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Optical Studies in ZnSe/PVK Polymer Nanocomposite

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Research Article

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ABSTRACT

Nano crystal-polymer composites of ZnSe/PVK Nanocomposite have been successfully prepared by chemical method.SEM and XRD indicate spherical particles with size in 72 nm to 88 nm range. Photoluminescence of ZnSe/PVK Nanocomposite film shows a peak in UV-VIS region and violet-green light emission in electroluminescence studies. The composites films require voltage in varying nature for light emission. The intensity of EL Cell varies nonlinear with increasing voltages. Particle size the SEM images shows the 80 nm, 88 nm, 72 nm of the Nanocomposite size of the ZnSe/PVK thin film.

INTRODUCTION

In Nano-composite different materials are used of in different phase i.e. multiphase these phases may vary from one dimension to three dimension of less than one hundred nanometer (100 nm), these Nano composite may be in the form of Gel, Colloid etc. The mechanical, electrical, thermal, optical, electrochemical catalytic properties of the Nano composite will differ markedly from that of the component materials. Size limits for these effects have been proposed, 5 nm for catalytic activity, 20 nm for making a hard magnetic material soft, 50 nm for refractive index change and, 100 nm for achieving super magnetism materials mechanical strengthening or restricting materials matrix dislocation movement. Nano composite are found in nature like in gaseous pollutant aerosols, Nano-particles help us to understand the original composition and understanding the physical and chemical properties. Ajyan et al. note that with polymer Nano composite properties related to local chemistry, degree of thermostat cure, polymer chain mobility polymer chain confirmation nature of polymer chain can all vary significantly and continuously from the interface with the strength into the bulk of the matrix [1]. This large amount of strength in surface area means that a relatively small amount of nano-scale reinforcement can have an observable effect on the macro scale properties of the composites. Other kinds of a Nano particulates may result in the increase of optical properties, like dielectric properties, heat resistance, or mechanical properties such as stiffness strengths and resistive to wear and damage. Another striking feature of the Nano composite LED's is the voltage dependence color of the emitted light .The phenomena is caused by recombination in polymer Nano composite system which usually takes place both in the nanoparticles. The and polymer matrix, varying the ratio of electron-hole pair undergoing recombination in the matrix and the nanoparticles. The correspondingly changes the injection conditions from the cathode and anode which affect the carrier penetration range within the structure resulting in a variation in the spectral content i.e. the color of the emitted light [2]. Since electron injection and electron penetration depth caused by the change in the voltage are responsible for the shift in recombination zone which result in the emission color change even though the similar voltage dependence color LED's have been reported based on electroluminescent conjugated polymer blends consisting of the polymers with different band gaps. Polymer Nano composite seems to be easier to produce process and produce the desirable color coordinate changing the particle size and thickness of the layer. A further conceptual development of polymer Nano composite LED's reported by Alleviator et al. was the application of core shell structure, due to the specificity of the confinement particle caused by the fact that the lower band gap semiconductors forms the core of the particle and he higher band gap its shell, the holes (+) are trapped in the

core part of the nanoparticles. Therefore the recombination or mixing probability is enhanced efficiently in comparison with the homogeneous nano-particle layer. In metal selenides, elemental selenide has also been used widely as a semiconductor material. Elemental serenades (selenium) exhibit a unique combination of interesting and important properties for example, a relatively low melting point, a high productivity, and a high reactivity toward a wealth of chemicals that can be exploited to convert selenium into other functional material like ZnSe [3]. The photoelectric and semiconductor properties of selenium are well known. It is used in rectifiers, solar cells, photographic exposure meters and xerography. It can be also used in glass industries, to eliminated bubbles and removed undesired tint's to produce by iron. The present investigation report on the optical characterization of polymer Nano composite of ZnSe/PVK material, we have characterized PL, EL, SEM, XRD of the composites material which shows that the phase confirmation morphology and particle size of Nano composite. These results are analyzed and discuss in detail.

EXPERIMENTAL

First of all we have to prepare ZnSe nanoparticles. The particular amount (99:1) of $ZnCl_2$ and $MnCl_2$ dissolved in double distilled water at higher temperature with continues stirring. Selenium powder is dissolved in toluene at higher temperature, the Se powder is taken in doubled walled glass flask and toluene is added in it at higher temperature and stirring it is dissolved and found gray solution of selenium powder. This solution is mixed in Zn:Mn at constant ph, further ZnSe solution has been prepared.

For preparation of PVK polymer solution, 0.5 gram of granules is dissolved in Dimethyl Formamide (DMF) continuous stirring and at gradually increase temperature and drop wise of ZnSe solution are mixed in it at higher temperature, hence ZnSe/PVK polymer Nano composite have been prepared. Few part of ZnSe/PVK is spread on glass slide and left of part is spread on conducting glass plate (in smaller area) which is already prepared by chemical synthesis process in which SnO_2 used as a conducting layer. Both of slides are dried at microwave oven at higher temperature. ZnSe/PVK thin film is used for the characterization of SEM, XRD, PL ABSn and dried film of conducting glass slide is used for the EL cell and its EL characterization. For EL cell preparation half of portion of composites layer is covered with mica window and Aluminum strip is attached on it with conductive paste it is used for the second electrode. This EL cell is attached on the PMT, and it is connected to Picco ammeter in high voltage power supply hence we have to take two types of characterization Voltage vs Current and Voltage vs Brightness with the help of this arrangement.

RESULT AND DISCUSSION

Figure 1 shows the photoluminescence spectra of ZnSe/PVK polymer composites film, in which the peaks are found in 408.6 nm, 430 nm and a smaller peak is found in 708 nm (UV-VIS) region .The energy band gap of ZnSe/PVK have estimated from the formula.

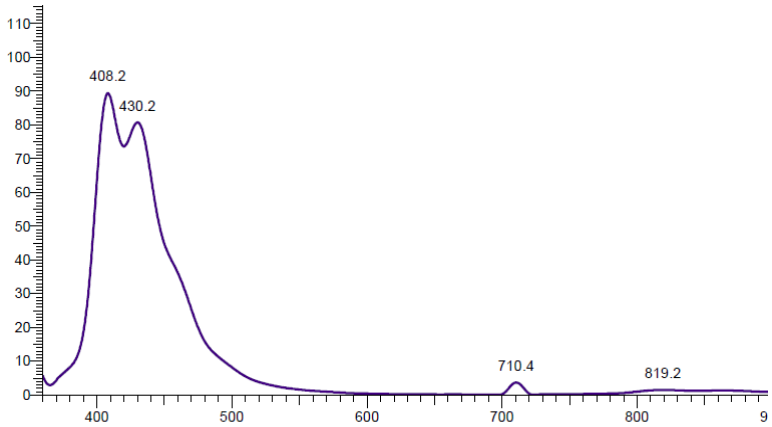

Figure 1. Photoluminescence characteristics of ZnSe/PVK.

$$Eg = hc / \lambda \quad (1)$$

Where Eg the band gap of the Nano composite, h is the Plank constant and C is the speed of light. For given wave length (408.6 nm, 430.2 nm, 708 nm) 3.0eV, 2.8eV, 4.32eV. **Figure 2** Shows the XRD characterization of polymer composites film. The 2θ values of the diffraction peaks are found in 13.88 nm and 20.02 nm. At room temperature XRD data is analyzed by using Bruker D-8 Advance X-ray Diffract meter from Deptt. Of Atomic energy DAE, Indore. The crystalline size of the synthesized ZnSe/PVK Nano composite has calculating by Debye Scherrer formula [4].

$$D = 0.9\lambda / \beta \cos\theta \quad (2)$$

Where D is the average crystalline size, λ is the x-ray wave length1.5045A0), β is the full width half maximum (FWHM) with length in radian. The uniform homogeneity and a sphere like morphology confirmed by SEM micrograph, which is characterized from MANIT Bhopal and formed to be size of Nano composite have been found in the 80 nm, 88 nm, 72 nm. In electroluminescence characterization, Electroluminescence starts at minimum voltages. Initially when we increase the voltage the current gradually

increase after that at higher voltages it goes to be in nonlinear way. Similarly in voltage brightness characterizations brightness change with the applied voltage and increasing in nonlinear way. **Figures 3 and 4** show the voltage vs. brightness and voltage vs. current characteristics. Nano-particles of semiconductor in a polymer matrix exhibit a quantum effect in which the electrons (-) and holes (+) are confined in a potential well, or increase in the conduction band. Electron or whole energy by term quantum energy,

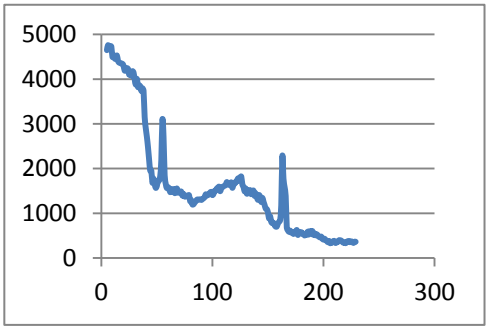

Figure 2. XRD Characteristic of ZnSe/PVK.

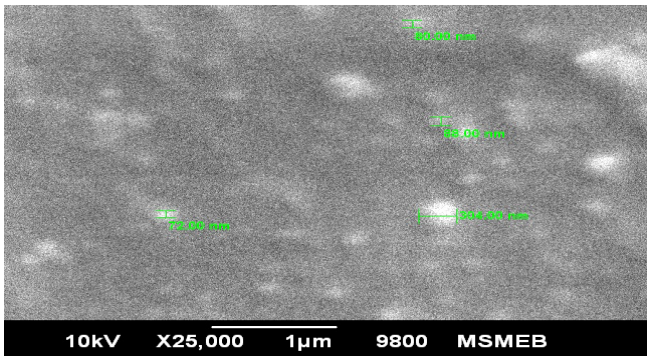

Figure 3. SEM Characterization of ZnSe/PVK.

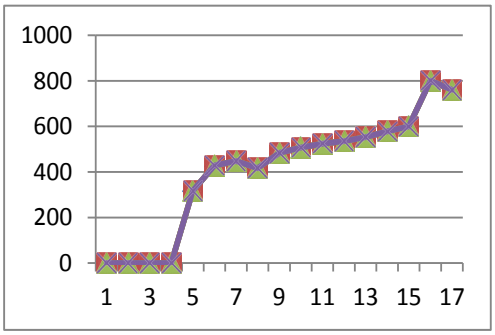

Figure 4. Electroluminescence characteristics of ZnSe/PVK.

$$Ei = E0 + 6.28h2 / 2mr2 \quad (3)$$

Where E0 is the initial energy of the particle, m is the effective mass of electron or whole and (r) is the radius of the Nano-particle energy [5]. Hence increase in the band gap if the particle size becomes smaller than the exaction radius. This mechanism is obey the photoluminescence characterization. In the case of polymer based structure, the radioactive transition between the electronic states of excited conjugated molecules and the granule states takes place. Before their recombination, in the polymer media, the electron and holes succeeded in exactions (bound states of the electron-hole pair) which than recombine through a number of radiative and a non-radiative channels. The polymer used as the EL media must combine high electron and whole injection based mobility with a high probability of radiative combination in comparison with the non-radiative channels [6]. The EL characteristic shows that, the result of emission sudden increase as (intensity or current) with applied voltage. The recombination of electron-hole pair in polymer matrix changes the injection condition from cathode to anode, which affect the range of carrier penetration within the structure resulting in the variation in spectral content; or color of the emitted light. Changes in the electron injection and electron penetration depth caused by the change in voltage are responsible for the shift recombination zone which results in the emission wave length [7].

CONCLUSION

Thin film of ZnSe/PVK polymer Nano composites prepared by chemical method. The EL stars at particular voltage and then it tends to increase rapidly with increasing voltage. For a cixed voltage the EL brightness increases nonlinear way with the frequency of applied voltage. The morphology of the particle size shows by SEM characterization.

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