Green synthesis, Morphological and Spectral properties of CdS nanoparticles

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ABSTRACT

CdS nanoparticles were tailored by environmentally benign green means with Cadmium sulphate precursor using aloe vera leaf extract. The CdS nanoparticles produced by the process after calcination at 500^0 C were characterized by X-ray diffraction (XRD) and the pattern reveals cubic structure. The sphere shape of CdS nanoparticles were observed by scanning electron microscopy. Raman spectra, is used to investigate the local atomic arrangements and vibrations of CdS nanoparticles. In addition, UV-Visible spectra were employed to conform the nanomaterial formed.

KEY WORDS: Green method, plant extract, Raman spectra, calcination, antibacterial studies

1. INTRODUCTION

Research on nanomaterials has enormously increased during the past years. The intense investigations are motivated by several envisaged application areas for the new class of materials. Novel optical, electrical, and mechanical properties of devices comprising nanocrystallite semiconductors and oxides have been demonstrated in photovoltaic solar cells, light-emitting diodes, and ceramics, sensors, antibacterial studies. Nanobuilding blocks of transition metal oxides, hydroxides, sulfides, semiconductors, metals, and metal salts have now been prepared by various process techniques giving rise to the possibility of constituting a nano tool box for a ‘‘top-down’’ approach in nanoscience and nanotechnology.

Cadmium sulfide is one of the most promising nanomaterials in semiconductor industry due to its high photo conducting nature and suitable band gap Eg=2.42eV (515 nm). Nanostructure sulfides (CdS and ZnS) have been broadly studied with a vision to find the relationship between structure, size and optical properties. These sulfides are used for various applications such as sensors, solar cells, photo detector, photovoltaic, photoluminescence light emitting diode, and transistors due to size reduction and cost effect. CdS nano particles currently have great interest for their practical applications like as zero dimensional quantum confined materials in optoelectronics and photonics. Cadmium sulfide has crystal cubic structure according to growth deposition.

Different synthetic methods are existing for the preparation of CdS nanomaterials viz. evaporation, spray pyrolysis, sputtering, chemical method metal organic chemical vapor deposition (MOCVD) and Sol-gel spin coating and green method. Among these methods, green method is considered to be the most suitable method due to its ease of formation, simplicity, inexpensive, ecofriendly and nonpolluting. In addition, the nanoparticles obtained using plant extracts have different shapes and sizes in contrast with those produced by other methods. The advantages of using plant and plant-derived materials for biosynthesis of metal nanoparticles have attracted researchers to investigate mechanisms of metal ions uptake and bio-reduction by plants, and to understand the possible mechanism of metal nanoparticle formation in plants. CdS nanoparticles are prepared by various cadmium source precursors such as cadmium nitrate, cadmium acetate, cadmium chloride, cadmium oleate and cadmium sulphate.

Present work reports the green synthesis of CdS NPs using alovera plant extract having ecofriendly polyphenols which acts as a reducing agent and a capping agent, using cadmium sulphate precursor, with their morphological, structural and antibacterial studies.

2. MATERIALS AND METHODS

Biosynthesis of CdS Nps: Fresh leaves of alov vera plant were washed with double distilled water and then sun dried for 15 min to remove moisture. 25 g of washed, dried, fine cut leaves were added to 50 mL of deionized water and boiled at 70^o C for 1 hour until the color of the aqueous solution changes from watery to light yellow. 2.5 g of cadmium sulphate (Merck) was added to the solution and then boiled it for 2 hours until it changed to a yellow colored paste and is cooled to room temperature. The yellow powder was then collected in a ceramic crucible and calcinated at 500^o C for 2 hours. A yellow colored powder was obtained and this was carefully collected and packed for characterization purposes.

Characterization techniques: The morphology and composition of the synthesized CuO NPs were observed by scanning electron microscopy coupled with (EDX) (SEM, Hitachi S-4700). The crystallinity and crystal phases were characterized by X-ray diffraction (XRD, Bruker D8 Analytical X-ray System) pattern measured with Cu- Ka Radiation (k = 1.54178 Å) in the range of 20–80º. UV visible spectra with systronics PC based double beam spectrophotometer. Fourier Transform Infrared (FT-IR) spectrum was recorded using the KBr pellets on Shimadzu IR Affinity-1 FT-IR spectrophotometer in the region 4000-500 cm^{-1}. Raman measurements were obtained using mini Raman Microprobe Imaging system 3000 coupled to an optical microscope with spatial resolution of 1.5µm and spectral resolution 2 cm^{-1}.

3. RESULTS AND DISCUSSION

XRD pattern of CdS NP's with diffraction angles from 30 to 80 is shown in Fig. 1. Perusal of figure it is clear that the peaks obtained for Cubic morphology are in agreement with the peaks form JCPS card 75-1549, also observed no other peaks indicating the purity of the CuO NP's synthesized by green method.

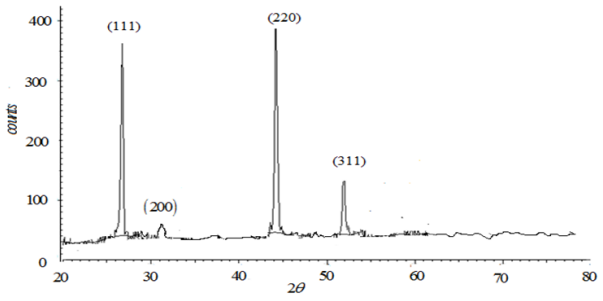

Figure.1.XRD- of CdS nanoparticles

The scanning electron microscopy (SEM) studies were carried out for CdS NP's sample and the image is shown in the Fig. 2. It is clear from the SEM micrograph that the Nano CdS particles are arranged over one another in spherical shape with morphology with narrow size distribution.

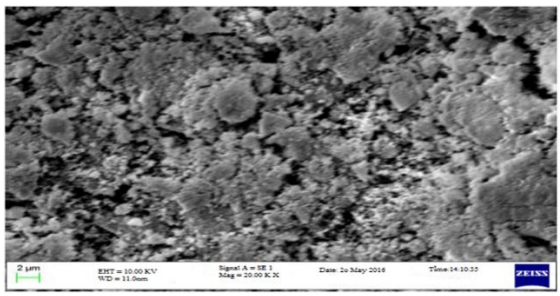

Figure.2.SEM image of CdS nanoparticles

Raman spectroscopy, which is a sensitive tool to investigate the local atomic arrangements and vibrations of the materials, has been extensively used to investigate the micro structural nature of the nanosized materials. Inspection of Raman spectra of CuO nanostructures in Fig. 3 one can find that the Raman spectra exhibit three main one-phonon modes at 301, 603 and 905 cm^{-1}, respectively. The interactions between the vibrational modes of molecules results in the number of physical properties of materials.

Fig. 4 shows the UV–Vis spectrum of CdS NPs biosynthesized from the leaves of aloe vera extract. CdS NPs displays a absorption band at 472 nm, assigning to the inter band transitions of core electrons of Cd metal and CdS nanocrystals.

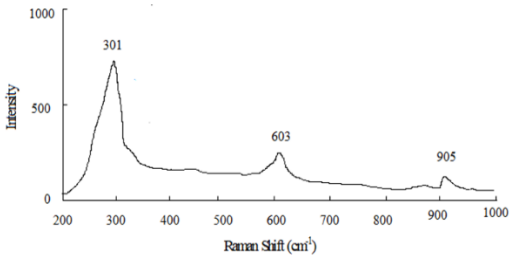

Figure.3.Raman Spectra of CdS nanoparticles

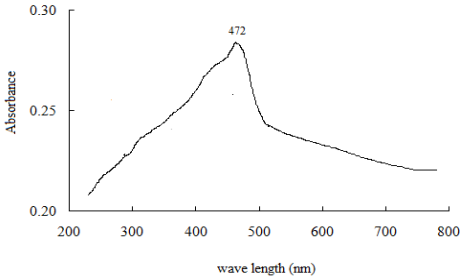

Figure.4.UV spectra of CdS nanoparticles

4. CONCLUSION

In this paper we have reported the synthesis of CdS nano powder by environmental benign green method with leaf extract aqueous solution. XRD data showed a cubic structure. SEM picture showed that particles were in spheres like morphology and are arranged in a systematic manner. Raman spectra and UV-Visible spectra supported the CdS NPs formation.

REFERENCES

1. A Mercy, R Samuel Selvaraj, B Milton Boaz, Synthesis, Structural and optical characterization of cadmium sulphide nanoparticles, Indian journal of pure and applied physics, 51, 2013, 448-452.

2. Saravanan L, Diwakar S, Mohan kumar R, Pandurangan A and Jayavel R, Synthesis, Structural and Optical Properties of PVP Encapsulated CdS Nanoparticles, Nanomater, nanotechnol., 1(2), 2011, 42-48.

3. Venkata Reddy C, Prabhakar Vattikuti SV & Shim J, Synthesis, Structural and optical properties of CdS nanoparticles with enhanced photocatalytic activities by photodegradation of organic dye molecules, J Mater Sci: Mater Electron (2016) 27: 7799. doi:10.1007/s10854-016-4769-x

4. Wang ZL, (Ed.). Nanowires and Nanobelts: Materials, Properties and Devices, Kluwer Academic Publisher, Boston, 122, 2003.