

# Synthesis and Characterization of Cds Nanoparticle

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**Abstract** - Cadmiumsulfide nanoparticles by using aqueous precipitation method is simple,fast and can developed at room temperature.The obtained particles were characterized using XRD (X-ray diffraction study),SEM(scanning electron microscopy), FTIR (Fourier Transform infrared Spectroscopy) and spectroscopic techniques. Cadmiumsulfide nanoparticles are good adsorbent.When CdS nanoparticles were dispersed in the solution as single entities,showed very good resistance against oxidation for months,according to their polymer shell.

**Keywords:** Cds; nanocomposites; semiconductors.

## INTRODUCTION

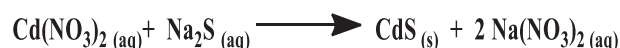
The term 'nano' is derived from Greek word "nano" which mean very small or dwarf. One nanometer is equal to one-billionth of a meter,  $10^{-9}$  m [1].The term nanostructure condensed matter structure having a minimum dimension approximately between 1nm ( $10\text{\AA}$ ) to 100nm ( $1000\text{\AA}$ ). Nanoscience is the study of phenomenon and manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale. Nanotechnology is the design, characterization, production and application of structures, devices and systems by controlling shape and size at nanometer scale [2]. Due to their small size, these particles exhibit properties remarkably different from their bulk counterparts of identical chemical composition. Nanocrystalline semiconductor metal oxide have been caught much special attention in materials research and more concentrated research is now on-going in the field of synthesis, characterization and applications of nanoparticles and nanocomposites. CdS nanoparticles have been getting much more attention compared to other in recent years in accordance with their remarkable electrical, optical and surface properties. Cadmium sulfide is a chemical compound that has the formula CdS. It is yellow in color and is a semiconductor of electricity. It exists as two different polymorphs, hexagonal greenockite and cubic hawleyite. The main applications of Cadmium Sulfide is as a pigment. Cadmium Sulfide is also used in the production of solar cells where it is used as a buffer layer in the manufacture of CIGS (Copper -Indium-Gallium-Selenide) solar cells.

## Properties of Cadmium Sulfide

Property	Value
Physical state and appearance	Solid. (Solid powder.)
Molecular Weight	144.46 g/mole
Color	Yellow or brown
Melting Point	Sublimes. ( $980^{\circ}\text{C}$ or $1796^{\circ}\text{F}$ )
Specific Gravity	4.82 g/cm <sup>3</sup>
Solubility	Insoluble in hot and cold water

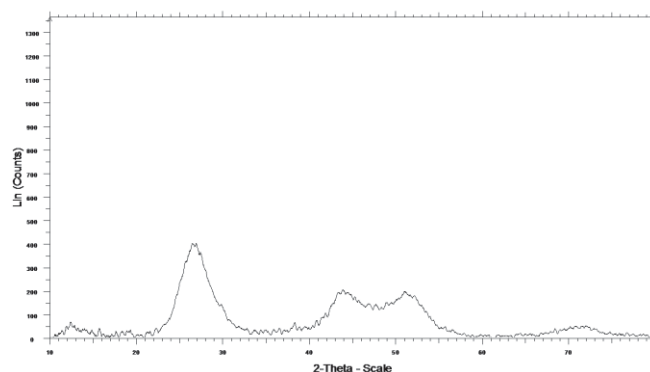
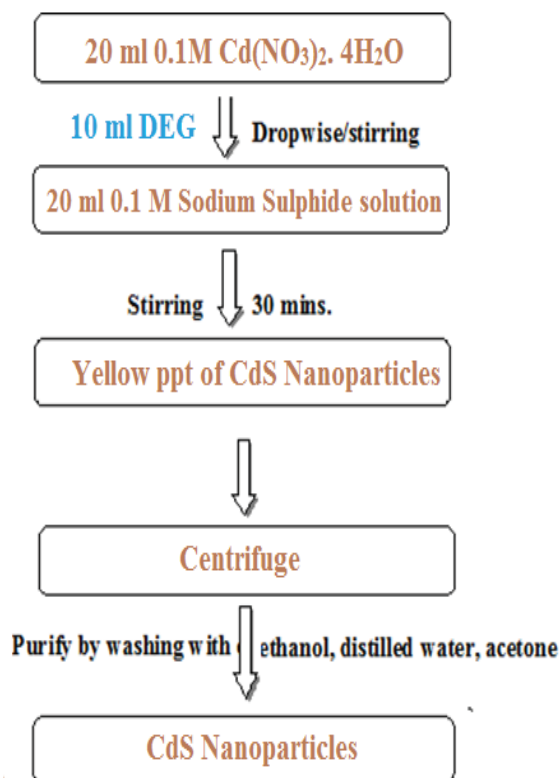
## 3. SYNTHESIS OF CADMIUM SULFIDE NANOPARTICLES:

Cadmium Sulfide (CdS) nanoparticles were synthesized using a simple and inexpensive aqueous precipitation method of Cadmium Nitrate and Sodium sulfide and particles size protected by Diethylene Glycol. Synthesis of Cadmium Sulfide nanoparticles is fairly simple as this compound, like most other Sulfides, is insoluble in an aqueous solution. So, mixing aqueous solutions of Cadmium Nitrate and Sodium Sulfide results in a Metathesis Reaction in which the product precipitates in bulk crystalline form. The size of nanoparticles effectively control by adding small amount of protecting agent such as Diethylene Glycol.



## METHODOLOGY:

20 ml 0.1M Cadmium nitrate tetrahydrate solution ( $\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ ) was taken in conical flask. Around 10 ml of Diethylene Glycol (DEG) was added to Cadmium nitrate tetrahydrate solution under constant stirring. After 5minutes, 20 ml sodium sulphide solution were added drop wise under constant stirring, reaction was kept for 3 hrs. at constant stirring and yellow precipitate of CdS formed, washed with ethanol and acetone and dried at room temperature (31).



XRD spectra of cadmium sulphide nanoparticles

The surface morphological of synthesized cadmium sulphide nanoparticles examined by scanning electron microscopy. The SEM images of the cadmium sulphide nanoparticles were shown in Figure. It can be seen that there is a collection of irregular particles and which were agglomerated randomly. Size of the particles in this sample was found to be very large. But the cadmium sulphide nanoparticles synthesized by aqueous precipitation method showed the existence of more spherical particles with some tiny alterations. Many of the particle size were falling in the size range of 30-50 nm, which is in high correlation with XRD data.

#### CHARACTERISATION

The XRD analysis in this work was performed on a Rigaku D/max 2500 diffractometer, using Cu K $\alpha$  ( $\lambda=1.542\text{\AA}$ ) with an accelerating voltage of 40 KV. Powder morphology and nanoparticle size were characterized by scanning electron microscopy (SEM) on JEOL, JSM 7500f microscope. The infrared absorption spectra, was recorded by FT-IR Spectrometer (Bruker). The CdS films were analysed by UV-VIS spectrophotometer (shimadzu UV 240) in the range between 350-600 nm.

#### RESULT AND DISCUSSION

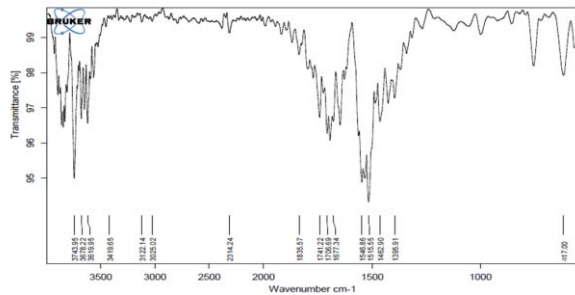
The XRD spectra of Cadmium sulphide nanoparticles are as shown in Figure. All the diffraction patterns were directly indexed to the cubic structure of CdS nanoparticles which was further confirmed by comparing with JCPDS file of Cadmium sulphide nanoparticles (JCPDS no: 10-454). No other peaks were identified in the XRD plot, indicating the phase purity of the as-prepared samples. High crystallinity was observed for both samples as evident from the high intensity of the diffraction peaks. The calculated crystalline size was found to be 30 nm determined by using Debye-Scherrer formula method. Generally, CdS may crystallize in cubic (space group F43m; lattice parameters  $a = 5.818 \text{\AA}$  at 25 °C; PDF card no. 10-454) or hexagonal form (space group P6<sub>3</sub>mc; lattice parameters  $a = 4.136 \text{\AA}$ ,  $c = 6.713 \text{\AA}$  at 25 °C; PDF card no. 6-314). The recorded XRD pattern, shown in Figure, can be assigned to a CdS phase of cubic structure (C).



SEM image of Cadmium Sulphide nanoparticles

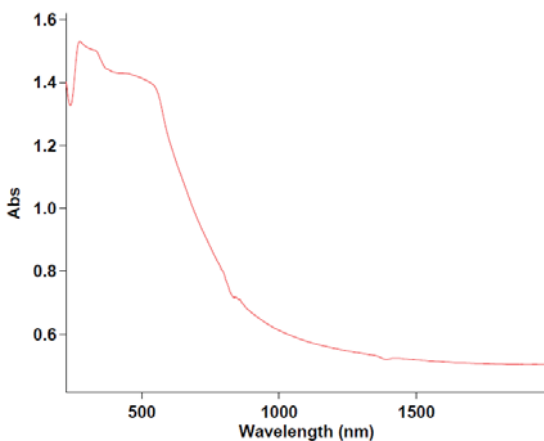
The FTIR is used to study the purity and composition of the synthesized products. It is used to determine the functional groups and types of bonds present in the system. The dried CdS nanoparticles mixed with KBr were characterized with FTIR. The FTIR spectra could be explained by various peaks (Figure 10) obtained by the sample. Table 1 contains the explanation of the peaks obtained by all the synthesized CdS nanoparticles[29]. The absorption peak in the range of 3600-3100 $\text{cm}^{-1}$  could be attributed to the -OH group of water adsorbed by the samples. The weak absorption band at 1635 $\text{cm}^{-1}$  was assigned to CO<sub>2</sub> adsorbed on the surface of the particles. In fact, adsorption of water and CO<sub>2</sub> are common for all powdered samples exposed to atmosphere and are even more pronounced in case of nano sized particles with high surface area. Small peak near 400-470 $\text{cm}^{-1}$  indicated the formation of CdS nanoparticles as this region was assigned to metal-sulphur (M-S) bond. The peak at 405 $\text{cm}^{-1}$  corresponded

to the characteristic peak of CdS. FTIR assignment of CdS nanoparticle.



FTIR spectra of cadmium sulphide nanoparticles

The UV-Visible absorption spectrum of the cadmium sulphide nanoparticles are as shown in Figure. The optical properties of cadmium sulphide nanoparticles reflected on the UV-visible spectral data in the region of 371–396 nm wavelengths with a red shift of absorption wavelength. The results in this study are in good agreement with previous researches [30]. A strong absorption in the UV region was observed at wavelength about 345 nm which was fairly blue shifted from the absorption edge of bulk size Cadmium sulphide.



UV-Visible spectra of cadmium sulfide nanoparticles

#### CONCLUSION:

In conclusion, Cadmium sulfide nanoparticles were synthesized by aqueous precipitation method. The synthesized nanoparticles were characterized by various spectroscopic, microscopic and thermal techniques like XRD (X-ray diffraction analysis), SEM (scanning electron microscopy), FTIR (Fourier transformer Infra-red microscopy) and UV Visible spectroscopy.

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