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Photoluminescence studies of Cadmium Selenide Polymer-Nanocomposite films

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Abstract

Nanocomposite films of CdSe nanocrystals in polyvinyl alcohol (PVA) matrix were synthesized by environmental friendly chemical method. These composites were characterized by X-ray diffraction which indicates the hexagonal crystalline structure of CdSe with particle size up to a few nm. The particle size was found to decrease with increasing PVA Concentration and CdSe content. The photoluminescence properties of these composite films have been investigated. The emission peak of CdSe was observed at 510 nm and higher peak intensity was observed by increasing PVA concentration in CdSe nanocomposite films without any change in position of the peak. In CdSe/PVA nanocomposites with varying CdSe content, PL peak shifts towards shorter wavelength as particle size is reduced. This emission can be attributed due to various surface states available and the blue shift can be attributed to size reduction of PVA matrix to CdSe nanoparticles with variations of CdSe content. Due to proper passivation of surface states, non-radiative transitions are reduced leading to enhanced PL intensity. The polymer matrix acts to stabilize the nanoparticles.

Keywords: Nanocomposite, XRD, AFM, Photoluminescence.

1. INTRODUCTION

Polymer- inorganic nanocomposites have attracted much attention recently due to their unique size dependent chemical and physical properties [1]. Recently there have been many efforts to produce nanosized materials because the electrical and optical properties can be varied via chemical control over size, stoichiometry and interparticle separation [2-5]. The combination of polymer with semiconducting nanoparticles allows the fabrication of thin film light-emitting devices several approaches have been reported, using two layer structures of PVA and CdSe Particle. The CdSe nanocomposites exhibit size dependent tunable photoluminescence; therefore they are potentially useful in a wide range of applications [6]. Studies have been undertaken to prepare CdSe nanoparticles in PVA matrix and investigate their luminescence [7].

2. EXPERIMENTAL

CdSe/PVA nanocomposites were prepared by chemical method. PVA solution was prepared in distilled water and then 1 ml $CdCl_2$ solution was added to it. After setting the pH at 10, 1 ml of freshly prepared Na_2SeSO_3 solution was added & stirred for 90 minutes to obtain CdSe/PVA nanocomposite. The solution was spread on glass plates and on solvent evaporation, nanocomposites films were obtained. A number of samples were prepared with different PVA concentration and different CdSe content, subjected to X-ray diffraction and photoluminescence and Atomic force microscopy investigations. All samples were characterized at Inter University consortium (IUC) Indore. XRD patterns have been obtained by Rigaku Rotating Anode (H-3R) diffractometer with irradiation from K_α, line of copper (λ=1.548A) and PL Studies have been Performed at MANIT, BHOPAL by F-7000 FL Spectrophotometer. The particle size was calculated using Debye Scherrer formula.

3. RESULT AND DISCUSSION:

For XRD analysis, thin film of CdSe/PVA nanocomposites with different CdSe content and varying PVA concentration were prepared. The X-ray diffraction patterns of CdSe/PVA nanocomposites are shown in figure 1. For CdSe/PVA samples, four peaks were obtained around 20, 25˚, 35˚ and 47º respectively. The first diffraction peak is obtained due to presence of PVA polymer matrix and second, third peaks are corresponds to (0, 0, 2), (1, 0, 2) lattice planes of Cadmium Selenide

hexagonal phase (ICSDII-0607791). Considerable broadening was observed in the X-ray pattern of the samples and this is due to the finite size of the nanocrytallities. The Scherrer formula was used to calculate the particle size (D) from full width at half maxima (FWHM) of the sample peaks.

$$D = \frac{K\lambda}{\beta COS\theta}$$

where D is crystallite size, K is constant, θ is Bragg's angle, λ is wavelength, β is full width half maxima of peak and the width of line is determined from ruler on X-axis.

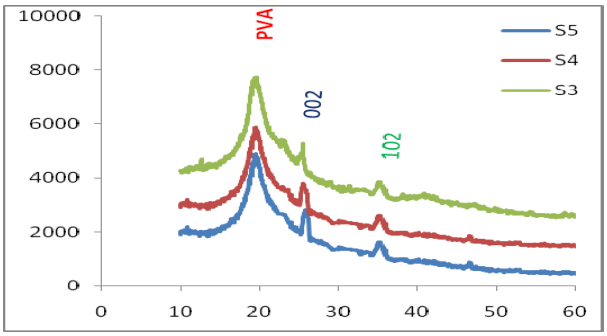

Figure1. XRD pattern of CdSe/PVA Nanocomposite

Photoluminescence (PL) spectra, when excited by 380 nm UV light of CdSe/PVA samples, showed a single peak at 510 nm and its intensity was found to increase with increasing PVA concentration. Higher intensity was obtained for smaller CdSe particles in PVA matrix. The emission may be attributed to band to band transition of CdSe. The oscillator strength is increased by reducing the size, which enhances the PL intensity. Due to proper passsivation of surface states non-radiative transitions are decreased.

The Photoluminescence spectra (Fig.2) of CdSe/PVA with variations of CdSe content show blue shift with lower particle size due to quantum confinement effect. The polymer matrix acts to stabilize the nano particle. Due to the PL peak in blue region, these composite films are promising materials for optical display devices.

From AFM studies, it is found that as the Cadmium Selenide (CdSe) content is increased, the AFM cluster size decreases i.e. smaller nanoparticles were found in PVA polymer matrix. The particle size from AFM image is below than 50 nm as shown in Fig.3 and are in strong agreement with those obtained from XRD.

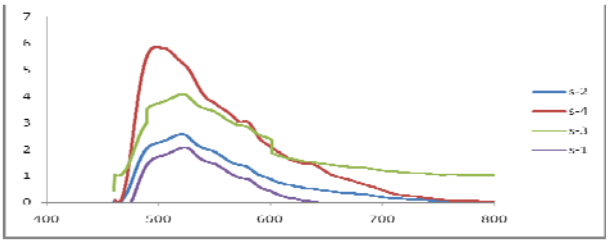

Figure 2. PL spectra of CdSe/PVA Nanocomposite

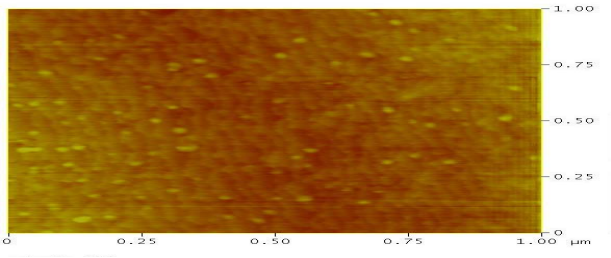

Figure 3. AFM Picture of CdSe/PVA Nanocomposite

4. CONCLUSION

In the present work, an economical and simple method was used to prepare nanocomposites. The average particle size of CdSe reduced on increasing PVA concentration in CdSe/PVA nanocomposites. The PL intensity also increased due to enhanced oscillator strength in nanoparticles. Strong blue shift was revealed due to shifting of PL peaks towards lower wavelength region in PL spectra. AFM observations showed uniform distribution of ZnSe particle in PVA matrix with nanometer regime.

5. REFERENCES

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