Volume : 4 | Issue : 10 | Special Issue Oct- 2015 • ISSN No 2277 - 8179

Aerosol synthesis of CdS nanoparticles and their characterization

Physics

KEYWORDS: Nanoparticles, Sol-gel, XRD, Semiconductors

Vijay Kumar	School of Sciences in Physics, Jiwaji University, Gwalior (M.P.)
P.Rajaram	School of Sciences in Physics, Jiwaji University, Gwalior (M.P.)
Y.C. Goswami	School of Physical Sciences, Turari, ITM University, Gwalior (M.P.)

ABSTRACT

CdS nanoparticles were prepared by aerosol chemical route. Cadmium chloride, thiourea were used as precursor respectively. TEA was used as complexing agent. All the samples were characterized by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), photoluminescence (PL) and UV-Vis spectroscopy. XRD confirms the cubic (zinc blende) structure. FTIR shows the presence of chemical functional groups. PL and optical study shows the shifting in peaks to higher wavelength with increase the sulphar content. Due to quantum confinement, the red shift occurs. This method can be utilized in preparation of various nanoparticles due to its low cost and less time consumption.

INTRODUCTION

Semiconductor nanostructures are a great interest due to their unique physical, chemical and optical properties [1]. CdS is the most important material and widely used as a yellow pigment useful for wide range of applications in photovoltaics, catalysis, sensors, hybrid solar cells and in optoelectronic devices [2-5]. Broad research has focused on the synthesis of various CdS nanostructures. CdS is an II-VI chalcogenide semiconductor family and having a wide band gap (2.42eV) in bulk [6]. CdS is the most studied materials due to well-established relationship between the optical absorption and the size of the particle. Firstly research was focused in the improvement of the synthesis method. Researcher reported various methods to synthesize the CdS nanoparticles such that sol-gel, dip coating, chemical bath deposition, hydrothermal, microwave method and spray pyrolysis [7-12]. However very fine and uniform particles can be obtained using aerosol route.

In this paper we have reported the synthesis of CdS nanoparticles by aerosol route which is low cost, less time consumes and reduce the particle size in nanoscale level.

EXPERIMENTAL STUDIES

Cadmium chlorides dehydrate, Thiourea TEA chemicals were purchased from Fisher chemical pvt. Limited India. All the chemicals were used without further purifications. Cadmium chloride and thiourea were used for Cd and S precursors respectively. TEA was used as a complexing agent. 0.1M of Cadmum chloride mixed with various molar ratios of Thiourea (sample A: 0.1M and sample B: 0.2M), 10ml of TEA solution and 10ml of ammonia in a 100ml beaker. Solution was stirrered ultrasonically for 3hrs at 70oC temperature. Yellow particles were obtained. These particles were centrifuge at 500 r.p.m. for 10 minutes and washed with distilled water and acetone in several times. The particles placed in oven at 100oC temperature for 1hr.

Samples were characterized by XRD, FTIR, PL and UV-Vis spectroscopy. X-ray diffraction carried out by using Bruker D8 Advanced XRD 2 θ ranging from 20 to 70o at wavelength 1.5413 AO. FTIR carried out by using Perkin Elmer Spectrum 2 in the range from 4000-450 cm-1. PL and UV were recording by using Perkin Elmer λ - 25 and PL-55 in the range 200-900 nm.

RESULTS AND DISCUSSION

STRUCTURAL ANALYSIS

X-ray diffraction pattern of CdS nanoparticles are shown in figure 1. All the peaks are identified; (111) at 26.50, (200) at 320, (220) at 44.20 and (311) peaks at 52.270 respectively. These peaks matched with standard data of CdS [JCPDS- 89-0019] and shows cubic phase. Figure shows' broadening in peaks indicates particles size of CdS is reduced in nanorange.

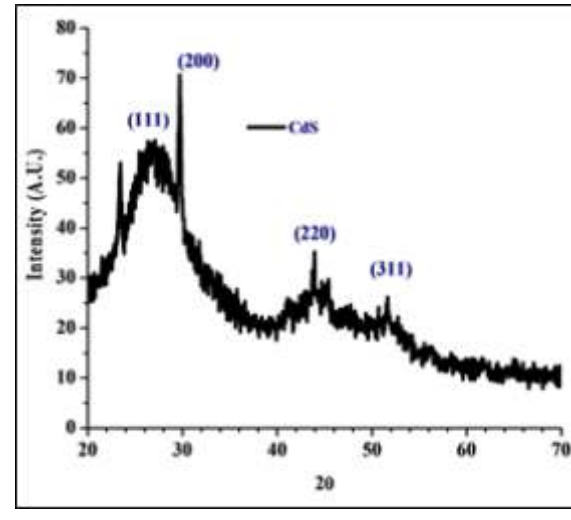


Figure: X-ray diffraction (XRD) pattern of CdS nanoparticles.

FTIR STUDIES

Figure 2 shows the Fourier transform infrared spectra of CdS nanoparticles and identifying the functional group present in the sample. A broad peak is observed at 3390cm-1 of O-H stretching due to

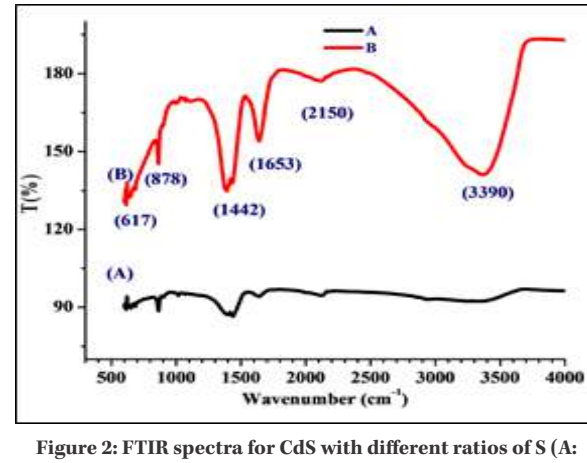


Figure 2: FTIR spectra for CdS with different ratios of S (A: 0.1M and B: 0.2M).

presence of moisture in the samples. A weak peak is observed at 1653 cm-1 due to O-H bending vibrations occurs. A strong peak is observed at 1442cm-1 in sample B as compared to sample A due to stretching vibrations of sulphate group. The peaks at 878cm-1 occurs corresponding to bending vibrations of C-H. The peak at 617 cm-1 is attributed to vibrations of Cd-S bond.

PHOTOLUMINISCENCE STUDIES

Photoluminescence (PL) spectra of CdS nanoparticles were obtained by aerosol route as shown in figure 3. Sample A shows the near band edge emission peak is observed at 464 nm (2.67eV). As the sulphar molar concentration is increase in sample B, the emission peak is shift to higher wavelength at 495 nm (2.50eV). It means the band gap decreases and shows red shift in the samples.

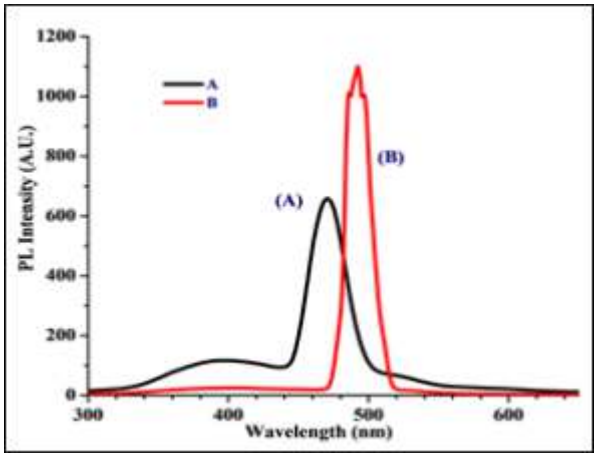


Figure 3: PL Spectra for CdS with different ratios of S (A: 0.1M and B: 0.2M).

OPTICAL STUDIES

Optical spectra of CdS nanoparticles were recorded by Perkin Elmer -25. Sample A shows the optical absorbance at wavelength 480 nm. With the increase of Sulphar content in sample B, the optical absorbance increases upto 500 nm. Therefore it shows that the band gap decreases with increase in sulphur content. Thus red shift is observed in the samples.

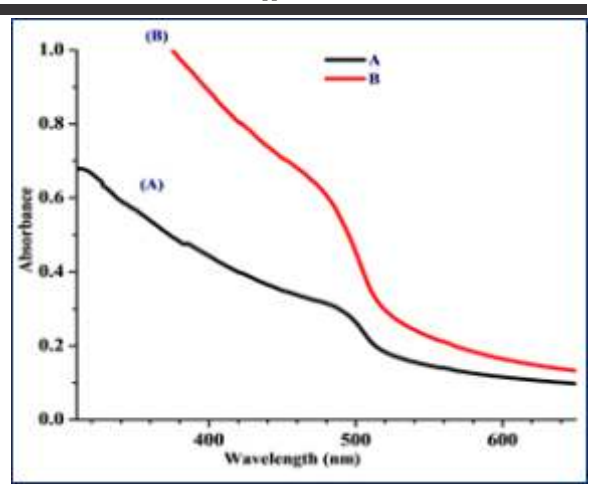


Figure 4: Optical spectra for CdS with different ratios of S (A: 0.1M and B: 0.2M).

CONCLUSIONS

In this paper, CdS nanoparticles were prepared by aerosol route. XRD shows the cubic phase of CdS nanoparticles. FTIR identified the presence of chemical functional groups in the samples of CdS nanoparticles. Shifting in peaks is observed due to increase in Sulphur content. Optical studies show the red shift in samples of CdS nanoparticles.

ACKNOWLEGEMENTS

Authors are thankful to Madhya Pradesh (M.P.) Council of Science & Technology (MPCST), Bhopal and AICTE for financial support.

REFERENCE

[1] Zhao, P. Q., Wu, X. L., Fan, J. Y. Chu, P. K., and Siu, G. G. (2006), "Enhanced and tunable blue luminescence from CdS nanocrystal–polymer composites." Scr. Mater. 55, 1123–1126.|[2] Guchhait, A., Rath, A. K., and Pal, A. J. (2009), "Hybrid core-shell nanoparticles: photo-inducced electron transfer for charge separation and solar cell applications", Chem Mater, 21: 5292-5299.|[3]Prabhu, R. R., and Khadar, M. A. (2005), "Characterization of chemically synthesized CdS nanoparticles", Indian Academy of Sciences, 65 (5), 801-807.|[4] Alonso, C. M., Marrero, H. J. C., Monroy, C. S. C., Arenas, M. C., Nicho, M. E., and Hu, H. (2015), "Solution synthesized CdS nanoparticles for hybrid solar cell applications", J Mater Sci: Mater Electron 26:5539–5545.|[5] Lavanya, T., and Jaya, N. V. (2011), "Synthesis and Characterization of Pure CdS Nanoparticles for Optoelectronic Applications", Transactions of the Indian Ceramic Society, 70(3), 119-123.|[6] Banerjee, R., Jayakrishnan, R., Banerjee, R. and Ayyub, P. (2000), "Effect of the size-induced structural transformation on the band gap in CdS nanoparticles", Journal of Physics: Condensed Matter, 12(50).|[7] Kumar, N., Purohit, L. P., and Goswami, Y. C., (2015), "Spin coating of highly luminescent Cu Doped CdS nanorods and their optical structural characterizations", Chalcogenide Letters, 12 (6), 333 – 338. |[8] Goswami, Y. C., Sharma, R., and Rajaram, P. (2011), "Growth of CdS nanostructures by new sol gel route and its optical characterization", Nanotechnology and Nanosciences, 2(1), 38-41.|[9] Kozhevnikova, N. S., Vorokh, A. S., and Uritskaya, A. A. (2015), "Cadmium sulfide nanoparticles prepared by chemical bath deposition", Russian Chemical Reviews 84 (3) 225 - 250.|[10] Jinxin, Z., Gaoling, Z., and Gaorong, H. (2007), "Preparation of CdS nanoparticles by hydrothermal method in micro emulsion", Frontiers of Chemistry in China, 2(1), 98-101. | [11] Choubey, S. K., and Tiwary, K. P. (2014), "Microwave assisted synthesis of CdS nanoparticles for structural and optical Characterization", International Journal of Innovative Research in Science, Engineering and Technology, ISSN: 2319-8753. | [12] Jamal, R. K., Hameed, M. A., and Zoba, W. A. (2013), "Study of Optical Properties (Linear and Nonlinear) and Structures for CdS Thin Film Preparation in Spray Pyrolysis Technique", International Journal of Engineering and Innovative Technology (IJEIT), 3(3), 409-412.