or overtones (2LO, 3LO) were also observed with decreasing intensity in Raman Spectra.. And after doping decreasing the peaks. Thus Raman spectra provide confirmation to the formation of nanocrystalline CdSe films.

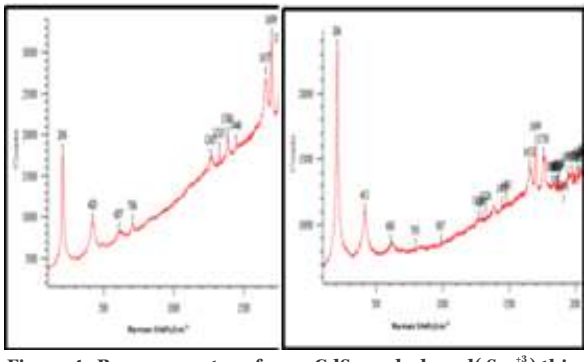

Figure 4. Raman spectra of pure CdSe and doped(Sm^{+3}) thin films

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Conclusions

CdSe and doped Sm films are polycrystalline in nature and have hexagonal structure.xrd confirm that particle size decrease on doping.The FE-SEM image shows the uniform spherical distribution of particles. Thus Raman spectra provide confirmation to the formation of nanocrystalline CdSe films.

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