SYNTHESIS OPTICAL AND LIGHT 1EMISSION FROM CDSE/PVK NANOCOMPOSITES

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Abstract:CdSe nanoparticles dispersed in polyvinylcarbozole (PVK) matrix were synthesized simple chemical technique. The effect of the concentrations of the PVK on the optical properties of CdSe/PVK films was investigated through UV-Visabsorption spectroscopy and electroluminescence (EL) study of CdSe/PVK nanocomposite. It is observed that the light emission starts at a threshold voltage and then rapidly increases with increasing voltage. Lower threshold and higher brightness have been observed for smaller particles. Current is found to increase linearly with voltage indicating ohmic nature.

***Index Terms*- Light emission UV-Vis absorption spectroscopy, Nanocomposites.**

I. Introduction

The semiconductor nanoparticles belong to the state of matter intermediate molecules and bulk solid in which the relevant physical dimensions changes on the length of a few to a few hundred nanometers [1]. The incorporation of semiconductor nanoparticles into polymer, glass or ceramic matrix materials may improve many of their interesting optical properties including absorption, luminescence etc. CdSe is one of such materials,which shows strong fluorescence and being considered in many applications such as optoelectronic devices, light sensors, biological labels, [2-4] etc. The effect of reducing the size of CdSe crystal in polymer (PVK) matrix is expected to improve the performance of these devices.

In the present study, the main focus is on the synthesis, technique and emission of light from CdSe/PVK nanocomposites by passing electric current.

II. RESEARCH METHODOLOGY

2.1Materials

All reagents such as cadmium chloride ($CdCl_2$), selenium powder (Se), sodiumborohydried ($NaBH_4$) and polyvinylcarbozole were purchased from Merck (India) Ltd. And used directly as received without any further purification.

Synthesis of CdSe/PVK nanocomposites

Cadmium Source: Weighing of $CdCI_2$ was done for obtaining 0.05 mmole solutions in 20 ml distilled water.

Selenium Source: Selenium source was prepared by adding 0.05 mmole of selenium powder to 20 ml distilled water in two necked flask then 0.10 mmole of sodium borohydried was carefully added to this mixture, and the flask was immediately purged with nitrogen gas. The mixture was then stirrer for 2 hours at room temperature using magnetic stirring. The entire selenium dissolves in water giving rise to a colorless selenium solution.

CdSe/PVK nanocomposite thin films have been prepared with the help of above prepared selenium source and cadmium source. The PVK solution was prepared by dissolving (200mg,400mg,600mg) PVK in 20 ml of DMF (Di-methylformamide) under constant stirring at 60^0c temperature. Then viscous transparent PVK solution was obtained. The prepared solution of PVK in beaker was kept in magnetic stirrer at 60^0c temperature. Then viscous transparent PVK solution was obtained. The prepared solution of PVK in beaker was kept in magnetic stirrer at 60^0 C temperature and 1ml $CdC1_2$solution was carefully added to it and stirred for 10 minute. The pH of the solution was adjusted between 9-10 using ammonia solutions. After that 1 ml of selenium solution was added drop wise in this solution, stirred for 2 hours and then cast on glass substrate and for electroluminescence studies prepared solution was cast on ITO coated conducting glass plate.

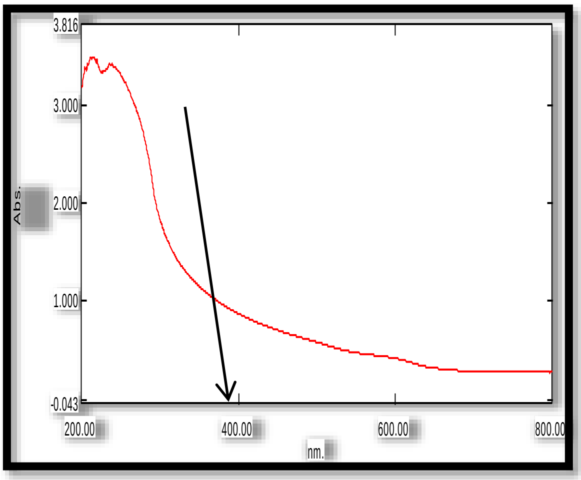
III CHARACTERIZATION

The optical absorption spectra of various CdSe/PVK samples were obtained at room temperature in wavelength range of 200-700nm using Perkin Elemer Lambda 950, spectrometer at IUC Indore. Emission of light from CdSe nanocomposites was investigated by placing CdSe/PNK nanocomposites between ITO coated conducting glass plate and Aluminium foil. The EL cell was connected with low distortion frequency generator coupled with power supply (wide band amplifier). The AC voltage was measured with the help of photomultiplier tube at Department of Physics, RDVV, Jabalpur.

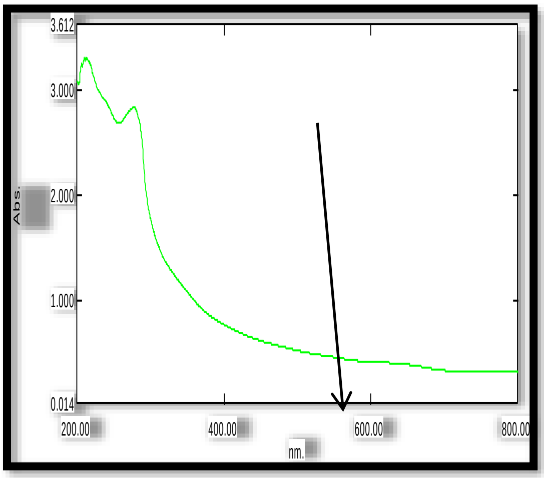
IV RESULT AND DISSUSION

4.1 UV-Visible absorption spectra

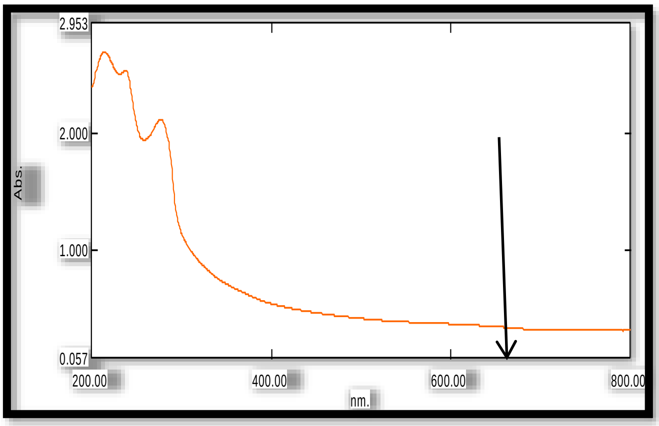
Figure1 shows typical absorption spectrum of CdSe/PVK nanocomposites for 200,400 and 600mg PVK.



a) CdSe/PVK 200 mg PVK



b) CdSe/PVK 400 mg PVK



c) CdSe/PVK 600 mg PVK

Fig. 1: Optical absorption spectrum for CdSe/PVK nanocomposites

It is clear from the figure the absorption is found at lower wavelength as compared to bulk CdSe and band edge shifts towards lower wavelength by increasing the concentration of PVK. As concentration of PVK was increased, estimated band gap was found to increase from 3.54 to 4.11 eV.

Determination of particle size using absorption spectra

The optical band gap of the crystalline samples was calculated from absorption edge using formula of equation 1

Eg= hc/λ (1)

Where h is planks constant, c is the speed of light and λ is the wavelength at absorption edge.

h=6.62*10^{-34}Jsec,

c=3*10^{8}m/sec

From the increased effective band gap of CdSe, the crystal size was computed from the effective mass approximation model [5].

$$\Delta E = \frac{h^2\pi^2}{2r^2}\left[\frac{1}{m_e^*} + \frac{1}{m_h^*}\right] \quad (2)$$

Table 1. Band gap values and particle sizes of CdSe /PVK from absorption spectra.

Samples	Sample name	Concentration of PVK	Band edge wavelength (In nm)	Effective Energy Band Gap (In eV)	Diameter by EMA (In nm)
CdSe I	Y1	200	350	3.54	2.8
CdSe II	Y2	400	323	3.83	2.6
CdSe III	Y3	600	301	4.11	2.4

4.2 Emission of light

Voltage was applied across the CdSe/PVK nanocomposite films and current through, it was measures and also emission of lighjt from the films was measured with the help of PMT.

4.2.1 Voltage-Brightness Characteristics

Figure 2 shows the variation of light intensity with applied voltage for three samples of CdSe/PVK nanocomposites.

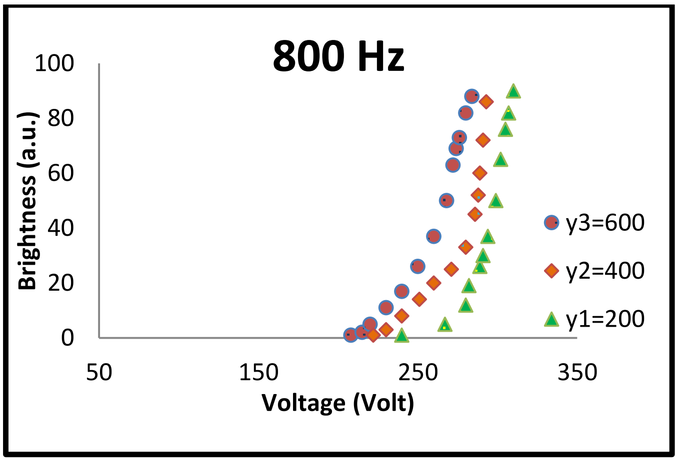


Fig. 2: Voltage –Brightness Characteristics of CdSe/PVA Nanocomposites at 800 Hz.

It is observed that there is no emission of light up to a particular threshold voltage and above the threshold, the light intensity increases rapidly. The threshold voltage decreases on increasing the concentration of PVK in CdSe composites that is with the decrease in size of the crystal. Smaller nanocrystal have increased oscillator strength, which improve the electron-hole radiative recombination and hence the light emission.

4.2.2 Current –Voltage characteristics curve

Figure 3 shows current-voltage characteristics CdSe nanocomposites at 800 Hz.

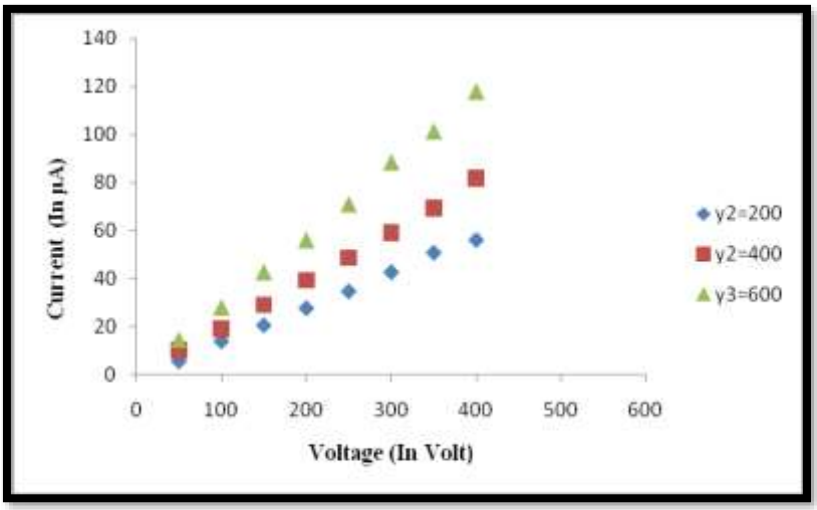


Fig. 3: Current- voltage characteristics CdSe/PVK nanocomposites at 800 Hz.

It is clear from graph that is a linear relation between current and voltage. The linear relation indicates the ohmic nature, that is, there is ohmic contact between sample and electrodes. It can be seen from the figure that with increasing the concentration of PVK in the nanocomposites slopes of V-I curve increases indicating reduced impedance. The variation of impedance with PVK concentration is shown in Figure 4.

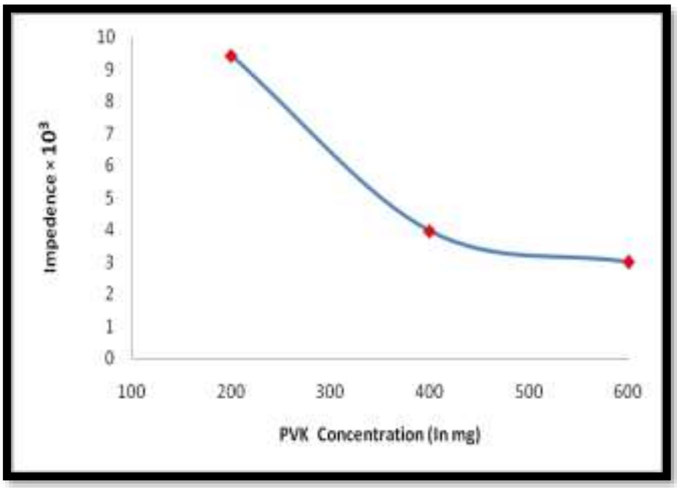


Fig 4: PVK concentration- Impedance curve for CdSe/PVK nanocomposites

V CONCLUSION

CdSe/PVK nanocomposites have been successfully synthesized by the chemical method.Three samples have been prepared by taking various concentration of PVK. The optical absorption spectra show that CdSe nanocrystals are formed in PVK matrix giving increased effective band gap as compared to bulk band gap of CdSe. Light emission is obtained from the CdSe/PVK nanocomposite films by applying AC voltage of about 200 V at 800 Hz. The light intensity increases on increasing the voltage above threshold and the variation pattern is almost exponential for all samples. The studies reveal that lower threshold voltage is required for samples with higher concentration of PVK. The voltage current curve represents ohmic nature and impedance decreases for higher PVK concentration.

VI ACKNOWLEDGEMENT

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REFERENCE

[1] S. Suresh, C. Arunseshn.2014. Dielectric Properties of Cadmium Selenide (CdSe) Nanoparticles synthesized by solvothermal method.App1Nanasci 4:179-184.

[2] Gaponik N, Radtchenko IL, Sukhorukiv GB, Rogach AL.2002. Toward encoding combinational libraries: charge-driven microencapsulation of semiconductor nanocrystals as fluorescent biological labels. Science. 281:2013-2016

[3] Bruchez M, Moronne M, Gin P, Weiss S, Alivisatos. AP 1998. Semiconductor nanocrystals as fluorescent biological labels. Science 281:2013–2016.

[4] Nazzal AY, Qu L, Peng X, Xiao M. 2003.Photo activated CdSe nanocrystals as Nano sensors for gases. Nano Lett 3:819–822.

[5] L.E. Brus.1984. Electron–electron and electron-hole interactions in small semiconductor crystallites: the size dependence of the lowest excited electronic state. J. Chem. Phys. 80(9), 4403–4409 .