RESEARCH PAPER | Physics | Volume : 5 | Issue : 10 | October 2015 | ISSN - 2249-555X

Optical Study of Zinc Selenide

KEYWORDS: ZnSe, Band Gap, Photoluminescence

Dr. Mahendra Kumar

Assistant Professor , Department Of Physics University Of Lucknow, Lucknow , India – 226007

ABSTRACT *One-dimensional nanostructure materials are very attractive because of their optical properties depending on their size. It is well known that properties of material can be tuned by reducing size to nanoscale because at the small sizes, that they behave differently with its bulk materials and the band gap will control by the size. These particles are characterized by UV-Visible absorption and Photoluminescence spectra. Due to their high refractive index and absence of absorption in the visible region, the monodispersed ZnSe could be potential building blocks to construct functional devices and photonic band gap crystals.*

1. Introduction

Nanoparticles or quantum dots with three dimension confinement structures are very attractive because of their optical properties depending on their size. The recognition of strongly size and shape dependent physical/chemical properties of nanostructure materials has stimulated efforts towards the fabrication of nanocrystals in a systematic and controlled way [1]. Chemically synthesized nanostructures and their assembly are of fundamental importance due to their unique dimension dependent properties and their potential applications as building blocks in nanoelectronics, nano-optronics, nanosensors & actuators, and in biology [2]. Recently much interest has been aroused in the preparation and assembly of semiconductor due to their narrow and intensive emission spectra, continuous absorption band, high chemical and photo bleaching stability, processability and surface functionality [3]. ZnSe an important II-VI, n-type, direct band gap semiconductor has attracted considerable attention due to its applications in light-emitting diodes, photo-detectors and full colour display [4]. The wide band gap (bulk band gap 2.7 eV) of ZnSe and significantly large binding energy (21meV), make this an ideal choice as an inorganic passivation shell for a variety of semiconductor core/shell nanocrystals, in order to improve the stability and emission properties of the semiconductor core nanocrystals with relatively narrow band gap and for efficient room temperature exciton devices with improve temperature characteristics. ZnSe is also attractive host for the formation of doped nanocrystals [5].

1.1 Experiments

ZnSe nanoparticles are prepared by dissolving 0.27 g of ZnCl2 (1/10 M, 20ml) in distilled water and added in it a definite concentration of 2-Mercaptoethanol in distilled water (1/10 M, 50 ml) by constant stirring and then 0.0579 g of Na2SeO3.5H2O (sodium selenite pentahydrate) dissolved in 50 ml distilled water was slowly added to above solution with continuous stirring. The resulting solution was stirred for three hours of constant stirring a red-orange solution of ZnSe was obtained. Washed with distilled water and methanol to remove the impurity possibly remains.

The absorption and luminescence spectra for ZnSe nanoparticles were recorded using UV-Visible spectrophotometer (UV-vis-NIR V670 JASCO) and spectroflurometer respectively.

Results and discussion

1.1.1 UV-Visible spectra

The nature and value of the optical band gap is determined when electron excitation from the valence band to the conduction band.. The relationship between absorption coefficient (α) and the incident photon energy (hv) can be written as

$$\alpha hv = A(Eg - hv)^m$$

where Eg is the band gap of the material and A is a constant, exponent m depends on the type of transition. For direct allowed m = 1/2, indirect allowed transition m = 2, and for direct forbidden, m = 3/2. Optical absorbance measurements of ZnSe nanoparticles in the wavelength range 300 – 700 nm at room temperature to ascertain the nature of the band gap. The absorption coefficient (α) at various wavelengths has been calculated using the equation.

$$\alpha = 2.303 ()/t$$

Where A is the absorbance value at a particular wavelength and t is the thickness of the cuvette. The direct band gap calculated from $(\alpha hv)^2$ vs hv plots. Extrapolation of the linear region to the hv axis gives the band gap of the material. Fig. (a) shows the $(\alpha hv)^2$ vs hv graph for the nanoparticles. The plots are linear, extrapolation of the plot to the hv axis yields the band gap 3.6 eV for the ZnSe nanoparticles. The absorbance vs wavelength graph is shown in Fig. (a).

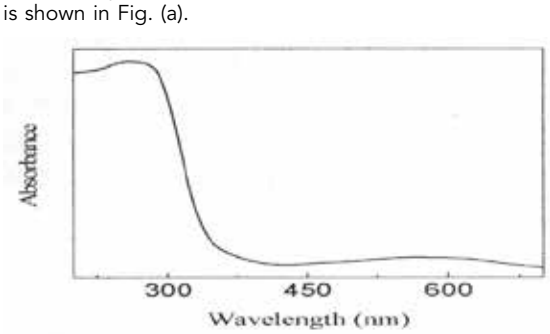

Fig.(a) UV-Visible spectra of ZnSe

1.1.2 Luminescence Study

Photoluminescence spectrum at room temp. centred at 325 nm of as prepared ZnSe nanoparticles excited at 230

Volume : 5 | Issue : 10 | October 2015 | ISSN - 2249-555X

nm is attributed to the recombination of excitons and the UV emission. The higher energy level excitation (λex ~325 nm) with higher absorption coefficients has a small contribution to the photoluminescence. The excitation spectrum of the sample at the long wavelength emission (λem ~ 501 nm), which exhibits a structure-less, wide excitation band with an excitation maximum centred on the direct absorption band edge. The excitation spectrum shows in Fig. (b) some difference compared with the absorption spectrum.

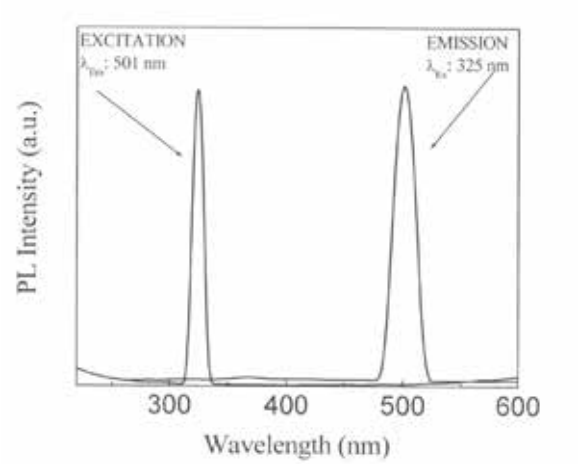

Fig. (b) PL spectra of ZnSe

Conclusion

The excitation spectrum of the ZnSe at the long wavelength emission (λem ~ 501 nm), which exhibits a structure-less, wide excitation band with an excitation maximum centred on the direct absorption band edge.

REFERENCE 1. Jiang, H., Yao, X., Che, J., Wang, M., Kong, F., (2004), Preparation of ZnSe quantum dots embedded in SiO2 thin films by sol-gel process, Ceram. International 30: 1685-1689. 2. Jiao, Y., Yu, D., Wang, Z., Tang, K., Sun, X., (2007), Synthesis, nonlinear optical properties and photoluminesce of ZnSe quantum dots in stable solution, Mater. Lett. 61: 1541- 1543. 3. Kumaresan, R., Ichimura, M., Arai, E., (2002), Photochemical deposition of ZnSe polycrystalline thin films and their characterization, Thin Solid Films 414: 25-30. 4. Wang, H., Du, F., (2006), Hydrothermal synthesis of ZnSe hollow microspheres, Cryst. Res. Technol. 41: 323-327. 5. Wang, Y., Yao, X., Wang, M., Kong, F., He, J., (2004), Optical responses of ZnSe quantum dots in silica gel glasses, J. Cryst. Growth 268: 580-584.