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Synthesis and Characterization of Cadmium Sulfide Nanoparticles

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Abstract

Cadmium sulfide is one of the most promising materials for solar cells and of great interest for their practical applications in up to electronics and photonics. The optical properties get modified due to the confinement of charge carrier within the nanoparticles. The physical and chemical properties of thus nano- particles are found to be size depended. In the present work describes synthesis and characterization of cadmium sulfide using chemical precipitation techniques. A pure nanostructure cadmium sulfide is synthesized at room temperature. The crystallite sizes (D_{hkl}) of cadmium sulfide crystals were estimated from the peaks of XRD. The optical properties of the samples were estimated by UV visible spectroscopy. The absorption spectrum were studied FTIR. Scanning Electron Microscopy (SEM) is used to carry out the structural characterization of the nanoparticles.

Keywords: *Nanoparticles, XRD, UV, FTIR, SEM*

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I. Introductio

The cadmium sulfide is an important II-IV group element semiconductor (Eg=2.42eV (515nm) at room temperature) with many excellent physical and chemical properties. This has promising application in multiple technical fields including photochemical catalysis, gas sensor, detectors for laser and infrared. Cadmium sulfide is a solid hexagonal or cubic crystal. Cadmium sulfide is an important n-type semiconductor with a direct band gap 2.42eV., the photoconduction and electroluminescent properties of cadmium sulfide have been applied in manufacturing a verity of consumer goods.

II. Experimental:

Synthesis of cadmium sulfide nanoparticles:

$CdSo_4$.2.5 H_2O dissolved in one liter of deionized water to a concentration of 2mM. This solution was placed in a reaction vessel. Under stirring (300 rpm) for three hours. Ammonium sulfide (30 con.) was rapidly added under ambient conditions to form CdS nanoparticles the precipitates obtained were washed several times using acetone and distilled water to remove the impurities. Finally wet precipitate was dried in hot air oven at 50^0 centigrade for 24 hours.

III. Characterization:

X-ray diffraction:

The phase composition of the nanoparticles determined by using X-ray diffractometer using copper K_α radiation. No other peaks were observed indicating the preparation of phase pure cubic powders.

The crystallite size (D_{hkl}) of cadmium sulfide crystal was estimated using Debye Scherer equations.

$$D_{hkl} = k\lambda / \beta \cos\theta$$

Were λ is the wavelength of Cu K_α radiation (λ=1.5406 A^0)
β Is the full width and half maximum intensity,
θ is the diffraction angle (in radian) of consider diffraction peak, and K is the shape factor constant taken as 0.90 for the almost spherical particles.

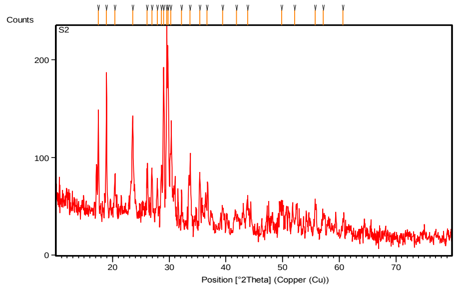

Fig (1)

The XRD pattern exhibit prominent broad peaks at 2θ values of 29.733, 49.72 and 51.83.These results are in agreement with (111),(220)and (311) plans. The intensity of the (111) is much higher than that of (220).

The following reaction has been absorbed for the preparation of cadmium sulfide nanoparticles.

$CdSo_4 + Na_2S \longrightarrow CdS + Na_2So_4$

IV. Uv:

The absorption of ultra violet or visible radiation results from excitation of bonding electrons as a consequence, the wavelength of absorption peaks can be correlated with the type of bonds in the species hence UV visible absorption spectroscopy is an efficiencies techniques to monitor the optical properties of quantum size particles.

The absorption spectrum of the nanoparticles of cadmium sulfide shown in fig.

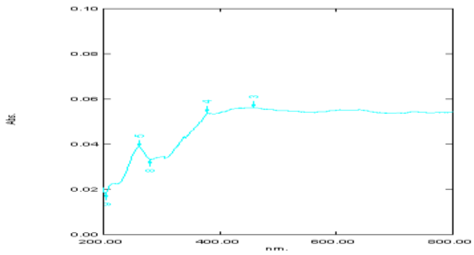

Fig (2)

The spectrum exhibits a well defined absorption peak at 458 nm. Which is considerably blue shifted related to the peak absorption of the bulk cadmium sulfide indicating quantum size effect. The well defined maximum at 458nm assign to the optical transition of the first exitanonic state.

V. Ftir

The functional groups present in the as – synthesized materials are identified by FTIR analysis.

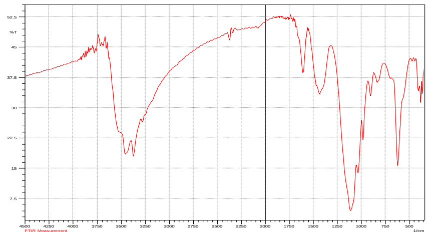

Fig (3)

Fig 3 shows the irrational spectra in the spectral range of wavelength 500 to 4500 cm^{-1}

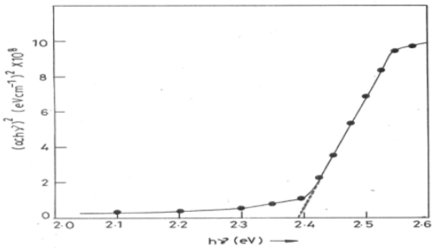

Fig (4)

Fig (4) shows the $(\alpha h\nu)^2$ vs hν

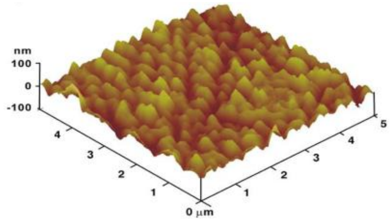

Fig (5)

Fig (5) shows the atomic force micrograph of the CdS nanoparticles prepared at room temperature.

VI. Conclusion:

We prepared Cadmium Sulfide nanoparticles by precipitation method the resulted samples were analyzed by XRD, UV, FTIR, AFM techniques. The Cadmium sulfide was obtained as uniform, fine and spherical particles. The mean diameters are calculated using Debye-Scherer equation. The electron spectra of CdS samples can be correlated with the mean diameter of the particles

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