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Preparation of cds Nanoparticles Using Paraffin Oil

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Abstract: - A method produced to preparate the CdS Cadmium sulfer using the paraffin oil instade the Olyelamine acid since it is toxic solution. The optical properties were measured by using the absorption and photoluminescence spectrum where the energy gap is about 2.8 eV. The structure properties of the prepared nanoparticles was carried out by measuring the X-ray diffraction which show the hexagonal structure, while the dimension of the prepared nanoparticles was 11 nm calculated from Scherer formula. The morphology of the CdS nanopartcles was studied from the Atomic Force Microscope (AFM) and Scanning Electron Microscope (SEM).

Keywords: Cadmium Sulref, Semiconductor nanoparticles, paraffin oil.

I. INTRODUCTION

The development of new synthesis techniques for the production of semiconductor nanoparticle materials [1] has attracted the attention of a great number of experimental and theoretical groups not only due to the understanding of its fundamental aspects, but also to its importance in various technological applications, such as: Quantum dots [2], probes for irregular DNA structures [3], fluorescence probes in peptides detection [4].

II-VI Semiconductor nanoparticles are presently of great interest for their physical applications, Direct and wide band gap are potential candidates for applications in nonlinear optics and optoelectronics [5], Cadmium sulphide CdS is an important semiconductor and has many optoelectronic applications including solar cells, photodiodes, light emitting diodes, nonlinear optics and heterogeneous photo catalysis. [6] Varying the size of the particle changes the degree of confinement of the electrons and affects the electronic structure of the solid, in particular band edges, which are tunable with particle size.[7] CdS is one of the most studied materials because it has a well established relationship between the optical absorption and the size of the particle; the first investigations in this area were focused in the improvement of the synthesis method [4-6], while the other investigation has focused in the preparation of nanoparticles for applications in the biological field as molecular probes or bio labels. [7] Many synthetic methods have been employed to prepare CdS nanoparticles including solid state reaction, sol-gel process and microwave heating [8-10]. Moreover, preparation of CdS nanoparticles using solution growth techniques at high temperature possessing hexagonal wurtzite structure is still a great challenge among the researchers. In this work, we have synthesized CdS nanoparticles using a simple chemical reaction method using cadmium chloride and sulfur as precursors, with paraffin oil and oleic acid as complexing agent in the reaction.

II. EXPERIMENTAL WORK

Materials: cadmium chloride ($CdCl_2$), sulfur (S), Paraffin oil, and oleic acide.

Processes:

The chemical synthesis used to prepare the CdS nanoparticles come through two separated steps, first step is the preparation of the [S- paraffin oil] solution with concentration 0.1 M, 1 mmole of Sulfur(S) dissolved in 10ml of paraffin oil and the mixture was heated to 220°c with stirring till dissolution was complete and the color of the solution change from yellow to nearly brown, which indicate the S-Paraffin oil was formed. The second step is the preparation of Cd complex solution with concentration 0.1M , 2mmole of cadmium chloride dissolved in 20 ml of the solution of (Paraffin : Olic acide) , have volume ratio as 5:3 The mixture was heated to 160° c with stirring to get the complete dissolution of $CdCl_2$ in solution . The period for heating the mixture was about 1 hour to form the Cd complex solution.

The CdS nanoparticles growth:

The CdS nanoparticles synthesis was done by mixing the cadmium and sulfur with mole ratio 2:1, by mixing the S-Paraffin solution and Cd-Paraffin+Oleic acid complexe. The process reaction was about 6 hours using 3-neck flask with magnetic stirrer. The complexes of Cd solution heated to 220°c for 20 min with Argon gas flow through the solution, then the S-Paraffin solution injected gently with stirrer into the hot reaction mixture, the heat was held at 300°c .then the reaction mixture will cool down and adding to it large volume of absolute ethanol at room temperature to quench the reaction. Then a yellow precipitate formed means that the CdS nanoparticles were formed. The CdS nanoparticles colloidal then washed three times by ethanol and centrifuged, the last treatment is washing and centrifuged by toluene (fast process).the precipitate dried at room temperature to get CdS nanoparticles powder. To study the characteristics of the CdS nanoparticles we dissolved it in suitable dissolving agent as the Chloroforme to take the uv-vis spectrum of absorption and the PL spectrum. In order to study the structure of the CdS nanoparticles the XRD was used for this purpose.

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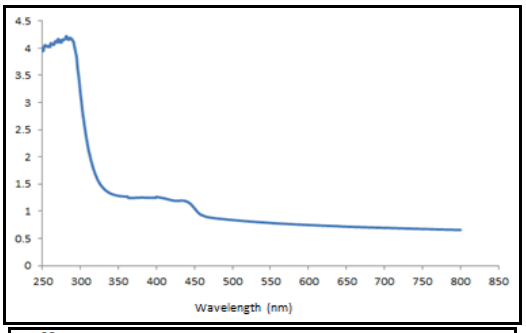
III. RESULT AND DISCUSTION

Cadmium sulfer nanoparticles were synthesized by the method mentioned perversely, the optical properties of the CdS nanoparticles have been measured by the UV-Vis spectroscopy and photoluminescence PL spectrum. The absorption spectrum shows peak at 436 nm as shown in Fig (1). The absorption spectrum show blue shifted relative to the peak absorption of bulk CdS indicating quantum size effect. The energy gap has been determined from photoluminescence PL spectrum of prepared CdS by using the equation:

$$E = 1240 / \lambda \quad \text{----------} \quad (1)$$

Which is equal (2.818) eV ,while the band gap of CdS nanoparticles on the basis of uv-vis spectrophotonic data is about (2.72) eV as shown in fig (3). Fig (2) represent the PL spectrum of CdS that excited with 300nm have luminescence peak at 452 nm .



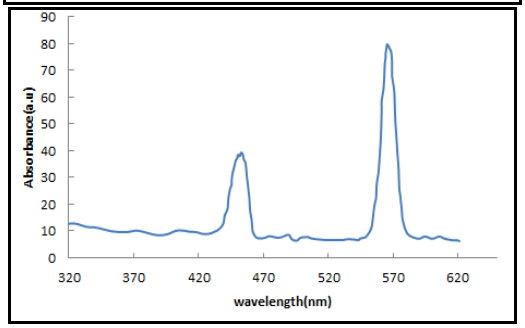


Fig (1) the absorption spectrum of CdS

Fig (2) PL spectrum of CdS

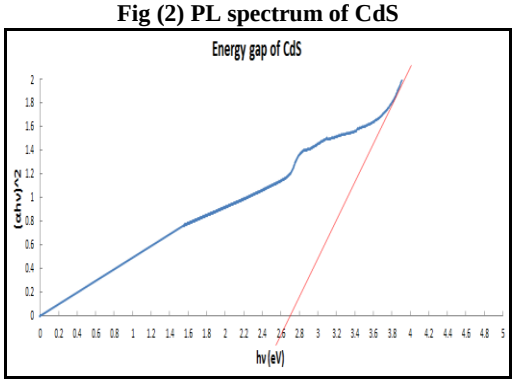


Fig (3) The band gap of CdS

The XRD patterns of the prepared CdS nanoparticles shows the presence of the diffraction peaks corresponding to the [100], [002], [101], [220] planes. All the peaks in the XRD pattern can be indexed as hexagonal wurtzite structure. Fig (4) shows the XRD of the prepared CdS nanoparticles. The average particle size of the CdS nanoparticles calculated from the Debye–Scherer formula is (11.62 nm).

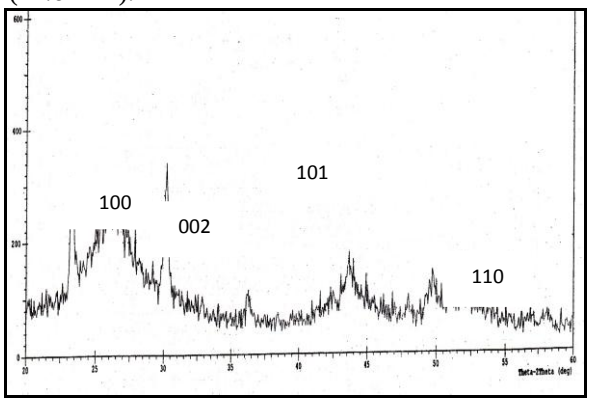
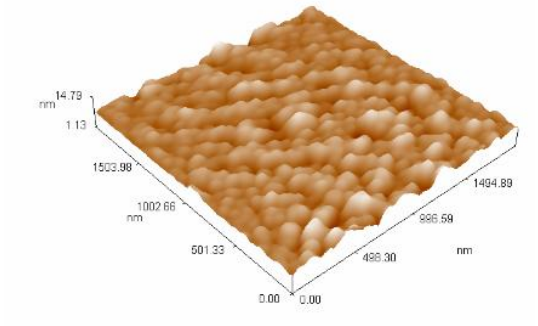


Fig (4) XRD for CdS nanoparticles

The morphology of CdS nanoparticles has been investigated using atomic force microscope AFM , it can be seen that spherical CdS nanoparticles in the form of nanoclusters in fig (5). The average diameter of the CdS nanoparticles was estimated from AFM was 77.52 nm .the SEM image is show the spherical nanoparticles of CdS with particle size about 20 nm. Fig (6) represents the SEM measurement of CdS nanoparticles.



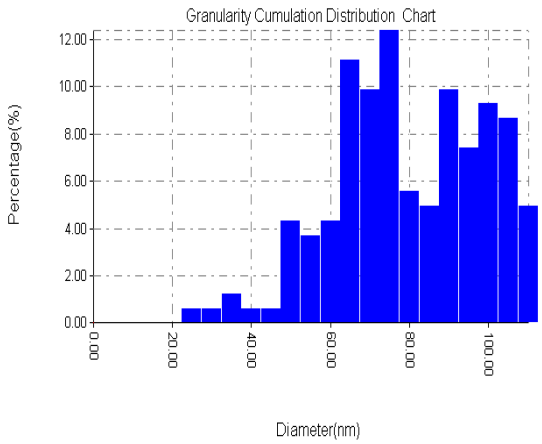


Fig (5) AFM Measurement for CDS Nanopartcles

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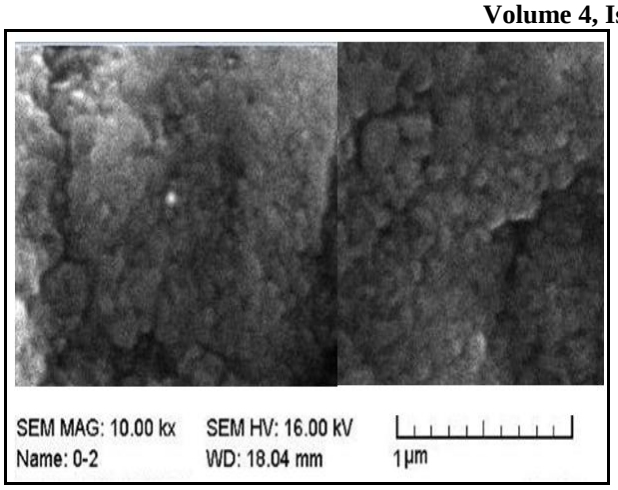

Fig (6) SEM image of CdS nanopartcles

IV. CONCLUSION

CdS nanoparticles have been prepared using this method exhibits nano size regime with a predominantly hexagonal phase. Optical absorption property of CdS nanoparticles showed a blue shift in their absorption band edge 436 nm from that of bulk at 517 nm, it is explained due to the quantum size effect of the CdS Nan clusters. X-ray diffraction analysis confirms the formation of hexagonal wurtzite structure of CdS with average grain size of 11 nm. AFM images depict the presence of spherical nanoparticles and pores in the sample. Thus, the present method is an efficient for the preparation of nano-crystalline CdS nanoparticles with excellent structural and optical properties which could find their applications in optoelectronic devices.

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