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A Comparative Study on the Properties of CdSe Nanoparticles Synthesized by Aqueous Method

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Abstract: Semiconductor nanocrystals have attracted considerable attention because of their unique size dependent properties and their versatility leads to numerous photonic applications such as solar cells, optical fibre amplifiers, color displays using light emitting diodes arrays, optical temperature probes and cellular imaging. In the present study, we have synthesized CdSe nanoparticles through a low cost, simple, green and aqueous based co-precipitation method and the same was treated under hydrothermal treatment. The experimental conditions and the properties of the as-synthesized CdSe nanoparticles prepared under co-precipitation and hydrothermal routes have been compared. The structural, morphological and optical properties of the CdSe nanoparticles were characterized by X-ray Diffraction (XRD), Transmission Electron Microscopy (TEM), Energy Dispersive X-ray Spectroscopy (EDS), and Ultraviolet-Visible Spectroscopy.
Keywords: CdSe nanoparticles, semiconductors, optical property, quantum confinement.

Introduction and Experimental:

Colloidal CdSe semiconductor nanocrystals have attracted tremendous attention recently in variety of applications as building blocks on nanoelectronics, nanooptronics, nano sensors, actuators and in biology [1]. CdSe being an n-type semiconductor exhibits a strong quantum confinement effect [2] and this effect causes the appearance of size dependent optical properties which makes them the prime candidate to be focused. CdSe semiconductor nanoparticles can be prepared through many synthetic methods. Till now, the most successful method of synthesizing II-VI semiconductors is the organometallic route which takes place at high temperatures using highly toxic chemicals [3]. To overcome this, chemically synthesized nanostructures and fabricating these kind of materials becomes the greatest challenge. The chemical synthesis has the advantages of producing size controlled, unagglomerated nanoparticles [4]. The tunability of the properties by controlling their size may provide an advantage in formulating new composite materials with optimized properties.

Keeping this in mind, in this work we have synthesized 3-mercaptopropionic acid capped CdSe nanoparticles with high efficiency which are soluble in water making them compatible with the biological systems through aqueous methods i.e co-precipitation method and hydrothermal method. The structural and optical properties of the as-synthesized nanoparticles have been compared and presented.

The typical synthesis procedure is as follows: In a 25 ml three necked flask, fresh NaHSe solution was prepared through a reduction reaction of Se powder and $NaBH_4$ in 10 ml of Millipore water. The air in the

system was then pumped off and replaced with argon atmosphere. The mixture was continuously stirred to obtain the Se source. For the Cd source solution, CdO and 3-MPA were dissolved in 60 ml of millipore water and the pH of the solution was adjusted to 9 by the drop-wise addition of 1.0 M NaOH. The Cd source solution was then added into the Se source solution in the three necked flask in the presence of argon atmosphere. The obtained solution was centrifuged to collect the precipitates and washed with methanol several times and dried in vacuum to obtain the sample A.

The same procedure as sample A was followed to synthesize sample B. But for the sample B, the solution was transferred into the Teflon-lined autoclave, sealed and hydrothermally treated. The precipitates were collected by centrifugation, washed with ethanol and dried in vacuum.

Results and Discussion:

Figure 1 shows the XRD patterns of 3-mercaptopropionic acid capped CdSe samples A and B prepared with slightly modified synthetic methods. The peaks are well broadened for both the samples which clearly depict the finite size of the synthesized CdSe nanoparticles. The three broad diffraction peaks for sample A and for sample B correspond to the (111), (220) and (311) planes which are assigned to the cubic structure of CdSe nanocrystals and observed data matches well with JCPDS No.19-0191 [5].

It is to be noticed for the sample B, that there a few additional peaks at 30.0º, 61.67º, which may be due to the presence of $Cd(OH)_2$ phase along with CdSe nanoparticles. Morover, the mean crystallite size of the CdSe nanocrystals of samples A and B were calculated employing Scherrer's equation and found to be 12 nm for sample A and 10 nm for sample B. Thus the above results confirm the formation of CdSe nanoparticles for both the samples with slight differences.

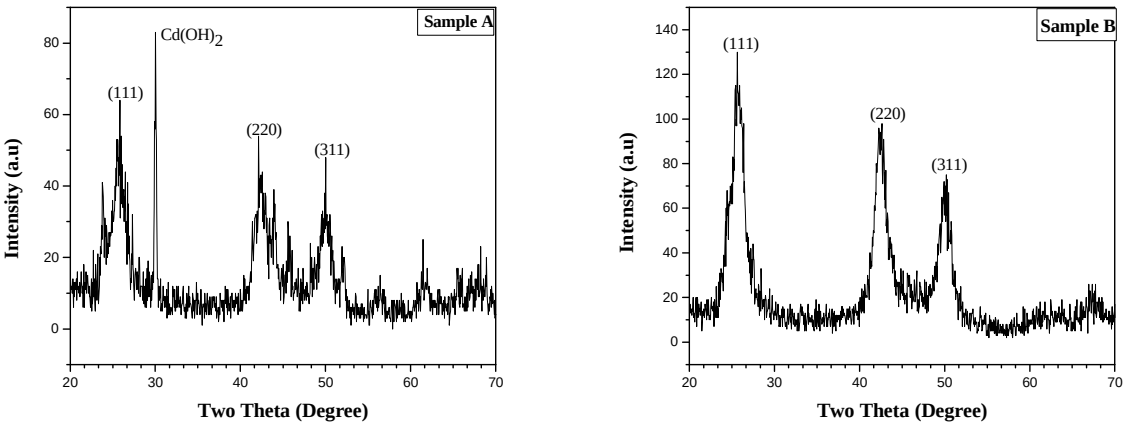

Figure 1 Powder XRD patterns of sample A and sample B

Typical TEM images of 3-MPA capped CdSe nanoparticle samples A and B are shown in Figure 2. The images depict the clear, spherically shaped, monodisperse and are of good quality nanoparticles with the slight tendency of agglomeration for those synthesized by hydrothermal method in comparison with co-precipitation method. The typical EDX spectra for the samples A and B in Figure 3 display that the samples synthesized by co-precipitation and hydrothermal methods are indeed composed of Cd and Se without the presence of any other elements. This result suggests the formation of CdSe nanoparticles with similar compositions from both the methods.

Figure 4 shows the absorption spectra of samples A and B. The UV-Visible spectra for the samples A and B exhibit a weak absorption shoulder at around 380 nm and 381nm and no other peaks were observed at higher wavelengths. From the obtained absorption peaks, the band gap of the samples A and B are calculated to be 3.26 eV and 3.25 eV that showed a strong blue shift of around 1.52 eV and 1.51 eV respectively for sample A and B from the standard bulk band gap (E_g = 1.74 eV) for CdSe semiconductor nanoparticles. Thus the result clearly reveals the strong quantum confinement of the synthesized CdSe nanoparticles and also signifies the smaller particle size.

In conclusion, CdSe nanoparticles with uniform size, morphology, good crystallinity and highlt efficient CdSe nanoparticles have been successfully synthesized by co-precipitation and hydrothermal methods.

Since the obtained nanoparticles are water soluble, they can have practical applications in biological systems and biomedical fields [6].

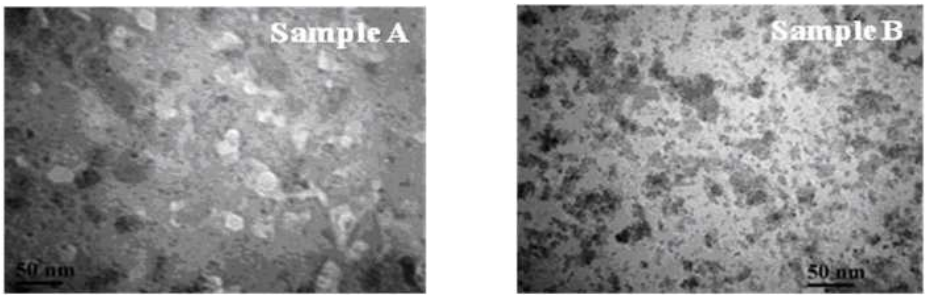

Figure 2 TEM images of sample A and sample B

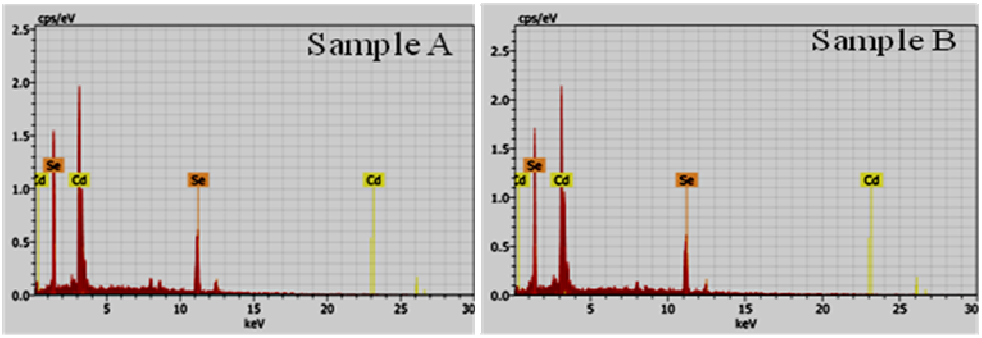

Figure 3 EDX spectrum of samples A and B

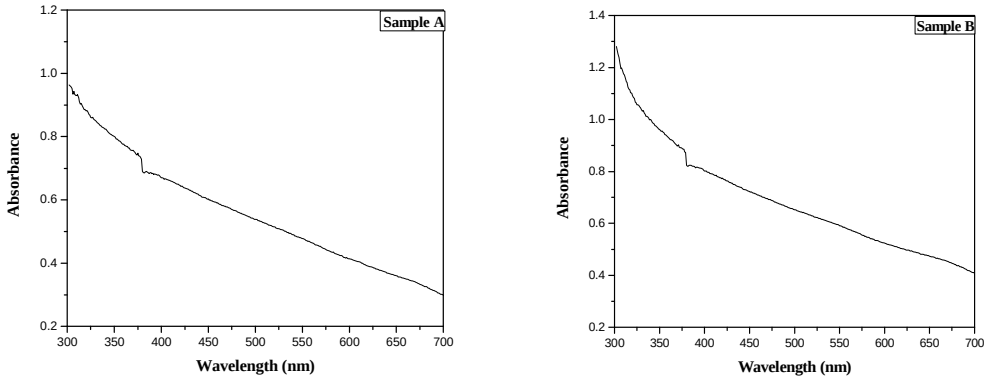

Figure 4 Absorption spectra of sample A and sample B

References:

1. Kumar P. and Singh K., Wurtzite ZnSe quantum dots: Synthesis, characterization and PL properties, J. Opt. Biomed. Mat., 2009, 1, 59-69.
2. Liu X., Ma C., Yan Y., Yao G., Tang Y., Huo P., Shi W. and Yan Y., Hydrothermal synthesis of CdSe quantum dots and their photocatalytic activity on degradation of Cefalexin, Ind. Eng. Chem. Res., 2013, 52, 15015-15023.
3. Silva O.F., Carvalho S.M., Mendonca R., Macedo W.A.A., Balzuweit K., Reiss P. and Schiavon A.M., Effect of surface ligands on the optical properties of aqueous soluble CdTe quantum dots, Nano. Res. Lett., 2012, 7, 536.
4. Sharma M., Kumar S. and Pandey O.P., Photo-physical and morphological studies of organically passivated core-shell ZnS nanoparticles, Dig. J. Nanomater. Bios., 2008, 3, 189-197.
5. Deng Z., Cao L., Tang F. and Zou B., A new route to zinc blende CdSe nanocrystals: Mechanism and Synthesis, J. Phys. Chem. B., 2005, 109, 16671-16675.
6. Ding Y., Sun H.B., Liu D., Liu F., Wang D. and Jiang Q., Water-soluble, high-quality ZnSe@ZnS core/shell structure nanocrystals, J. Chin. Adv. Mater. Soc., 2013, 1, 56-64.

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