International seminar on Nanoscience and Technology- conference proceedings. Oct- 2016
Volume 3, Special Issue - Available Online: http://ijrset.in/Volume3,Special-Issue-IV.php Pages: 24-28

ISSN 2394-739X
International Journal for Research in Science Engineering and Technology

SYNTHESIS AND CHARACTERIZATION OF CADMIUM SELENIDE (CdSe) AND ZINC SELENIDE (ZnSe) NANOPARTICLES BY SOLID STATE REACTION METHOD

[1] K. PRABHA, [2] M. HIDAYA NASRIN, [3] T. AMUTHA, [4] M. RAMESHBABU
[1, 2, 3] Department of Physics, Mother Teresa Women's University, Kodaikanal-624101
[4] Departments of Physics, Arulmigu Palaniandavar College for Arts and Culture, Palani

ABSTRACT- Nanotechnology has dynamically grown as an important field of recent research with wide spread applications in the fields of electronics and medicine. Nanotechnology can be defined as an investigation for the design, synthesis, and handling of the structure of particles with a dimension smaller than 100 nm. In the present work, the author's report the structural, optical and FT-IR properties of the Cu doped ZnS nanoparticles were synthesized by chemical method. The crystal structure studies show that samples have cubic phase crystal structure. The optical energy bandgap of pure and Cu doped samples were determined by optical study. The presence of functional groups of pure and Cu doped ZnS have been identified by FT-IR study.

Keywords- ZnSe, CdSe, Semiconductor, FT-IR, X-ray diffraction.

1. INTRODUCTION

During the past decades, wide band gap semiconductor materials have attracted considerable attention due to their size-dependent properties and important technological applications [1, 2]. The ZnSe quantum dots have been prepared using an arrested precipitation colloidal technique [3], a sol–gel process [4] and arrested nucleation in glass [5]. Of the various II−VI semiconductors, zinc selenide (ZnSe) with a direct band gap of 2.70 eV (460 nm) is especially interesting because it is widely used for various applications [6], such as nonlinear optical devices [7], displays [8], sensors [9] and infrared windows [10]. ZnSe has long been a material of choice of blue diode lasers and photovoltaic solar cells [11, 12]. The ZnSe material is used for short wavelength visible light lasers has stimulated interest to synthesis ZnSe nanoparticles in the quantum size regime. Synthesis of CdSe nanoparticles (NPs) with uniform size distribution and controlled dispersity is an important area of research in the field of optoelectronics and semiconductor devices due to their unique optical properties, bright photoluminescence and tunable size [13,14]. Peng et al. first employed ammonium as a complexing agent for cadmium ions to synthesize cadmium selenide (CdSe) nanocrystals using the hydrothermal method. They found that at

140◦C, CdSe with a mixed morphology of branch-shaped fractals and nanorods was produced, and at 180◦C, the products were mainly CdSe nanorods [15]. CdSe QDs are probably the most extensively investigated colloidal II-VI semiconductor nanoparticles because (i) their band gap can be tuned across the visible spectrum by variation of their diameters, and (ii) of the advances made in their preparation [16]. CdSe nanoparticles can be prepared by diverse methods such as co-precipitation, electrodeposition [17], pulsed sonoelectro chemical [18], solvothermal [19] and hot injection methods [20]. Various inorganic/organic capping agents have been used as a stabilizer for obtaining stable CdSe nanoparticles [21]. PVA capped CdSe NPs with the size within their quantum dot regime have been applied in the fabrication of LEDs, TFTs, solar cells etc [22]. In this work we report on a successful synthesis of ZnSe and CdSe by solid state reaction method and characterization such as powder XRD, FT-IR.

2. EXPERIMENTAL PROCEDURE

2.1 (A) SYNTHESIS OF CDSE NANOPARTICLES

Cadmium selenide is prepared in the solid state reaction method which is the easiest and inexpensive method. Compound of cadmium acetate dehydrate and selenium dioxide is taken 1:1 ratio. Cadmium acetate dehydrate of 7.9956 gm is dissolved in 100 ml of distilled water by constant stirring for half an hour in a magnetic stirrer. Similarly, selenide dioxide of 3.3288 gm is dissolved in 100 ml of distilled water by continuous stirring in the magnetic stirrer for half an hour. Now selenium dioxide is added to cadmium acetate dehydrate in drop wise at 50°C. The solution is mixed after completing the adding process is heated for an hour in magnetic stirrer 50°C. The solution is allowed to cool at room temperature then the sample get settle down at the bottom of the beaker. The precipitated is centrifuged and washed with distilled water 4-5 times, the sample is collected and dried at 80°C for one hour but after 30-40 mins, the substance change from white to chocolate brown substance. The substance is powdered in the mortarand pestle and is collected for characterization.

2.2 (b) Synthesis of ZnSe nanoparticles

The zinc selenide also was prepared in the same method as cadmium selenide by solid state reaction method but the precursors taken were selenium dioxide and zinc acetate dehydrate, both of this compound is taken in 1:1 ratio. Zinc acetate dehydrate of 6.5853 gm is dissolved in 100 ml of distilled water with constant stirring. Similarly selenide dioxide of 3.3288 gm is dissolved in 100 ml of distilled water and constantly stirred for half an hour in magnetic stirrer. Now selenium dioxide is added in drop wise at 50°C, after completing the adding process the solution is mixed thoroughly for an hour in magnetic stirrer at 50°C. The solution is allowed to cool at room temperature, the precipitate settle down at the bottom. The precipitate is centrifuged to 3-4 times, collected in a test tube and heated in the magnetic stirrer for an hour at 80°C, but the colour of the substance changes from white to light brown colour after 30-40 mins. The substance is powdered in the mortarand pestle and is collected for characterization.

3. RESULTS AND DISCUSSION

3.1 XRD analysis of CdSe and ZnSe nanoparticles

The XRD pattern provides the structure and phase purity of the synthesized samples CdSe and ZnSe nano particles. Fig.1 Shows the XRD patterns of CdSe nanoparticles. The maximum high intensity of the peak appeared at the position of (23.882). Cadmium selenide nano particles have the hexagonal structure with the lattice constant a= b= 4.299 A^o, c= 7.010 A^o which is in good agreement with the reported data [JCPDS-80-0008]. There are some peaks appeared due to

the impurities present in the as- synthesized sample. Fig.2 shows the XRD pattern of ZnSe nanoparticles. The zinc selenide nano particles appeared at the maximum high intensity of the peak (25.867) and also have a same hexagonal structure and different lattice constant of a= b= 3.974 A^o, and c = 6.506 A^o which is in good agreement with the reported data [JCPDS-15-0105]. The average particle sizes of the nanoparticles have been calculated by using Debye- scherer's formula

$D_{av}= K\lambda/\beta \cos\theta$

The average particle size was calculated as 52 nm for CdSe nanoparticles whereas 23 nm for ZnSe nanoparticles.

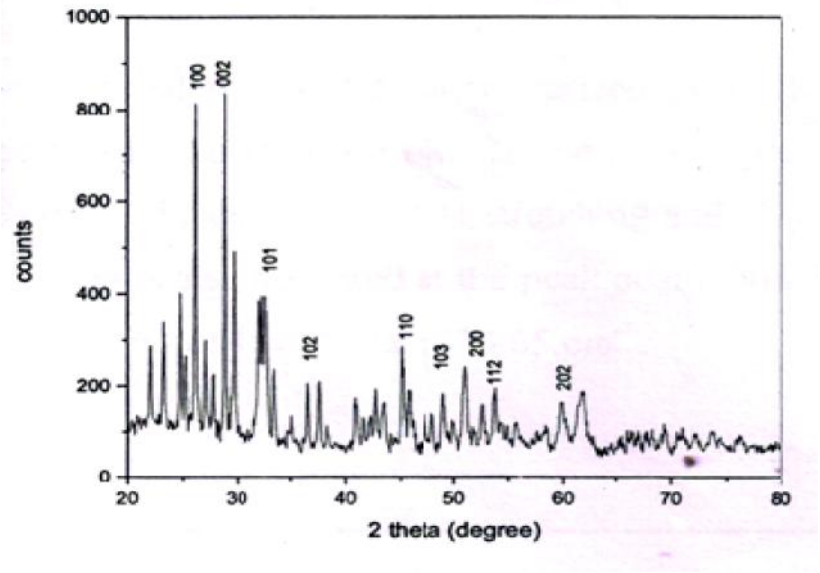

Figure 1- XRD pattern of CdSe nanoparticles

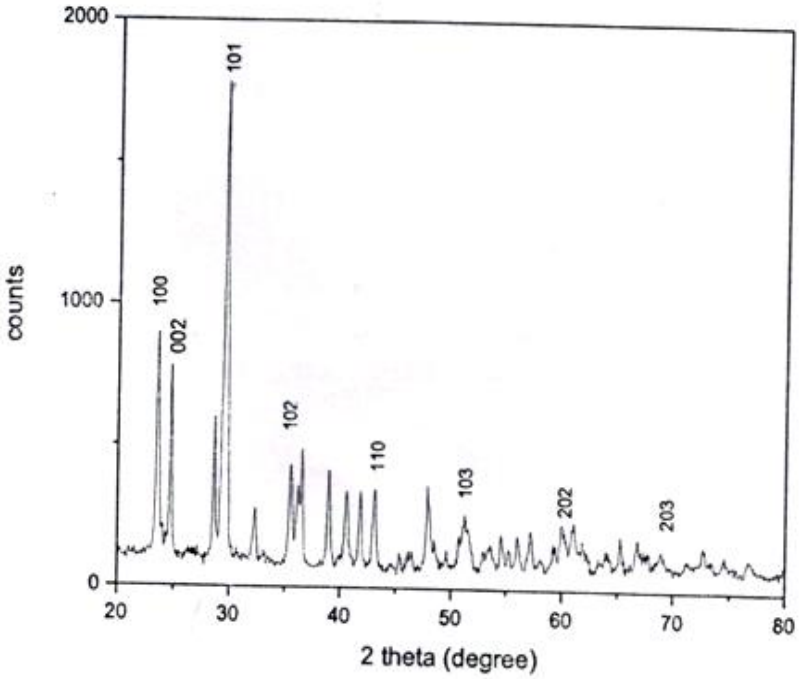

Figure 2- XRD pattern of ZnSe nanoparticles

3.2 FT-IR analysis for CdSe nanoparticles

The prepared sample was characterized by FT-IR analysis and the corresponding spectrum is shown in fig 3. The peak appears at 3697 cm^{-1} is OH-stretching, the peak 2755 cm^{-1} shows CH stretching and CH_2 asymmetric was stretching and S-H stretching is also appeared at the peak position in 2314 cm^{-1}. CH_2 wagging is seen in the peak 1605.84 cm^{-1} and 1414.65 cm^{-1}.

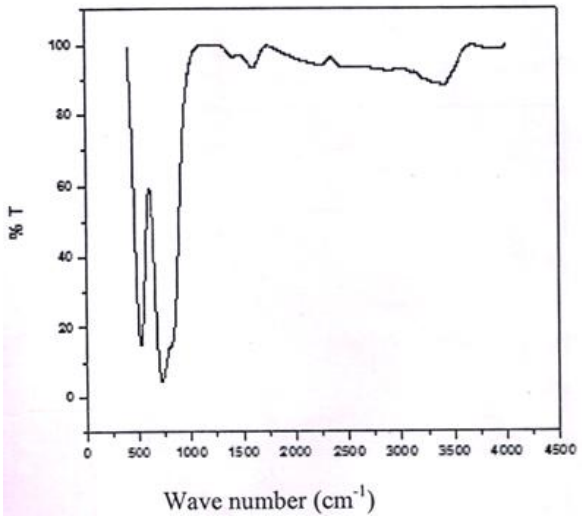

Figure 3- FT-IR spectrum of CdSe nanoparticles

3.3FT-IR analysis for ZnSe nanoparticles

The prepared sample was characterized by FT-IR analysis and the corresponding spectrum is shown in fig 4. The peak appears at 3697 cm^{-1} is OH-stretching, the peak 2755 cm^{-1} shows CH stretching and CH_2 asymmetric stretching. S-H stretching is shown in the peak 2314 cm^{-1}. CH_2 wagging is seen in the peak 1605.84 cm^{-1} and 1414.65 cm^{-1}. The H_2O stretching appears at the peak 496.74 cm^{-1}.

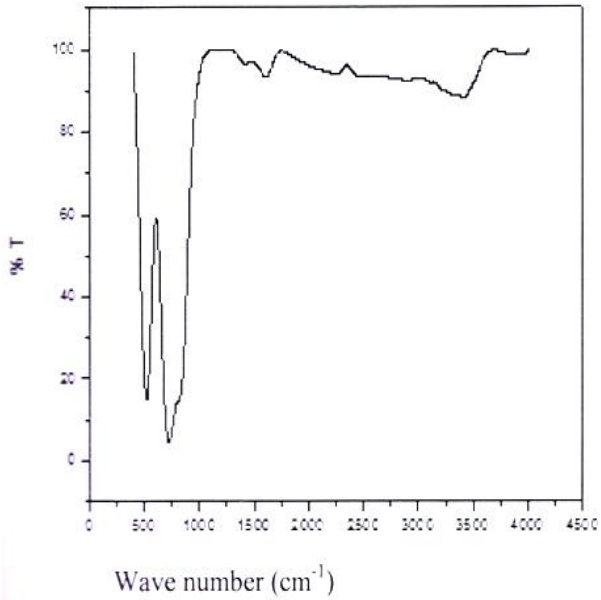

Figure 4- FT-IR spectrum ZnSe nanoparticles

CONCLUSIONS

Cadmium selenide and Zinc selenide nano particles have been synthesized by a simple and inexpensive solid state reaction method at 80°C. The prepared nanoparticles have been characterized using XRD, FTIR studies. The powder XRD confirmed the formation of Cadmium Selenide (CdSe) and Zinc Selenide (ZnSe) nanoparticles. XRD results showed that the obtained CdSe and ZnSe particles have hexagonal structure. The average particle sizes were calculated as 52 nm for CdSe nanoparticles and 23 nm for ZnSe nanoparticles. FTIR investigation showed the presence of OH, NH2 groups in the as-synthesized CdSe nanoparticles and the presence of CH, CH2, SH group in the as-synthesized ZnSe nanoparticles.

REFERENCES

[1]. Q. Peng, Y.J. Dong, Y.D Li, J. Angewandte Chemie, 42, (2003) 3027−3030.
[2]. G. Li, M. Nogami, J. Appl. Phys. 75 (1994) 4276.
[3]. V.J. Leppert, S.H. Risbud, M.J. Fendorf, Philos. Mag. Lett. 75 (1997) 29.
[4]. H.R. Heulings-iv, X.Y. Huang, J. Li, J. Nano Lett, 1 (2001) 521−525.
[5]. M.A. Malik, N. Revaprasadu, P.O. Brien, J. Chem Mater, 13 (2001) 913−920.
[6]. Y.W. Jun, J.E. Koo, J. Cheon, J. Chem Commun, 20 (2000) 1243−1244.
[7]. M.A. Hines, P.G. Sionnest, J Phys Chem B, 102 (1998) 3655−3657.
[8]. F.T. Quinlan, J. Kuther, W. Tremel, W. Knoll, S. Risbud, J. Langmuir, 16 (2000) 4049−4051.
[9]. Y. Hu, J. Chen, W. Chen, X. Lin, X. Li, J. Adv Mater, 15 (2003) 726−729.
[10]. J.J Zhu, S. Xu, H. Wang, J.M. Zhu, H.Y. Chen, J. Adv Mater, 15 (2003) 156−159.
[11]. J. Y. Lee, Y. S. Kang, International Journal of Nanoscience, 1 (2002) 501- 505.
[12]. B. Suo, X. Su, J. Wu, D. Chen, A. Wang, Z. Guo, Materials Chemistry and Physics, 119 (2010) 237-242.
[13]. Q. Peng, Y.J. Dong, Z.X. Deng, Y.D. Li, Inorg. Chem. 41 (2002) 5249.
[14]. L.H. Qu, X.G. Peng, J. Am. Chem. Soc., 124 (2002) 2049-2055.
[15]. D. Soundararajan, J.K. Yoon, International Journal of electrochemical science, 4 (2009)
1628 – 1637.
[16]. Y. Mastai, R. Polsky, Yu. Koltypin "Journal of American Chemical Society, 122 (1999) 10047-10052.
[17]. J. Singh, G. Singh Lotey, Digest Journal of Nanomaterials and Biostructures, 6
(2011) 1733-1740.
[18]. S. Mahajan, M. Rani, R. B. Dubey and J. Mahajan, International journal of Latest Research in Science and Technology, 2 (2013) 457-459.
[19]. Y.A. Kalandaragh, Optoelectronics and advanced materials . rapid communications, 4 (2010), 174-179.
[20]. S.A. Pawar, R. S. Devan, D. S. Patil, A. V. Moholkar, M. G. Gang, Y. Ma, J. H. Kim, P. S. Patil, Electrochimica Acta 98 (2013) 244-254.