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L-Ascorbic Acid Influenced Structural and Optical Properties of CdS Nanoparticles Synthesized Via Co-Precipitation Technique

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Abstract: *L-Ascorbic acid doped CdS nanoparticles were synthesized using the co-precipitation method. Dopant ion impacts on the structural, morphological, and optical characteristics of CdS have been studied. XRD analysis demonstrates the substitution of ions by doping. The study recommends that the samples be utilized in high-efficiency UV light-emitting devices due to the more substantial UV peaks than the weaker visible ones. The particle size of synthesized nanoparticles was determined using particle size analysis.*

***Index Terms* -** *Nanoparticles, L-Ascorbic acid, Cadmium sulfide nanoparticles, XRD, Optical Properties*

1. INTRODUCTION

Nanotechnology is now considered one of the most important technologies of the twenty-first century. It has several applications in nanoelectronics, nanobiotechnology, nanomedicine and health care, cosmetics, material science, developed-country economic growth plans, and many other fields. Nanometer-sized semiconductor particles are a type of material that resides between molecules and solids. Because of their intriguing unique properties, research on quantum scale semiconductor particles has increased significantly during the last two decades [1-4]. The ability of semiconductor nanoparticles to change color as they expand in size is one of their most enticing qualities. Controlling and increasing the luminescence properties of quantum dots has been a major focus of nanoparticle production. Practical applications of II-VI semiconductor nanoparticles, such as zero-dimensional quantum confined materials, optoelectronics, and photonics, are becoming increasingly popular. Several papers have been published in the literature on synthetic procedures and potential applications of nano-sized semiconductor particles [5-9]. Colloidal methods can be used to produce semiconductor nanocrystals that are soluble in organic solvents and have a narrow size distribution. Surface chemistry is a potent tool for organizing and immobilizing nanocrystals, as well as successfully changing their emission properties. Manipulation of the generated nanocrystals is also possible by appropriate surface modification with capping agents, allowing them to be compatible with almost any chemical environment and soluble in organic solvents. Large-scale production of semiconductor nanoparticles, such as solid powder, is critical not only for understanding their physical properties, but also for practical applications in catalysis, photocatalysis, and microelectronics. Recent improvements in the chemical manufacture of monodispersed II-VI semiconductor nanoparticles on a gram scale [10, 11] have shown the method's usefulness. Cadmium sulfide is an important semiconductor with a variety of optoelectronic applications including solar cells, photodiodes, light-emitting diodes, nonlinear optics, and heterogeneous photocatalysis. In this study, we employed a chemical precipitation method to generate CdS nanoparticles. The particles are described using XRD, UV-visible, and particle size analysis. Cadmium chalcogenides are intensively researched materials [12, 13] due to their well-known relationship between optical absorbance and size, among other fascinating properties. Cadmium sulfide could be used as a bioorganic detector [14] for proteins [15] or DNA [16, 17]. We can make core/shell nanoparticles with enhanced luminescence using cadmium sulfide and an appropriate surface modification [18, 19].

2. EXPERIMENTAL

2.1 MATERIALS AND CHARACTERIZATION

For a synthesis, analytical grade purity Cadmium Chloride ($CdCl_2$ 99% Purity), Sodium Sulphate (Na_2S), and L- Ascorbic acid were utilized. The co-precipitation approach was used to synthesis $CdCl_2+Na_2S=CdS+2NaCl$. Cadmium Chloride and sodium Sulphate were utilized as precursors in the synthesis, which was carried out in double distilled water mixed solvent. X-ray diffractometer (XRD) (Mini Flex II, Rigaku, Japan) with CuKα radiations of wavelength 1.5406 Å was used to study the structural properties. Ultra-violet-visible (UV-vis) portable spectrophotometer BLACK-Comet-SR (Stellar Net, USA) was used to explore the optical properties.

2.2 SYNTHESIS OF CDS AND L- ASCORBIC ACID DOPED NANOPARTICLES

For the synthesis of CdS nanoparticles, in 100 ml of double distilled water, 0.2 M of cadmium chloride (1.8322 grams) was dissolved. The sample was gently settled down and the solvent was withdrawn when an equimolar solution of sodium sulfate (0.7804 gram) was added drop by drop to the solution of cadmium chloride under continuous stirring. To eliminate contaminants, the precipitate was washed twice or three times with double distilled water. Finally, it was dried at 100 °C for 3 hours. The CdS nanoparticles were doped in various quantities. In an air atmosphere, 1.3 wt% L-ascorbic acid was produced in distilled water. 0.2

M of cadmium chloride (1.8322 gm) was dissolved in 50 ml of double distilled water and 0.2M of sodium sulphate (0.7804 gm) in 50 ml of distilled water were added drop by drop to the solution of $CdCl_2$ under continuous stirring, then 1wt% of L -ascorbic acid (0.035224 gm) was added to the above solution and stirred until the homogeneous. The process was performed with a different concentration of 3% L-ascorbic acid (0.105672 gramme) doping.

3. RESULT AND DISCUSSION

3.1 STRUCTURAL PROPERTIES (XRD)

Fig. 1 depicts the powder XRD patterns of CdS and doped 1,3 wt.% of L-Ascorbic acid CdS nanoparticles obtained using X-ray diffractometer. The particle size of these nanoparticles was calculated using the Debye-Scherrer formula.

$$D = K\lambda / \beta\cos\theta \text{ -------------- (1)}$$

Where, is the X-ray length, is the angle of reflection, and B is the entire breadth of half maximum. The X-Ray diffraction patterns of L-Ascorbic acid doped CdS nanoparticles were recorded on an X-Ray diffractometer, and the data was analyzed with powder X software. It is obvious from the XRD patterns that the produced CdS particles are nano size. As confining from the entire width at half Maxima, the surface is high. The determined average size is 10 nm.

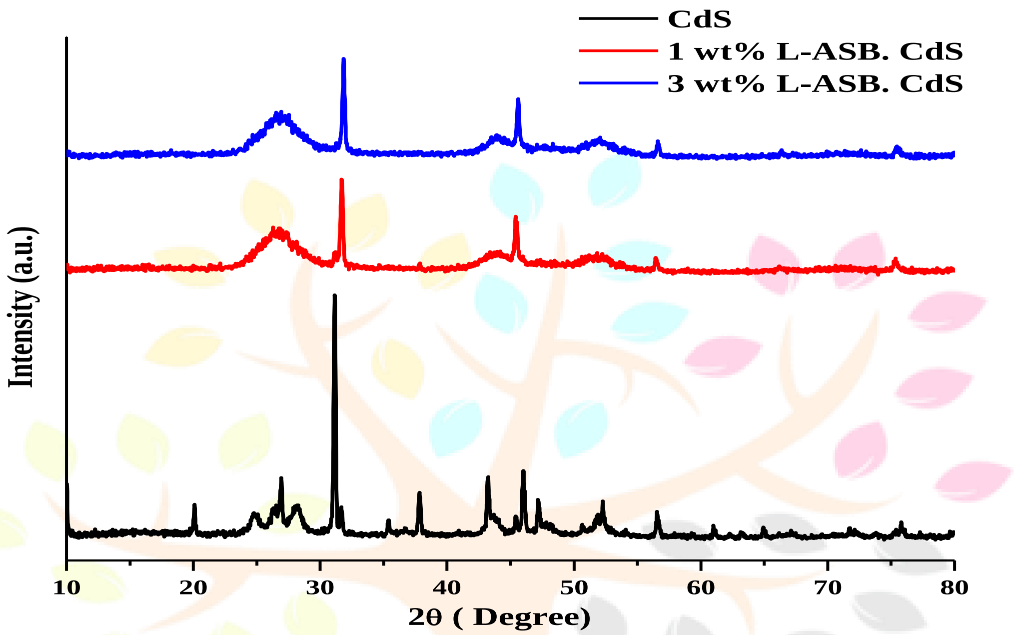

Fig.1 Powder XRD pattern of nanoparticles of CdS

3.2 UV- Vis. study

Fig.2 depicts the UV-visible spectrum of CdS nanoparticles. The acute sharpness of the absorption edge can be ascribed to the particle size dispersion being relatively tiny. The absorption edge of raw CdS is about 515 nm (2.43 eV), while the absorption peak location in processed samples is around 300-320 nm. A UV visible spectrometer was used to evaluate the synthesized liquid Model –Black –Comet-SR 50, Steller net Inc USA spectral range 190-1083 nm. The UV-Vis. spectra of pure and L-ascorbic acid doped (fig.3) show that the transparency of rises with increasing concentrations of 1, 3 wt% L-ascorbic acid.

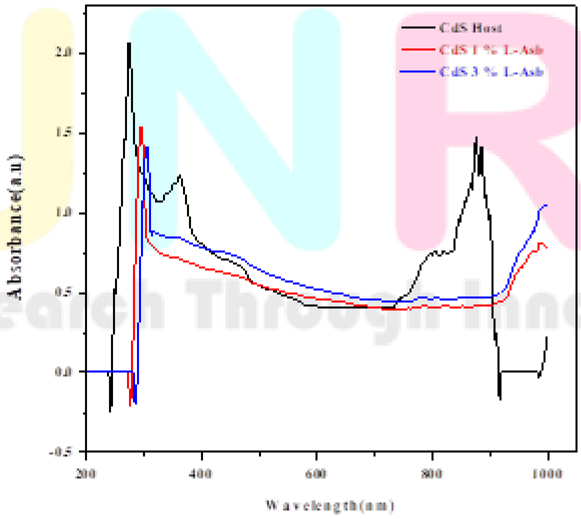

Fig.2 UV-visible absorbance spectra of CdS nanoparticles and doping with 1, 3 wt % of L Ascorbic Acid

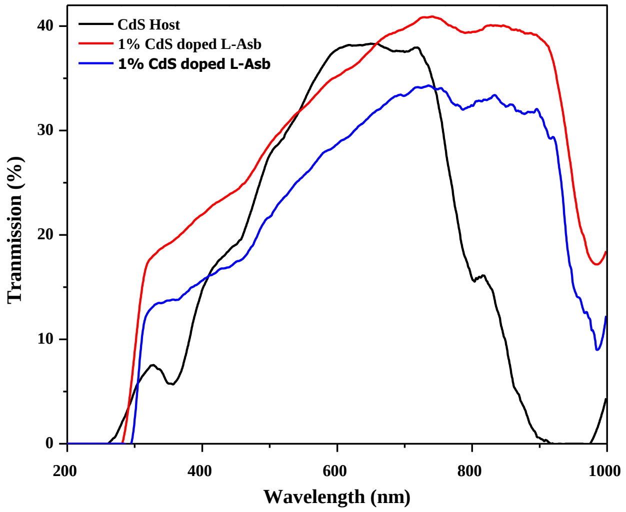

Fig. 3 UV-visible transmission spectra of CdS nanoparticles and doping with 1, 3 wt % of L Ascorbic Acid

3.3 Particle size analysis study

Particle size distribution was analyzed by using the particle size analyzer. Fig. 4 shows the particle size distribution of pure CdS nanoparticles in form of intensity peaks. The intensity strong peak observed at ~ 590 nm that confirmed the average particle size distribution. Similarly, fig. 5 and 6 shows the particle size distribution of 1 and 3 wt.% of L-ascorbic acid doped CdS nanoparticles respectively. As increased the concentration of L-ascorbic acid in CdS nanoparticles the particle size increases.

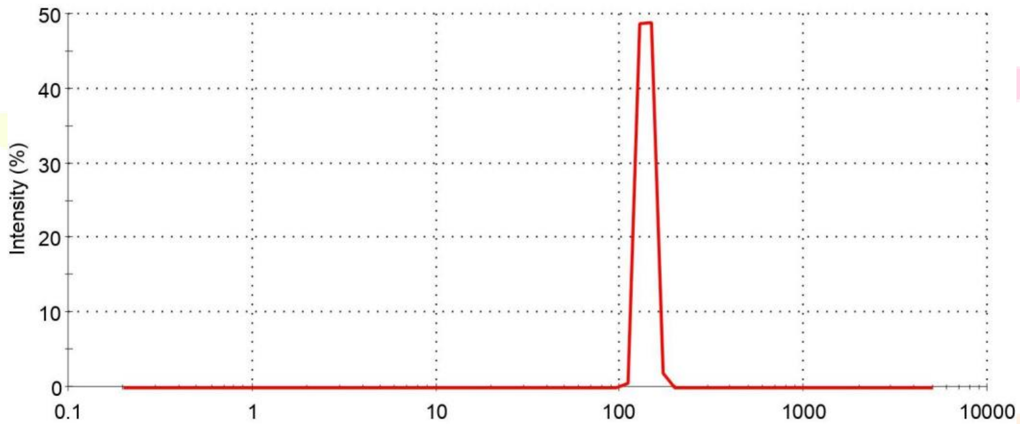

Fig 4. Particle Size analysis of CdS particle

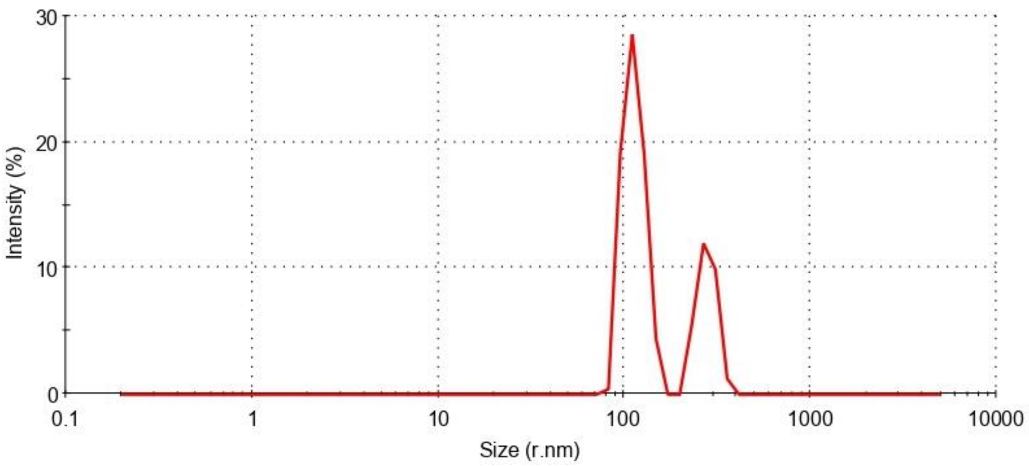

Fig 5. Particle Size analysis of 1 wt % of L- Ascorbic acid CdS particle

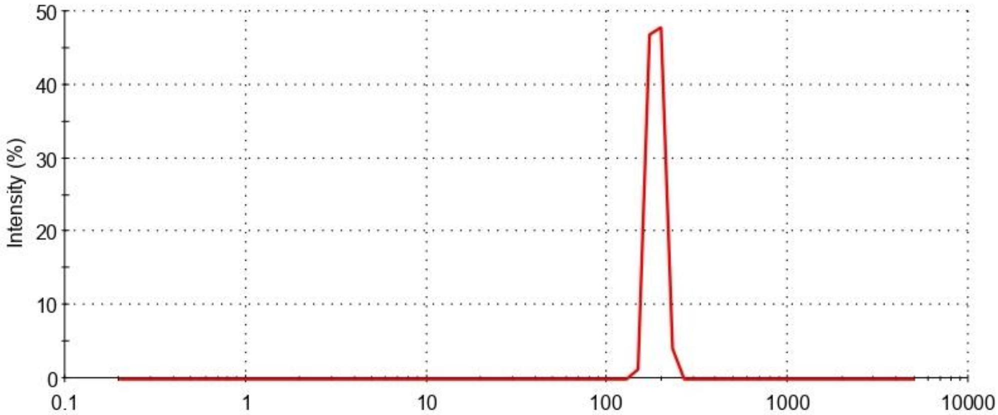

Fig 6. Particle Size analysis of 3 wt % of L- Ascorbic acid CdS particle

4. CONCLUSION

CdS nanoparticles are synthesized via a chemical precipitation process. XRD is used to determine the crystal structure and grain size of the particles. A blue shift in the UV-visible absorption spectra indicated the quantum confinement of charged particles. The grain size of the nanostructure CdS sample computed using the Brus equation is compared to that obtained using Scherrer's formula, and it is discovered that the two values do not correspond closely. The particle size analysis confirmed the effect of L-ascorbic acid on the CdS nanoparticles.

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