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Advances in Applied Science Research, 2012, 3 (5):2826-2829

ISSN: 0976-8610
CODEN (USA): AASRFC

Effect of Film Thickness on the Transmittance of Chemical Bath Fabricated CdS Thin Film

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ABSTRACT

Effect of Film Thickness on the Transmittance of Chemical Bath Fabricated CdS Thin Film was investigated in this paper. The films of different thicknesses were deposited on to glass substrate. Structural and surface morphology of the films were carried out using an x-ray diffractometer with Cukα radiation and Olympus Optical microscope respectively. The films were found to have high transmittance (67.5 %) for the film with the lowest thickness of approximately t = 1.126µm (Cd2) and low transmittance (30%) for the film with highest film thickness of approximately t = 1.216. The material was confirmed to have cubic zinc blend structure.

INTRODUCTION

CdS is a technologically useful material, as many devices based on CdS, including sensors have come up in the recent years. The thin film cadmium sulphide solar cell has for several years been considered to be a promising alternative to the more widely used silicon devices. It is widely used as window layer of CdTe – or CuInSe2 – based solar cells. It is also essential in the preparation of light emitting phosphors and these phosphors are useful in applications such as color displays, x-ray instruments, luminescent dials, fluorescent lamps, and cathode ray tubes. CdS photoconductive cells are used in photographic exposure meters for cameras, where it acts as a light sensitive resistor. It also has applications in electro-photographic systems in photocopiers. Cadmium sulphide (CdS) can be deposited by various techniques like co-evaporation [1] or elements evaporation [2] from a concentric cylindrical source [3]. [4] prepared evaporated thin film on glass substrate.[5] prepared CdS by rf diode sputtering technique. One of the t promising techniques for producing inexpensive CdS film for various applications is chemical bath method and here we followed this method to synthesize the CdS film.

MATERIALS AND METHODS

We synthesized all the films for this experiment using chemical bath deposition (CBD).

The deposition of CdS thin film by CBD was based on the reaction between cadmium bromide ($CdBr_2$) and thiourea ($CS(NH_2)_2$, using TEA ($N(CH_2CH_2OH)_3$) as a complexing agent and ammonia solution as a pH adjuster. In this experiment, four reaction baths (50mls beakers) were used. 5mls of cadmium bromide was measured into a 50ml beaker using burette; 5mls of TEA was then added and stirred gently to achieve uniform mixture. On addition of TEA the solution turned milky and after about a second clears. The reaction is exothermic. 5mls of thiourea was then added, the solution remained clear. 5mls of ammonia solution was now added and the solution turned light yellow, the mixture was then topped to 50mls level by adding 30mls of distilled water and stirred to achieve uniform mixture. A glass substrate was dipped vertically into all of the five reaction baths. The baths were left to stand for

different time intervals (as indicated in Table 1) after which the substrates were removed at the end of the various time intervals and dried in air. The reaction mechanism is of the form:

$CdBr_2.4H_2O + TEA \rightleftharpoons Cd\,[TEA]^{2+} + 2HBr + 3H_2O$

$Cd\,[TEA]^{2+} \rightleftharpoons Cd^{2+} + TEA$

$(NH_2)_2\,CS + OH^- \rightleftharpoons CH_2N_2 + H_2O + HS^-$

$HS^- + OH^- \rightleftharpoons H_2O + S^{2-}$

$Cd^{2+} + S^{2-} \longrightarrow CdS$

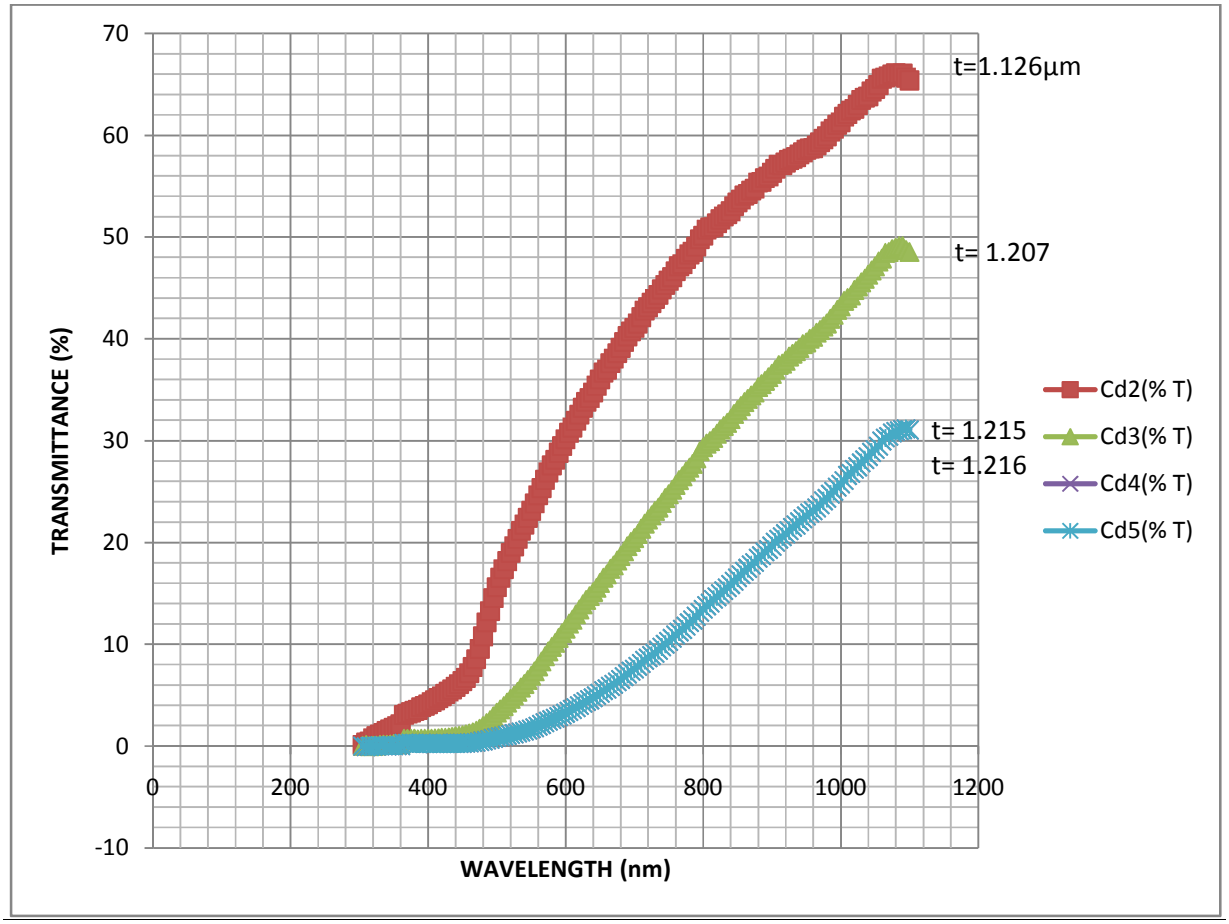

Fig.1: Spectral Transmittance of CdS films

Table 1: Bath constituents for the deposition of cadmium sulphide Thin Film

Slide No.	Vol. of Complexing agent (TEA) (mls)	Vol. of CdBr2 (mls)	Vol. of thiourea (mls)	Vol. of ammonia Solution (mls)	Time (hrs)	Thickness (µm)
Cd2	5.0	5.0	5.0	5.0	4.0	1.126
Cd3	5.0	5.0	5.0	5.0	6.0	1.207
Cd4	5.0	5.0	5.0	5.0	8.0	1.215
Cd5	5.0	5.0	5.0	5.0	10.0	1.216

The transmittance spectra of the fabricated films were obtained with a Janway 6405 UV/ Visible spectrophotometer. Structural and surface morphology of the films were carried out using an x-ray diffractometer with Cukα radiation

and Olympus Optical microscope respectively. Other solid state and optical properties of the films had been investigated in our earlier publication [6].

RESULTS AND DISCUSSION

Fig.1 is a plot of transmittance of CdS thin film as a function of wavelength. The optical transmittance spectra of CdS films deposited onto a glass substrate were studied at room temperature in the wavelength range of 300nm-1100nm. The optical transmittance spectra were obtained for the film deposited with different film thickness. The curves show high transmittance (67.5 %) for the film with the lowest thickness of approximately t = 1.126µm (Cd2) and low transmittance (30%) for the film with highest film thickness of approximately t = 1.216

The transmittance is low in the uv region for all the samples. In the visible the transmittance is moderate. The transmittance is highest in the near infra-red region of the spectrum. From this experiment one can infer that increase in the film thickness in the chemical bath deposition of CdS thin film reduces the transmittance of the film. Sample Cd2 with the lowest film thickness has a transmittance of approximately 67.5% at 1100nm, while sample Cd4 with the highest film thickness has a transmittance of approximately 30% at1100nm.

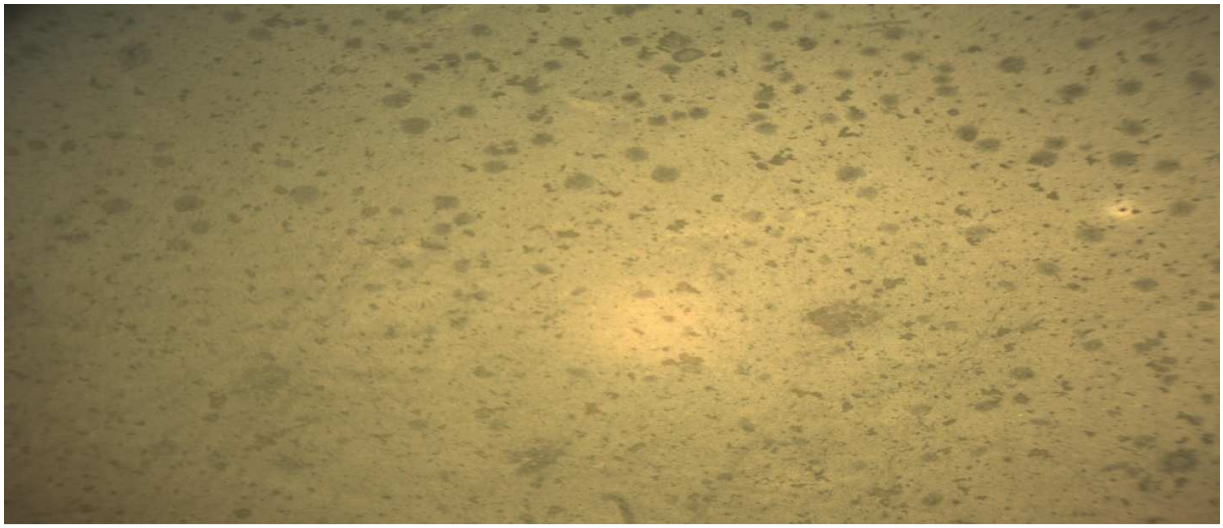

Fig.2: Optical Micrograph of CdS Thin Film

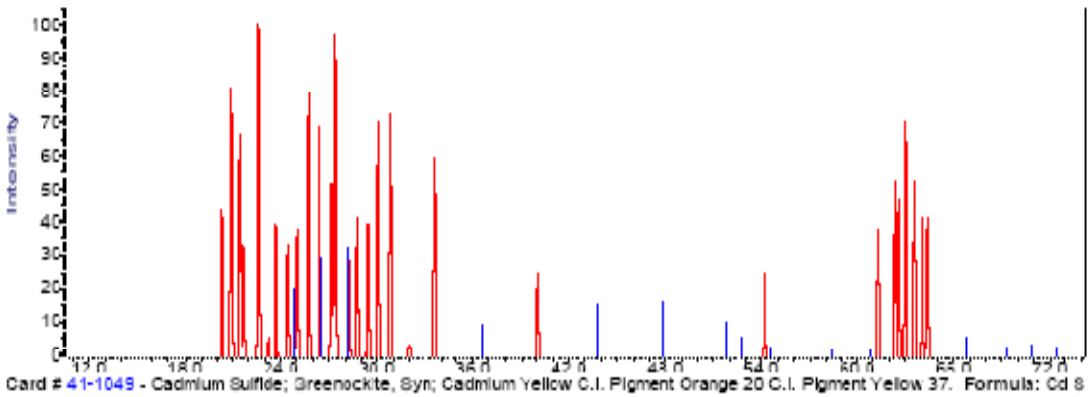

Fig .3: X – ray Diffraction spectra for CdS

Fig. 2 shows the optical micrograph of the deposited thin film. From the micrographs, it can be seen that the surface of the film is smooth and covers the glass substrate well. The grains are very small with unequal size and shape.

Fig.3 shows the x-ray diffraction spectra of CdS thin film. According to the XRD result, the chemically deposited film of CdS is of cubic zinc blend structure. This crystal structure is consistent with that obtained by Fumitaka et al. (1999)[7]. It has been reported that both hexagonal and cubic CdS can be grown by chemical bath (Kaur et al. (1980) [8]. From the XRD measurements, a lattice constant of 5.6954Å was calculated for CdS thin film in the (101) plane at a maximum intensity of 2 = 28.183 using Bragg's law given by n = 2dsin . This is in close agreement with 5.8320Å reported by Sze (1981) [9].

CONCLUSION

We have successfully deposited good quality thin films of CdS by CBD technique on glass substrate. The films were found to have high transmittance (67.5 %) for the film with the lowest thickness of approximately t = 1.126µm (Cd2) and low transmittance (30%) for the film with highest film thickness of approximately t = 1.216. XRD shows that the material is of cubic zinc blend structure, which is an important characteristic for device performance.

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