Structural and Optical Analysis of $Cd_{0.8}Zn_{0.2}S$ Thin Film Synthesized by Chemical Bath Deposition Method for Solar Cell Application

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Abstract

$Cd_{0.8}Zn_{0.2}S$ thin film was prepared on glass substrate using chemical bath deposition technique. The films were heated up to 80°C for 45 min. Micro structural features, obtained from X-ray diffraction, Scanning Electron Microscope (SEM) and UV rays. The crystal structure of $Cd_{0.8}Zn_{0.2}S$ films was hexagonal and the film was grown with cubic Zinc blended structure. The SEM studies showed that the value of grain size about 100nm and optical studies (UV) which brings that the film were used as window material in hetro junction solar cells.

Keywords: Chemical bath deposition, $Cd_{0.8}Zn_{0.2}S$, morphology, band gap.

Introduction

The $Cd_{0.8}Zn_{0.2}S$ films grown by the chemical bath deposition (CBD) method, The use of $Cd_{0.8}Zn_{0.2}S$ instead of CdS can lead to an increase in photocurrent by providing a matching the electron affinities of the two materials. This CdZnS ternary compound is also potentially useful as a window material for the fabrication of p-n functions without lattice mismatch in the devices. Semiconductor nano particle is the regime of few nanometers have received considerable alternation recently because of their interesting physical and chemical properties like size quantization, catalytic properties and improved optical properties. Among these nano particles exhibit size tunable photoluminescence in visible region of the electromagnetic spectrum. One of the most well studied systems is the solid solution of ZnS and CdS, which aids in tuning the band gap through by doping. This ternary system has potential application in the fabrication of solar cells flat panel displays. $Cd_{0.8}Zn_{0.2}S$ thin films are used as a wide band gap window material in hetro junction solar cells.

Experimental Procedure

In this study $Cd_{0.8}Zn_{0.2}S$ thin film was prepared on glass substrates by chemically bath deposition method, ZnS thin film were deposited on to a cleaned glass substrate 1M of Thiourea solution, 0.8M of Cadmium Acetate, 0.2M of Zinc Acetate, 1M of TEA (Tri ethanol Amine Solution) were mixed slowly at room temperature. A glass substrate was mounted vertically in a beaker contain in a beaker contain in the mixed solution and addition of ammonia solution at 80°C. After 45min, when the glass substrate turned into pale yellow. It was picked up and washed with deionized water to remove loosely bound precipitate

to detachment of the film was observed, during cleaning with deionized water, indicating that the ZnS film adhered tightly on the substrate.

Characterization

The X-ray diffraction measurements were made in 0° to 80° for the sample deposited on the glass substrates. In this investigation Rigaku Corporation Japan powder diffractometer was used. UV/VISIBLE spectrophotometer (model Lmbda35) with heat sensitive graphic printing recorder fed with heat sensitive chart paper was used. The spectrophotometer has a wavelength range of 190 to 1100 nm with an accuracy of ± 0.3 nm. The scanning electron microscopy (SEM) images of the $Cd_{0.8}Zn_{0.2}S$ obtained thin films were taken on a JEOL5410.

Result and Discussion

Structural analysis

The phase identification from the recorded XRD patterns has been carried out with help of standard JCPS data base files have confirmed the mixture of cadmium and zinc phases. It is reported that the grain size, dislocation density, Number of Crystalline, strain are determined using Debye-Scherrer formula. The grain size of the films increases with the increase in deposition temperature. The size of the crystallites (D) is calculated using the Scherrer formula (Atay et al., 2003),

$$D=K\lambda/\beta \cos \theta$$

where λ is the wavelength of the X-ray used (1.5406A ˚), b is the full-width at half-maximum (FWHM) of the peak which has maximum intensity, h is the Bragg angle. The interplanar spacing of the ZnS microcrystal agreed well with those registered in the JCPDS card is tabulated (Table 1) and the $Cd_{0.8}Zn_{0.2}S$ diffraction pattern is shown in figure 1. The average crystalline size was found from 4nm to 319nm. The dislocation density (**δ**), defined as the length of dislocation lines per unit volume, has been estimated using the equation (Bilgin et al., 2005), since **δ** is the measure of the amount of defects in a crystal. $\delta = 1/D^2$

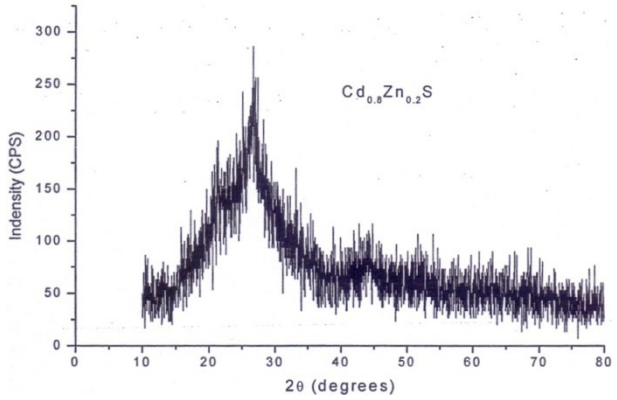

Figure 1 XRD pattern of $Cd_{0.8}Zn_{0.2}S$ film

Table 1. $Cd_{0.8}Zn_{0.2}S$ XRD pattern

Standard value (2θ)	Experimental Value (2θ)	Standard Value (d)	Experimental Value (d)	Grain Size D (nm)	Dislocation Density (δ)
15.797	15.747	5.6054	5.6232	20	2.5000
35.423	35.449	2.5319	2.5302	26	1.4790
38.821	38.833	2.3178	2.3171	37	0.7304
48.832	48.442	1.8797	1.8776	54	0.3429

Surface Morphology

SEM micrographs for $Cd_{0.8}Zn_{0.2}S$ film grown at 80°C. From the SEM photo image, the particles are seen to be spherical in shape and are agglomerated. It can be seen that the surface of the film is spherical like morphologies. The crystalline size is approximately same as XRD diffraction as shown in figure 2.

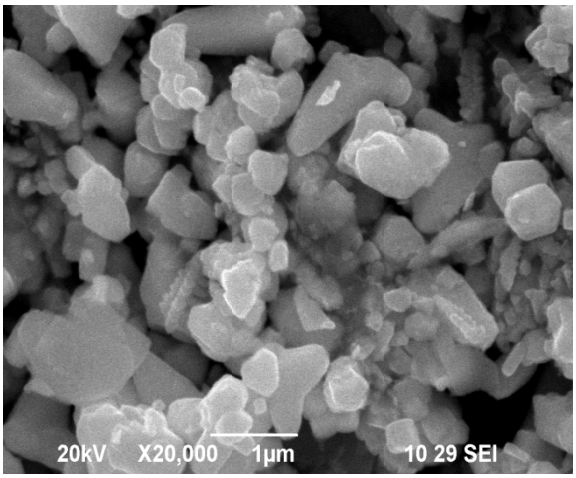

Figure 2 SEM of $Cd_{0.8}Zn_{0.2}S$ thin films

Optical Analysis

Optical analysis of $Cd_{0.8}Zn_{0.2}S$ samples deposited over glass was performed using UV-Visible spectroscopy. These characterization techniques are generally used for band gap determination. UV-visible spectroscopy was performed in room temperature and at a region from 300 nm to 800 nm.

The UV-visible spectrum of deposited glass is $Cd_{0.8}Zn_{0.2}S$ shown in Figure (3, 4&5). The spectral transmission began to fall at one band edge which was indication of the good crystalline of the films.

The value of energy gap is given by the intercept the straight line with the energy axis. The band gap E_g was determined and tabulated (Table 2). The band gap energy decreases as thickness increases. It is clear that the $Cd_{0.8}Zn_{0.2}S$ were used for the photovoltaic applications.

Table 2. Optical parameters - Band gap E_g

Samples	Thickness (nm)	Band Gap(eV)
I	61	2.35
II	200	2.32
III	267	2.26

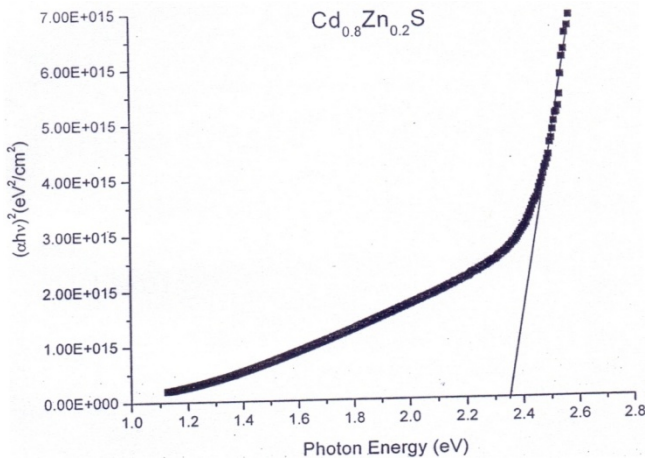

Figure 3 Band gap Energy of $Cd_{0.8}Zn_{0.2}S$ Thin film (61 nm)

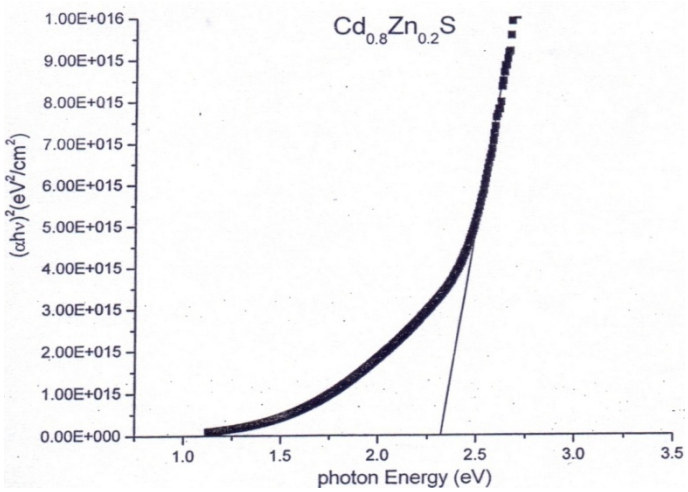

Figure 4 Band gap Energy of $Cd_{0.8}Zn_{0.2}S$ Thin film (200 nm)

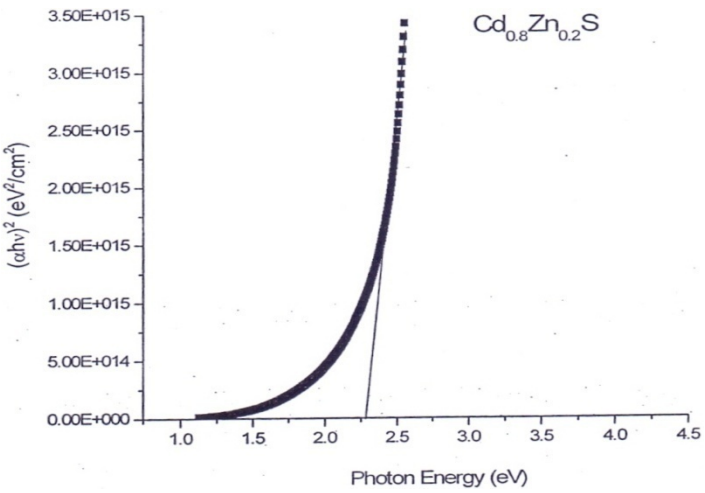

Figure 5 Band gap Energy of $Cd_{0.8}Zn_{0.2}S$ Thin film (267 nm)

Conclusion

$Cd_{0.8}Zn_{0.2}S$ thin films have been successfully deposited on glass substrate using chemical bath deposition technique. In-Situ Zn doping is found to induce considerable modification in the optical band gap of CdS nano crystalline thin films. XRD peaks showed average particle size 4 to 319 nm. The surface morphology of the films was also investigated. The SEM revealed that the samples were highly agglomerated. The grain were regularly shaped and the grain sizes were in hundred of nanometers. The optical band gap for the as-deposited, annealed at 80°C were respectively 2.26,, 2.32, 2.35 eV. The band gap decreases as thickness increases. $Cd_{0.8}Zn_{0.2}S$ thin films are used as a wide band gap window material in hetro junction solar cells.

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