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Study of Photoluminescence Properties of Undoped and La Doped (Cd-Zn)S Thin Film.

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ABSTRACT

The present paper reported the Photoluminescence properties of the undoped and Lanthanum (La) doped Cadmium Zinc Sulfide (Cd-Zn)S, deposited on the glass substrate by using chemical bath deposition(CBD) method. The outcomes of Photoluminescence (PL) Study are reported for prepared sample. The thickness of the prepared Undoped and different concentration of La doped (Cd-Zn)S thin films are 1.14 μm and 1.09 μm to 1.11 μm respectively.

Keywords: (Cd-Zn)S *thin film, Lanthanum, CBD, photoluminescence ,thickness*

1. INTRODUCTION

Semiconductor Nanoparticle has good optical, electronic and thermal properties. In the recent time there are many techniques used to make (Cd-Zn)S thin film such as hydrothermal solvothermal vacuum deposition, electrochemical deposition, pulsed laser deposition, spray pyrolysis, successive ionic layer adsorption reaction and photochemical.

Cadmium sulphide thin films have received considerable attention during current scenario because of their numerous excellent properties in optoelectronic and nanoscience fields. CdS thin film has a broad range of application in important technical fields such as heterojunction solar cells (1, 2), light emitting diodes (3), large screen liquid crystal devices (4), gas sensors (5) and field effect transistors (6,7). CdS thin film belongs to Cadmium Chalcogenide family. It is an II-VI wide direct band gap (2.42eV) semiconductor. This particular property makes it a key element for solar cell applications. From the x-ray diffraction pattern (XRD), the hexagonal structure of ZnCdS thin films was confirmed with an average size of the crystallite (30–36 nm). The optical properties of ZnCdS thin film were investigated using UV–visible absorption and photoluminescence spectral analysis (UV-Vis and PL). The optical studies of thin films indicated that the band gap increased from 1.85 eV to 2.81 eV with increasing the concentration of Zn(13). The resistivity of $Cd_{1-x}Zn_xS$ films was found to vary linearly with zinc contents, and the properties of the films suggest potential application to photovoltaics as window layers (14). The optical band gap of CdS thin films increased from 2.63 to 2.73 eV with the increase of Zn dopant from 2 to 10% (15). The surface morphology of hexagonal $Cd_{1-x}Zn_xS$ thin films is denser than that of cubic phase, the lattice mismatch rate of cubic phase $Cd_{1-x}Zn_xS$ thin films and CIGS is lower, only 0.56%, the interfacial state density is lower (16). bandgap energy of CdZnS film was 3eV and was found to be increased to 3.1 eV after using poly-ethylen oxide (PEO). All of these results show that PEO can make CdZnS film better. The better transmission of the prepared films also shows that the method described is good for making CdZnS thin films for solar cells (17).

II. EXPERIMENTAL STUDIES

2.1 Film Preparation:-

For the preparation of (Cd-Zn)S thin film on Soda lime glass substrate (Scientific Plaza Company) (75mm X 25mm) was to be use, The Stock solution of high purity cadmium sulphate, ($CdSO_4$), thiourea $(NH_2)_2SC$, Zinc Acetate $Zn(CH_3COO)_2$ & Ammonia in aqueous medium were prepared using distilled water, TEA is used for complexing agent, For the doped thin film Lanthanum Nitrate ($La(NO_3)_3$)solution of 0.001M were used.

2.2 Instrumentation:-

Photoluminescence spectra were measured with Shimadzu RF-5301 spectrofluorometer .The study was done in National Institute of Technology (NIT) Raipur Chhattisgarh.

3. RESULTS & DISCUSSION :-

3.1 Thickness Measurement:-

We use following formula in order to calculate thickness of deposited thin film:-

$$t = m / A\rho$$

Where t is the thickness of film, m- is the mass of deposited material, A is the area of deposition , ρ is the standard value of density of material. The thickness was found **1.14** µm for undoped sample and for different La Doped Sample it is **1.09 µm to 1.11 µm**. (**Khare et al. 2006 reported thickness as 1-2 µm**)

3.2 Photoluminescence Spectra :-

The following graphs contain the PL spectra of doped and undoped (Cd-Zn)S thin film under an excitation wavelength region from 200 nm to 800 nm are recorded.

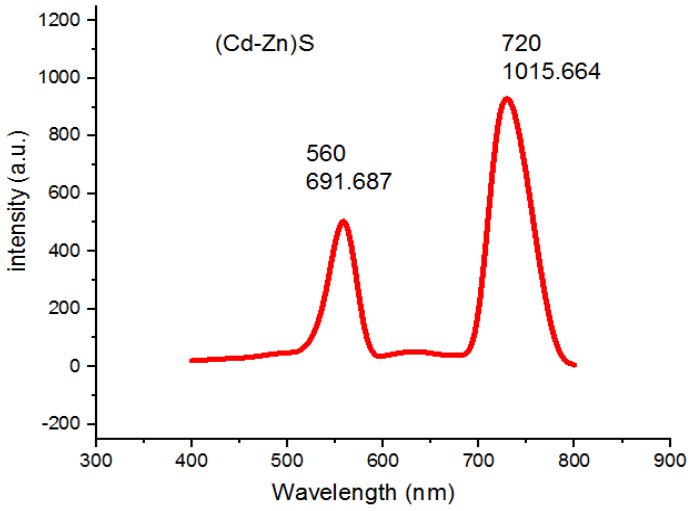

Figure 3.2 – (A) Photoluminescence spectra of Undoped (Cd-Zn)S

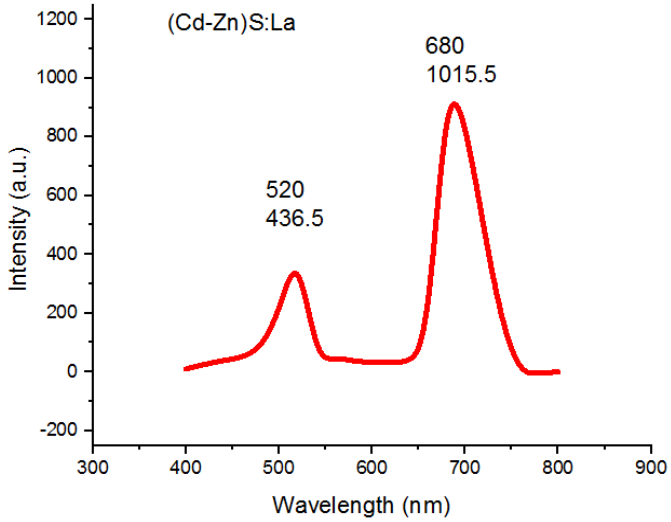

Figure 3.2- (B) Photoluminescence Spectra of (Cd-Zn)S:La

(Table 3.2 - Observed peak positions of PL emission spectra of doped and undoped (Cd- Zn)S

Sample	Peak Position (nm)	Intensity (a.u.)
(Cd-Zn)S	560	691.687
	720	1015.664
(Cd-Zn)S:La	520	436.5
	680	1015.5

The PL spectra of **(Cd- Zn)S** under an excitation wavelength of 274nm are recorded and are presented in figures 3.2(a). The spectra display strong peaks centered at 560nm and 720nm due to high energy photon in the undoped case and 720nm peaks correspond to band to band transition and other peaks at 560nm might be correspond to excitonic level emission. In case of doped material again two prominent peaks are observed which are 680nm and 520nm presented in figures 3.2(A & B). The peaks are shifted to lower wavelength side due to the doping of La in the host material. This indicate that blue shift of emission found in the prepared sample and that should be indicated to the increased band gap of **(Cd- Zn)S**. This shows that the quantum confinement effect occurs in the prepared sample when doing comes in picture. Photoluminescence emission spectral response curve is observed and utilized in understanding the effect of particle size reduction and doping. Normally increase in band gaps are expected with reduction in particle size which may cause shift of photoluminescence emission spectra toward lower wavelength side and discreteness in the continuum of valence band and conduction bands. The value of excitonic level is found to be 3.09eV. This emission in shorter wavelength side reflects information about the discreteness of energy states and the transition involving levels higher than lowest unoccupied CB.

4. Conclusion:-

The (Cd-Zn)S undoped and La Doped thin films can be successfully formed on soda lime glass Substrates by chemical bath deposition technique.

1. By Gravimetric method he thickness of the material calculated by the Thermo gravimetory Method and obtained 1.14μm and 1.09 μm to 1.11 μm respectively for Undoped (Cd-Zn)S and Doped (Cd-Zn)S:La material.
2. The prominent peak of PL spectra also shifted toward the lower wavelength side when doing occurs .

The quantum confinement comes into the picture when the doing of La has to be done.

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