Synthesis and Characterization of Copper doped Cadmium Sulphide Thin Films by Electrodeposition Method

V. J. Fulari *, U. M. Chougale, A. S. Powar, S. V. Tikone, S. K. Shinde, G. M. Lohar, J. V. Thombare.

Holography and Material Research Laboratory,
Department of Physics,
Shivaji University, Kolhapur.416 004, Maharashtra, India
**Corresponding author Tel.: +91 231 2609224, Fax: +91 231 2690533*
E-mail address: vijayfulari@gmail.com

Abstract

Copper doped cadmium sulphide thin films were deposited using simple and inexpensive electrodeposition (ED) method. The concentration of copper was varied from 0.5 to 5% by volume. These films were characterized using X-ray diffraction (XRD), Fourier transform infrared (FTIR) spectroscopy and optical absorption. The XRD pattern revealed that the Cu doped cadmium sulphide films are hexagonal in nature. Formation of Cu-cadmium sulphide was confirmed from the FTIR studies. The optical absorption study showed existence of direct band gap of 2.25 eV.

Keywords: Copper doped cadmium sulphide, Electrodeposition, Optical absorption, Thin films etc.

1. Introduction:

Cadmium sulphide is an n-type semiconductor that has been used extensively in many applications, including photo resistance sensors, low cost solar cells for energy conversion, light emitting diodes, optical waveguides and nonlinear optical devices [1-4].

Different techniques have been used to fabricate cadmium sulphide thin films, such as vacuum evaporation, chemical bath deposition, sputtering, spray Pyrolysis and electrodeposition [5]. Electrodeposition is recognized as an important technique for the fabrication of multi-component thin films, due to exibility and the stoichiometric deposition of the materials. Copper impurity changes the type of CdS semiconductor from n to p. The Cu:CdS thin films have many applications, such as high efficiency photovoltaic cells and light emitters because the thin films of Cu:CdS are known to be sensitive to the absorption of electromagnetic radiation that on exposure to any form of radiation, is capable of exciting electron-hole pairs and can exhibit structural changes [6]. Moreover, the doping of copper changes the bandgap energy of CdS and also improves its photoelectrical properties. Different methods have been used to dope the CdS films by Cu, such as the thermal annealing of a Cu/CdS bi-layer [1]. The aim of the present work is to add a few percent of Cu in CdS and study the effect of copper on the optical, structural and photo-conducting properties of the CdS thin films prepared by electrodeposition.

2. Experimental

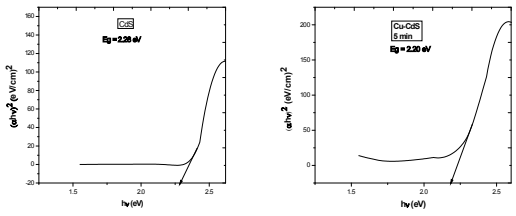
2.1 Preparation of Cu doped CdS thin film

Thin films of CdS and Cu:CdS have been prepared by electrodeposition method. CdS thin films were prepared by 10 ml of 0.05M $CdSO_4$, 10 ml of $0.05Na_2S_2O_3$ and 0.1 M solution of EDTA, which was vigorously stirred using a magnetic stirrer. For the preparation of Cu: CdS thin films , 0.6 ml solution of $CuSO_4$ solution with different percentages was added along with solutions of $CdSO_4$, $Na_2S_2O_3$ and EDTA in the initial stages of preparation. The rest of the process was same as in the case of preparation of pure CdS thin films.

3. Results and Discussion:

3.1 Optical studies:

Optical properties of thin film were calculated with the help of optical absorption and percentage transmission. The band gap of CdS and Cu: CdS thin film deposited by electrodeposition method was 2.2 eV and 2.25 eV, respectively.



(a) (b)

Fig.1: Optical absorption of CdS and Cu: CdS thin films

3.2 X-Ray Diffraction studies:

The structural analysis of CdS and Cu: CdS films were carried out using X-ray diffraction technique. Fig. 1(a) shows the X-ray diffraction pattern of CdS and Cu: CdS films on to stainless steel substrate. The XRD pattern contained sharp and high intense peak, suggesting hexagonal crystalline structure of CdS and Cu: CdS film.

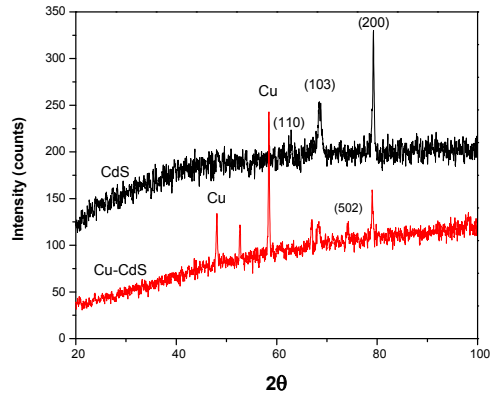
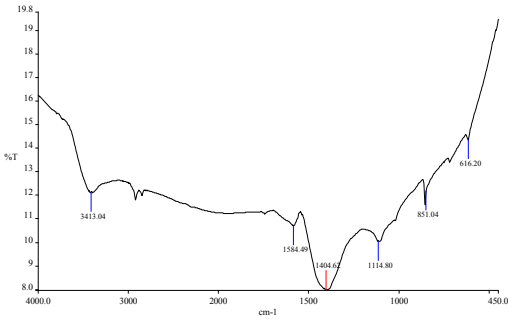


Fig. 2: XRD patterns of CdS and Cu: CdS thin films .

3.3 FT-IR studies

FT-IR study reaveled the formation of Cu doped CdS thin films.



(a) (b)

Fig.3 The position and vibration assignment of Cu-CdS thin film.

FT-IR spectrum of CdS film is presented in figure 3. The band at 3420.28 cm^{-1} is due to O-H stretching vibrations of water molecules. The bending vibrations of C=N appeared at 1584·49 cm^{-1}. CdS particles showed two stretching bands of C-O at 1114.80 cm^{-1}. At 623.42 cm^{-1} and 717.36 cm^{-1}, there are medium to strong bands which have been assigned to Cd–S stretching.

4. Conclusions:

An electrodeposition technique is an economical and relatively simple method for synthesis of CdS and Cu: CdS thin films. The electrodeposited Cu-CdS is nanocrystalline in nature with optical band gap of 2.25eV.

References:

1. Kashiwaba, Y., Sato, J. and Abe, T., Appl. Surface Science, 212-213, pp 162-165(2003).
2. Bacaksiz, E., Novruzov, V., Karel, H., Yanmaz, E.,Altunbas, M., Kopya, A.I. , J. Phys. D: Appl. Phys., 34, pp 3109-3112 (2001).
3. Ullrich, B., Bagnall, D.M., Sakai, H. and Segawa, Y, Journal of Luminescence, 87-89, pp 1162-1164 (2000).
4. Senthil, K., Mangalarj, D., Narayandass, S.K., Applied Surface Science, 169-170, pp 476-479 (2001).
5. Ulrich, B., Tomm, J.W., Dushkina, N.M., Tomm, Y.,Sakai, H. and Segawa, Y., Solid State Communications, 116, pp 33-35 (2000).
6. Oriaku, C., Osuwa, C., Njoku, C., Journal of Non-Oxide Glasses, 3-1, pp 25-30 (2011).

.