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Synthesis and study of Cadmium sulphide nanoparticles from thiocomplexes

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Abstract

In the present work, A Cadmium complex of tetramethylthiuram monosulphide was used as single-source precursor for the generation of Cadmium sulphide nanoparticles using propylene glycol as high boiling solvent. Thus obtained nanoparticles exhibited spherical shape and gave optical absorption spectra and their photoluminescence showed an emission maximum that was characteristically red shifted in relation to the band edge. The X-ray diffraction (XRD) pattern showed that the materials were hexagonal.

Keywords: Nanoparticles, CdS, propylene glycol, tetramethylthiuram monosulphide.

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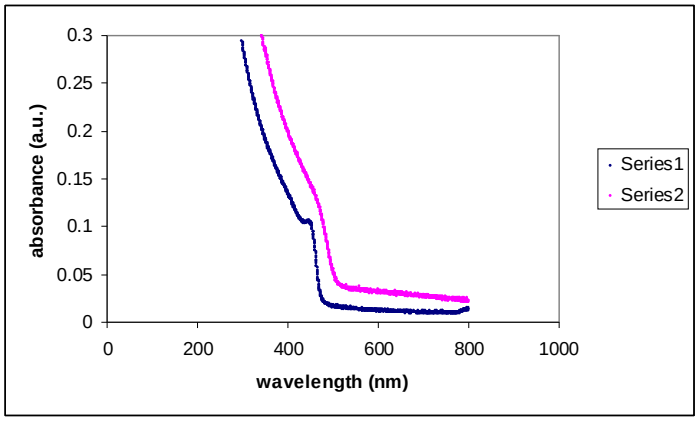
1.0 Introduction

Nanoparticles have dimension that measures 100 nanometers or less. Nanoparticles are used, or being evaluated for use, in many fields like in medicine, manufacturing and other fields for various purposes. Researchers have demonstrated that nanoparticles can be used for early diagnosis of infectious disease, nanoparticles that kills lymphoma cancer cells. Researchers are also investigating the use of bismuth nanoparticles to concentrate radiation used in radiation therapy to treat cancer tumors. A synthetic skin which may be used in prosthetics, has been demonstrated with both self healing capability and the ability to sense pressure and this material is a composite of nickel nanoparticles and a polymer. Researchers are also making attempt to use nanoparticles called nanotetrapods studded with nanoparticles of carbon to develop low cost electrodes for fuel cells [1]**.** Among various types of Nanoparticles, Cadmium sulphide nanoparticles are being exploited for various purposes. There are numerous applications for Cadmium sulphides nanoparticles like in photonic crystals, IR windows, and if doped with additional ions, as luminescent materials[2-5]. For these applications, highly crystalline particles are required. Many methods of preparation are available to obtain hightly crystalline nanoparticles which are either liquid-based or gas phase-based aimed at the attaining of these requirements[6-11]. Other methods which has proved its versatility in the preparation of nanoscale metal and oxide particles is the polyol method. In this method, a metal precursor is heated in a high boiling alcohol which has a boiling point around and above 200 ^{0}C. Due to the high temperature during the synthesis well crystallised materials are realized normally. The polyol medium efficiently complexes the surface of the particles and hence limits the particle growth and agglomeration of particles is prevented. This method is applicable for preparing chalcogenides also. Inspite of advantage of this methods, there are very few literature available in which this method is used for preparation of Cadmium sulphide nanlparticles. In the present work, an attempt has been done to prepare Cadmium sulphide nanoparticles by this method.

2.0 Materials and methods

Synthesis in Cadmium sulphide nanoparticles

A solution of Cadmium complex of tetramethylthiuram monosulphide in propylene glycol was injected into Propyleneglycol and kept at its boiling point and the mixture was kept at boiling temperature to yield colloidally stable suspensions of Cadmium sulphide. 1ml aliquots of samples were withdrawn after 5 minutes and 30 minutes respectively after reaching the anealing temperature.



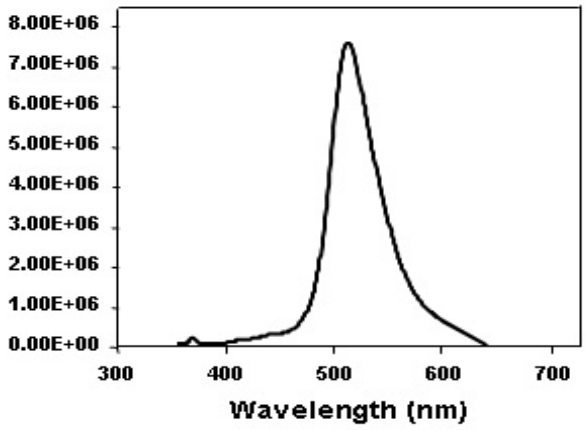
Series 1- t = 5 min
Series 2- t = 30 min

Figure-1: UV-Vis Spectra of CdS nanoparticles

Optical properties using UV-Vis and Photoluminescence spectra

The UV-Vis spectra of CdS samples suspended in toluene was recorded in transmission mode as solutions in toluene.

Figure- 2: PL Spectra of CdS nanoparticles

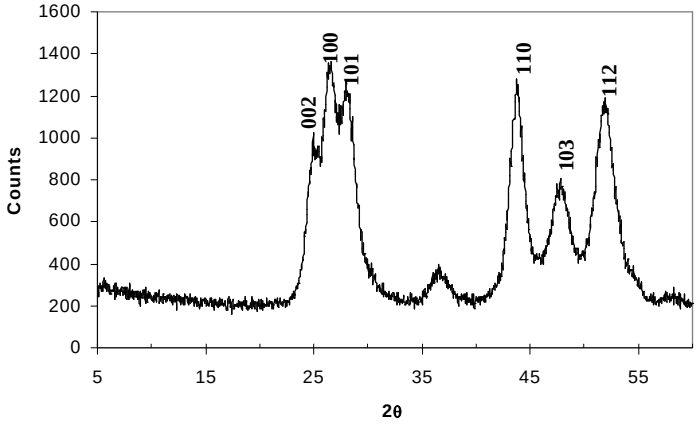


UV-Vis spectra of CdS samples was taken five minutes after reaching annealing temperature of two representative complexes and it is represented in Figure-1. Photo Luminescence Spectra of CdS prepared was also recorded and it is represented in Figure-2. It has a maxima around 515 nm. This red shift in relation to the adsorption band edge is generally observed in II-VI semiconductor nanoparticles [11-12]. Bulk CdS has a broad emission with a maximum in the 500-700 nm region of the luminescence spectrum.

Structural Characteristics using TEM and XRD

Structureal charterstics of prepared Cadmium sulphide nanoparticles was determined by TEM and XRD analysis. TEM and XRD data is given in Figure-3 and Figure-4.

Figure- 3: XRD Pattern of CdS nanoparticles

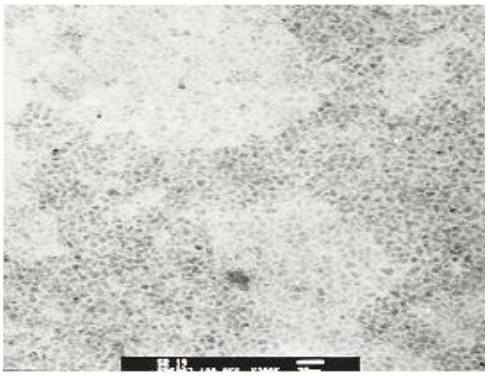


3.0 Results and discussion

For the bulk crystallites, it was usually observed that the interband absorption spectrum with a band edge around 515nm. In the present work, we observed a blue shift of absorption edge as is expected for nanoparticles. There was not much difference between samples taken at 5 minutes and 30 minutes showing the versatility of the method in arresting the growth to give monodisperse particles.Figure- 2 shows the Photo Luminescence Spectra of CdS prepared, It

has a maxima around 515 nm. This red shift in relation to the adsorption band edge is generally observed in II-VI semiconductor nanoparticles [11-12].

Figure-4: TEM image of CdS nanoparticles



Bulk CdS has a broad emission with a maximum in the 500-700 nm region of the luminescence spectrum. The broadness of the XRD peaks compared to those of the bulk CdS indicates that the particles are in the nanosize regime. The (110), (103) and (112) planes of wurtzite CdS were distinguishable in the diffraction pattern. Figure-3 shows the XRD pattern of the CdS sample prepared. Figure- 4 shows one of the TEM images of CdS particles prepared. The particles had a narrow size distribution with mean particle size around 4.7 nm thus confirming the formation of desired nanoparticles.

4.0 Conclusion

The present work showed that CdS nanocrystallites with a relatively narrow size distribution can be obtained by the thermolysis of cadmium complex of tetramethylthiuram monosulphide. TEM studies confirmed the formation of nanoparticles of Cadmium sulphide. X-ray diffraction studies revealed that the CdS nanocrystallites exist in the hexagonal phase. A blue shift was observed in the band shift in Optical absorption measurements indicating quantum confinement of the particles. Optical measurement of samples withdrawn from the reaction vessel at various time intervals after the injection of the precursors was used to monitor the growth of the particles with time. It is concluded that cadmium acetate complexes of tetramethylthiuram monosulphide can act as a good nanoprecurser when using ethyleneglycol as high boiling solvent in the polyol method

Acknowledgement

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