SYNTHESIS AND OPTICAL CHARACTERIZATION OF PVA CAPPED CADMIUM SULPHIDE NANOCRYSTALLINE FILM BY SOLUTION CAST TECHNIQUE

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Abstract: ***Nanocrystalline film was synthesized by solution cast technique at normal temperature. In which PVA is used as capping agent. Two films of desired concentration were synthesized. The size of the particles in film is controlled by using cadmium chloride and sodium sulphide of different molar concentration, while the thickness of the film was controlled by altering the concentration of poly (vinyl alcohol) (PVA) during the synthesis process which also acts as a capping agent. Obtained film was, dried and preserved in air tight bag. The analysis of UV pattern shows that the given film has a band gap of 1.2-1.5eV. It was observed that on increasing the concentration of capping agent, nucleation and growth of the film increases which increases the thickness of film. UV-Visible spectroscopy also examine that the given sample have absorbance from (200nm-300nm) of wavelength.***

Keywords: solution cast technique, Poly (vinyl alcohol), cadmium chloride, sodium sulphide, nucleation and growth, UV-visible spectroscopy.

I. INTRODUCTION

There are various chemical based methods available for the synthesis of PVA capped CdS nanocrystalline film. The present work report to the synthesization of PVA capped CdS nanocrystalline film using solution cast technique and investigates the optical properties using ultraviolet visible spectroscopy. All these interesting properties of CdS like electrical, optical, physical and chemical properties of the material are determined. Among all semiconductor CdS nanocrystalline film is an interesting material with many applications in various fields such as optoelectronics, photo catalysis, solar energy conversion, projection television, fluorescence microscopy, etc. Nano-sized semiconducting thin film have been generating an extensive interest in recent years owing to their structural, optical, and electrical properties which are different from those of the bulk materials. These improved optical properties can be ascribed to the various phenomena like quantum confinement of electrons, surface disorderness etc., that takes place in the nano-regime. The quantum confinement of excitons in semiconductor nanostructures can cause widening of the band gap, thereby making them eligible for optoelectronic applications. The surface of nano-particles are highly disordered which is the reason behind the huge value of electrical conductivity they exhibit [1]. Hence a detailed investigation in to the underlying reasons of novel properties that nanocrystalline film possess would be in the interest of the world. CdS has wide band gap of 2.4eV and the band gap energy can be tuned in the UV region. It is an important material for a variety of applications including photoconductors, solar cells, and field effect transistors, sensors, transducers, optical coatings and light emitting materials.

II. EXPERIMENTAL

PVA capped CdS nanocrystalline film was synthesized by using solution cast technique. All chemicals were used of analytical grade. Distilled water was used as solvent. The starting materials CdS nanocrystalline film with pure and 10% compositions were synthesized by solution cast technique. Cadmium chloride and, Sodium sulphide are the main reagents that were used in synthesis process. The appropriate amounts of Cadmium chloride and sodium sulphide were dissolved separately in50mL distilled water and stirred at room temperature for 2h. The pH of the solution is maintained to 7 which is neutral. Sodium sulphide solution was added into cadmium chloride solution slowly which give the formation of CdS sol and NaCl while the NaCl is washed no of times by distilled water and filtered then pure and colloidal sol of CdS was obtained. In which PVA is added slowly in the sol of CdS and stirred for 2 hour so that it may dissolved uniformly through the solution and thin film of PVA doped CdS was formed by drying the film over the mercury at 55 oC for 4 hours. Then the PVA doped CdS nanocrystalline film was obtained which is enclosed in air tight bag [2].

3.2.1 Flow chart of synthesis of thin film by Solution Cast Technique

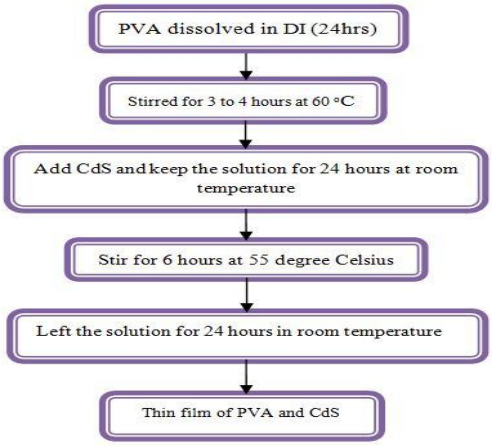

Figure.1 The flow chart of preparation PVA: CdS nanocrystalline film by solution cast technique.

III. OPTICAL CHARACTERIZATION

UV-visible Spectroscopy:

The absorption edge is observed in the range of 200–500 nm, which is blue shifted compared to bulk CdS. As the Cd concentration increases, the absorption edge shifts to lower wavelength side and intensity also increases with increasing Cd concentration compared to undoped CdS. This blue shift of the absorption edges for different sized nanocrystals is related to the size decrease of particles and is attributed to the quantum confinement limit reaching of nanocrystals. The quantum confinement effect is expected for semiconducting nanocrystals, and the absorption edge will be shifted to a higher energy when the particle size decreases Absorption coefficient (α) of the nanocrystal at different wavelengths can be calculated from the absorption spectra as given in graph [3]. UV/Vis spectroscopic analyses were performed on CdS:nanocomposites of sample 1 and sample 2. Peaks of CdS:nanocomposite of sample1 occurred at 220 nm and 490 nm for the mass compositions of 0.2:1.0 and 0.8:1.0. However, the absorbance band became broader as the mass composition of CdS was increased. A similar result was found with the CdS:nanocomposite of sample 2. The absorption bands gradually broadened as the mass composition of CdS increased, and the UV absorption for sample-1and sample-2shifted to a shorter wavelength (blue shift) with respect to that of the bulk CdS (520 nm). This observation indicated that quantum confined electronic behavior occurred in this PVA dopped CdS nanocrystalline film [5]

The absorption spectra of the samples are shown in Figure. 3

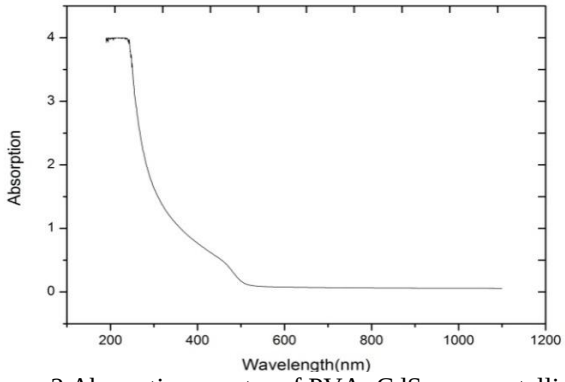

Figure.2 Absorption spectra of PVA: CdSnanocrystalline film.

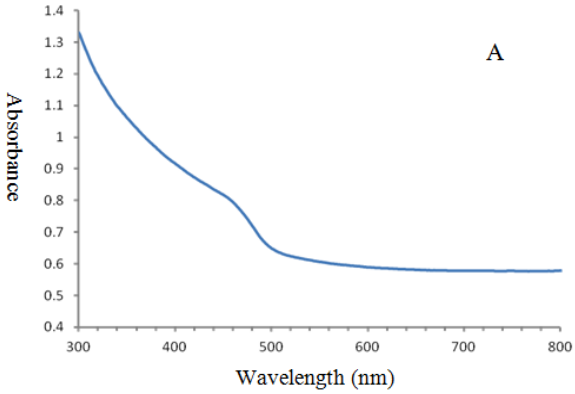

Figure 3Absorption spectra of PVA:CdSnanocrystalline film [2].

Sample-1	*Energy band gap (Eg) eV*
CdS	2.4
PVA:CdS	1.6

Table .1 Showing band gap comparisons of pure CdS with PVA capped CdS.

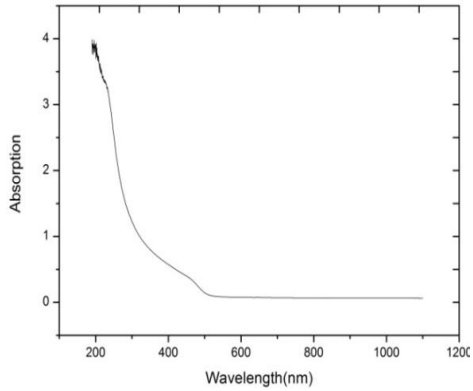

Figure4. Absorption spectra of PVA:CdSnanocrystalline film.

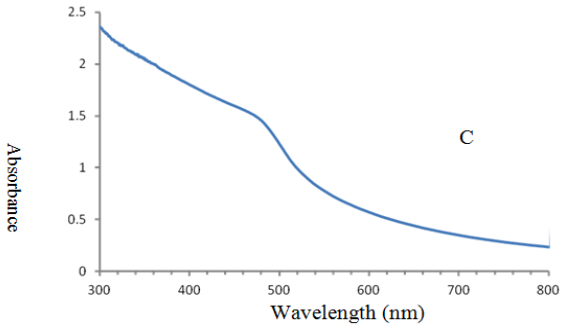

Figure5. Absorption spectra of PVA:CdSnanocrystalline film[2].

Sample-2	*Energy band gap (Eg) eV*
CdS	2.4
PVA:CdS	1.5

Table 2 Showing band gap comparison of pure CdS with PVA capped CdS.

Determination of energy band gap

i. By Tauc method $\propto = A(hv - Eg)nhv$

By rearranging the above equation,

$(\propto hv)1n = A1nhv\text{-}A1nEg$

Where $\propto = \ln(1Tx)$ α = absorption coefficient

T= Transmittance

x=Thickness of the sample

Eg= Band gap of the material n= 2, ½, 2/3 and 1/3 for direct allowed, indirect allowed, direct forbidden, and indirect forbidden transition respectively.

Plotting graph of (α*hv*)1/n V*shv*, we will get slope as A1/n and y intercept as A1/n .

Dividing y intercept by A1by n we can estimate the band gap.

On further calculation it was found to be 1.6 eV for sample-1 and 1.5 eV for sample-2.

ii. Thickness calculation

Absorbance A = - Log (I/Io)

$I=I_o e-t/\delta$

Where,

I_o = intensity of glass plate

I = intensity of the coated glass sample

t = thickness of the film

δ = skin depth of the material

$\delta= \rho\lambda\pi c\mu$

Where,

ρ= Resistivity

λ= Wavelength

c= velocity of light

μ= absolute magnetic permeability.

The thickness of film was calculated that is 2-4 micro meter.

IV. RESULT AND DISCUSSION

It is possible to produce different size and thickness of PVA:CdS nanocrystalline film by using a solution cast method with the use of different molar concentration of PVA as a capping agent and cadmium sulphate and sodium sulphate. UV-visible spectroscopy has been employed to confirm nano-size of the particles and thickness of the film. A decrease in formation rate of thin film gives rise to a larger final particle size for all the synthesis conditions. As the thickness of the film and particle size depends on the molar concentration of capping agent, a decrease in the size of particle is observed with the increase of molar concentration of capping agent [5]. The values UV-Visible exhibit a blue shift which is related to the size decrease of the particles and to the quantum confinement limit reaching of thin film. The band of the film was found to be decrease in band gap i.e. from 1.6eV for sample 1 and 1.5eV for sample 2. Considering these results, the solution cast technique using, Poly (vinyl alcohol), as a capping agent is very efficient for the preparation of PVA:CdSnanocrystalline film in order to control the particle size and also for modern optoelectronic applications like decorative coatings, optical coatings, protective coatings ,thin-film photovoltaic cells, thin-film batteries, anti-reflection coatings on eyeglasses or solar panels etc.

Comparative analysis : with reference to the paper "Mustafa B. "Study of Dielectric Properties of CdS/PVA Nanocomposites Obtained by Using Successive Ionic Layer Adsorption and Reaction" World Journal of Condensed Matter Physics, 2013, 3, 82-86" the graph shown in figure 3 and 5 resembles with the graph observed in our result shown in figure 2 and 4 which states that our result is appropriate and correct to the published work.

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