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SYNTHESIS OF CDS NANOPARTICLES BY PRECIPITATION METHOD AND ANTIBACTERIAL ACTIVITIES

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ABSTRACT

A simple route High quality and monodispersed CdS nanoparticles were synthesized through chemical method. The synthesized nanoparticles have been characterized by the X-ray diffraction (XRD) pattern. These nanoparticles show the cubic structure with particle size of the order 20-40 nm which was in fine agreement with the transmission electron microscopic (TEM) studies. The optical properties are characterized by Photoluminescence (PL) spectra and Ultraviolet-Visible (UV-Vis) absorption. The particle size was controllable in the range between 35-50 nm by adjusting the concentration, time, pH and choice of the solvent and the in vitro agar well diffusion method confirmed the potential antibacterial activity of the synthesized CdS nanoparticles against the common bacterial pathogens Gram-ve Escherichia coli and Gram +ve bacteria S. aureus.

Keywords: CdS nanoparticles, Optical properties, luminescence, XRD, FESEM, TEM.

I INTRODUCTION

In the last two decades, semiconductor nanoparticles have been intensively investigated due to their unique size dependent properties.[1-3] Among the II–VI semiconductors, Cadmium sulfide is an important material 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] and its potential use in advanced technologies, in photovoltaic cells, in the fabrication of thin-film transistors, photoresistors, phosphors, diodes, etc. For that justification, as well as from the scientific point of view, researchers focused on the synthesis and characterization of CdS powders and thin films. It is a well known reality that the synthesis route may influence the properties so for many in organic materials. CdS is one of the first semiconductors to be exposed and is probably one of the most important optoelectronic materials and electronic, with well-known applications in optical devices etc.[7–9] Many studies have persistent on CdS because of its high photosensitivity properties and potential application in photoconducting cells and a multiplicity of optoelectronic conversion devices.[10] A large number of artificial methods like as hydrothermal, solvothermal, [11, 12] and sonochemical process[13] microwave heating[14] and solution-based chemical methods[15] contribute precious routes to organize semiconductor nanoparticles. For nanoparticles arranged by solution-based chemical methods, a capping agent,

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which adsorbs on to the nanoparticle surface, is generally added both to control the size of the nanoparticles and to prevent agglomeration of the synthesized particles. These adsorbents have been shown to alter the electronic structure of the nanoparticles.[16, 17] Synthesis of CdS nanoparticles in large scale is important for industrial applications in the areas of catalysis, photocatalysis and microelectronics as well as antibacterial activities.[18] CdS NPs have two universal crystalline phases of hexagonal wurtzite and cubic.[19-21] The bulk wurtzite structure is a thermodynamically stable phase which exists under regular conditions (such as room temperature and atmospheric pressure).[22] The variation in intrinsic energy between these two phases is minor. It was considered that the phase stability between the zinc blende and wurtzite structures of CdS was size dependent. Generally, the cubic CdS nanoparticles exist in smaller sizes and in the wurtzite structure appear larger due to the growth of the particles.[23–25] The aim of this work is to synthesize water-soluble CdS NPs by a novel and simple aqueous method. The samples were characterized using TEM, SEM, XRD, FTIR, fluorescence and UV–visible spectroscopy for the structural, thermal and optical behaviour of the CdS NPs.

II MATERIALS AND METHODS

2.1 Synthesis of CdS nanoparticles

CdS nanoparticles of CdS are synthesized from CdO. By adding 50 ml DIW water to 5 gm CdO with stirring using magnetic stirrer at room temperature .Then dropping dil. HCl (2:2) till complete dissolution to get a transparent solution .The PH was found to be 3.3 wt% Na_2S was added slowly till the whole solution appears completely pale yellow. The chemical reaction occurs as follows

$$CdO + 2HCl \rightarrow CdCl_2 + H_2O \ldots (a)$$

$$CdCl_2 + Na_2S \rightarrow CdS + 2NaCl \ldots . (b)$$

pH controlled the rate of reaction due to the common ion effect. At higher pH, the solubility of product increases and an result no formation of CdS particle is formed. The resulting solution was a radish yellow. The pale yellow color indicated the formation of CdS nanoparticles [26] the resulting powder was washing, centrifuged, and finally dried at 80°C .The nano-particles were collected by centrifugation at 2800 rpm for 15 minutes, and washed about two times. Further purification was made by ultrasonic bath. The size of the CdS nanoparticles formed depends on the number of cadmium ions exchanged and hence on the concentration of the cadmium chloride solution. Changing the temperature of the solution, amount of polymer stabilizer, pH of the whole solution and controlling the stirring time of the solution controlled the size nano particles.

2.2 Characterization of nanoparticles

Nanoparticles were carefully characterized by resources of advance analytical techniques. The absorption spectra were record using UV-Vis spectroscopy (Schimadzu UV over a range of wavelength i.e. 200-800 nm, where DIW water is used as a reference. The surface morphology of the CdS examined using a JEOL-2010F TEM operating with electron beam of energy of 200 kV. FTIR (UV 3000+ was examined to achieve broad spectrum of nanoparticles over a narrow series. This process gives us information regarding phytochemicals that have enclosed the particles through synthesis method. The XRD investigations were performed using Rigaku diffractometer with Cu at 25^{o}C to determine the phase purity and the crystal structure of the NPs.

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III RESULTS AND DISCUSSION

3.1 XRD Analysis

XRD patterns of the CdS nanoparticles prepared by precipitation method is shown in Figure which indicates the CdS has hexagonal wurtzite phase structure The peak and relative intensities obtained for the CdS The X-ray diffractograms revealed major peaks at 2θ values of values of 25.2±0.3, 41.3±0.3 and 51.4±0.3 corresponding to the (111), (220) and (311) crystal planes, respectively. The XRD pattern reveals the existence of both cubic and hexagonal phases and peaks corresponding to the purity of CdS nanoparticles. The broadened of diffraction peak provides information about the sizes of the particles being in the nano range. As the width increases, the particle size decreases and vice versa.

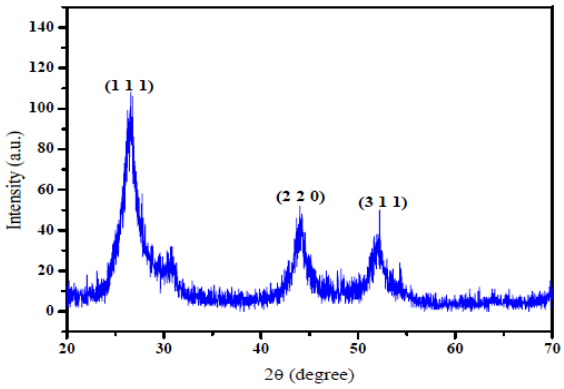

Fig.1 XRD plot of synthesized CdS NPs via precipitation method

3.2 UV-Visible Analysis

UV-Visible absorption spectroscopy is very efficient technique to monitor the optical properties of nano sized particles. The optical absorption spectra of the nanocrystalls were measured using UV-Vis spectrophotometer and the absorption spectra was recorded at room temperature over the range 300 nm to 800 nm. The optical absorption of sample is shown in Fig. It is evident from the fig. that sample exhibit a strong absorption at wave length, 418nm.

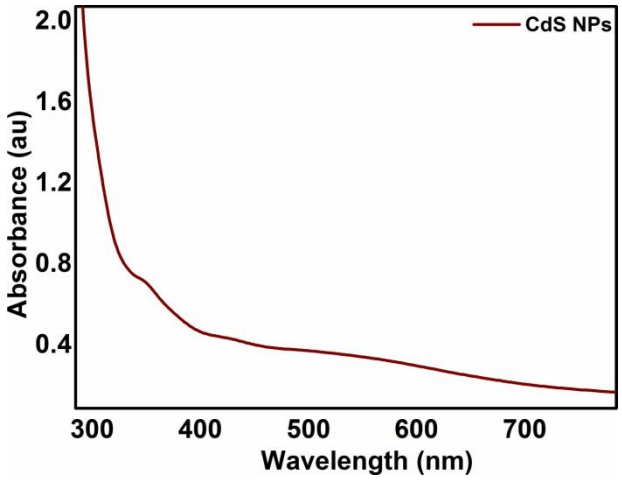

Fig.2 UV-Visible spectra of synthesized CdS NPs by precipitation method

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3.3 FTIR Analysis

FTIR spectra CdS crystallites were taken between the ranges of 400 to 4000 cm^{-1} for CdS at temperature 700C. FT-IR spectrum of CdS nanoparticles Figure showed significant absorption peaks shows the infrared spectra of strong band at 690 cm^{-1} and 853 cm^{-1} have been assigned as Cd-S band.

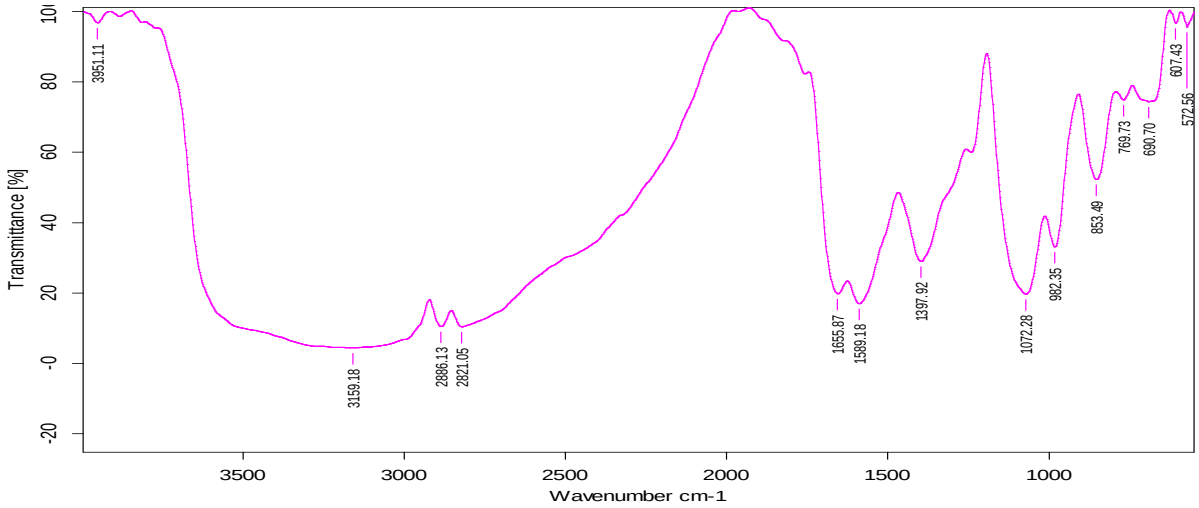

Fig.3 FTIR spectra of synthesized CdS NPs by precipitation method

3.4 SEM and TEM Analysis

The SEM image shown in figure with different magnifications clearly indicates the shape and formation of nanoclusters. The grains have aggregated to form like clusters. The cadmium sulfide was obtained as uniform and fine particles, which form crystalline aggregates. From TEM analysis, the calculated lattice parameters a=4.138A^{o}, b=4.138A^{o} and c=6.692A^{o} and particle size of 45 nm was originate to be in good agreement with the values reported from the XRD data.

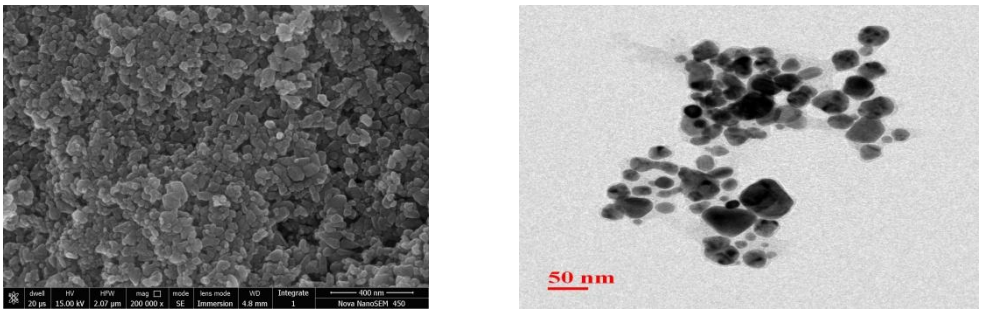

Fig.4 (A) FESEM images of CdS NPs **(B) TEM images of CdS NPs**

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3.5 Antibacterial Activity

The antibacterial property of the CdS NPs was evaluated against Gram-ve Escherichia coli and Gram +ve bacteria *S. aureus* using agar well diffusion method. In agar well diffusion method the CdS nanoparticles showed significant antibacterial activity on bacterial strains Gram-ve and Gram +ve bacteria and Table 1 clearly represents the comparative activities in terms of inhibition zone i.e 16 and 14, respectively. Study demonstrated that the CdS NPs show best antagonistic activity of against Escherichia coli.

TABLE 1: CdS nanoparticles showed significant antibacterial activity

Organism	**Zone of inhibition (mm)**
Escherichia coli	16
Staphylococcus aureus	14

lV. CONCLUSION

CdS powder was successfully synthesized by precipitation method at near room temperature. The crystallite size calculated from the XRD is 45 nm is in good agreement with TEM results. FT-IR results confirm that the presence of Cd-S at 690 cm^{-1} as well as UV-visible Spectroscopy. The absorption spectrum was 418 nm show the blue shift compared to bulk CdS. The antibacterial activity of CdS nanoparticles was confirmed by Zone of inhibition. As the diameter of the zone of inhibition is high, we can conclude that CdS is also a very effective antibacterial agent. CdS nanoparticles are effective against both the bacteria which gives a conclusion that it is effective against gram +ve and gram –ve bacteria. Therefore we can conclude that CdS nanoparticles are a very effective antibacterial agent.

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