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The properties of chemical bath deposited cadmium sulfide thin films with the effect of ammonia salt concentration

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ABSTRACT

Cadmium sulfide thin film was prepared on glass substrate by a chemical bath deposition technique using aqueous cadmium chloride and thiourea solutions in a basic medium a (pH ~ 11.8) at 90°C for 4 hours. The structural and morphological properties of films obtained by CBD were investigated using X-ray diffraction, Scanning and Electron Microscope, Energy Dispersive X- ray Spectrometer, FT-IR Spectroscopy and photoluminescence. X-ray pattern showed that the CdS thin film deposited without any complexing agent was grown on an amorphous phase. SEM image showed that the CdS thin film deposited homogeneous, uniform grain size and good adhesion to the substrate. The band energy gap value was found as 2.61 eV.

Keywords: CdS, XRD, SEM, EDAX, FT-IR and Photoluminescence.

INTRODUCTION

Cadmium sulphide (CdS) is semiconductor material. It is used extensively in photo sensors, transducers, optical detectors, and other devices. In the last five decades, CdS has been one of the most investigated thin film semiconductors for photovoltaics. Today CdS is considered as the best-suited window material for both CdTe and CuIn(Ga)Se_2 solar cells [1-3]. The most important parameter for transparent thin films used for optical window applications due to the band gap energy. There are several deposition techniques used for the deposition of thin film CdS including sputtering [4] chemical bath deposition [5],thermal evaporation [6] chemical vapour deposition [7] close space sublimation [8], molecular beam epitaxy [9] and spray pyrolysis [10] screen printing and electrolysis. Each deposition process produces different structural, electrical and optical properties of the CdS thin films.

Among the different technique Chemical bath deposition is now widely used for the elaboration of low cost polycrystalline thin film solar cells because it offers the advantages of economy, convenience and the capability of large area deposition. Cds thin films can be achieved by chemical bath deposition in an alkaline aqueous solution consisting of thiourea, cadmium salts and ammonia. In CBD method ammonia is mainly used as a complexing agent for the cadmium ions in the reaction solution and the bath temperature was maintained at around 90°C and the deposition time was 4 hours. Many researchers investigated the optical properties of CdS thin films, but few have studied the relation between bandgap energy and film thickness and the tailing in the forbidden bandgap. In this work the Cds thin films can be prepared by chemical bath deposition method and measured the structural, optical, electrical and magnetic properties of the films.

MATERIALS AND METHODS

The glass substrate(35 X 25 X 1)mm used in the present study. They were rinsed with distilled water and treated with NaOH solution. The alkaline agent dissolves fatty material by saponification and renders then wet. After rinse

with disstilled water, the substrates were kept in ultrasonic agitator for 30 minutes to remove organic impurities. Finally substraes were clened with isopropyl alcohol vapours and hence enhance the removal of surface contaminates. The substrates were then heated in an oven for about 45 minutes at a temperature 100^{o}C. Drying and dust removal finally makes them ready for the coating process. Any slight marks found on the substrates mean that the whole process must be repeated.

The chemical bath deposition (CBD) method was employed to deposit CdS thin films on to glass substrates using thiourea as sulphide ion source and cadmium chloride as cadmium ion source in ammonia bath. the molar solutions of $CdCl_2$(0.05M) and thiourea (0.2M) were prepared using doubly disstilled water. NH_4NO_3 solution (0.1M) was then added to the $CdCl_2$, the pH of solution was maintained at 11.8 with the pH meter for the film deposition. The substrate were immersed in solution containd in glass beaker placed in side a water bath.The bath temperature was maintained at around 90^{o}C and the depositon time was 4 hours. From theses condition uniform film deposition on all substrates was achieved. the coated film was processing for characterisation studies such as opticall studies, X- ray diffraction, SEM and EDAX.

RESULTS AND DISCUSSION

3.1. Quantitative element analysis (EDAX)

Structural, surface morphology and elemental composition analysis of CdS thin flims by chemical bath deposition technique using aqueous cadmium chloride and thiourea solutions in a basic medium a (pH ~ 11.8) at 90^{o}C for 4 hours.

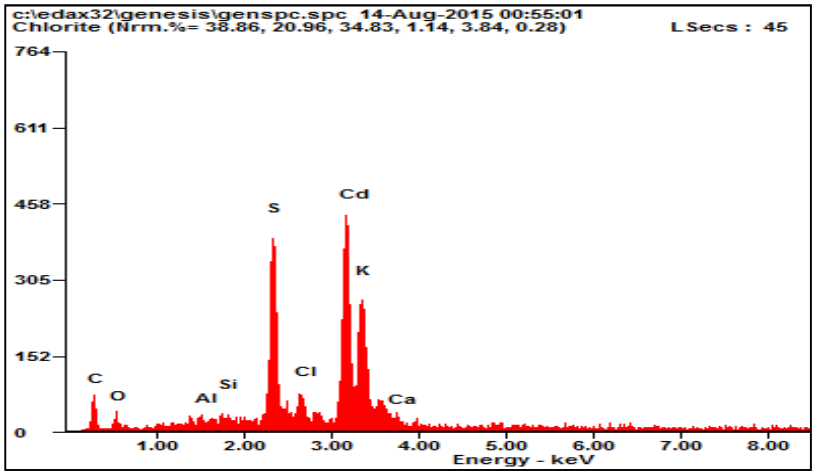

Fig.1. Elemental analysis of CdS thin film (5:3:2:1)

EDAX results which are consistent with the formation of thin flms of CdS deposited on silica glass substrates.it is widely known that CBD processees are associated with films which possess a relatively high concentration of impurities.

The energy dispersive X-ray spectra shows that the expected elements detected in the thin film. the small percentage of S, Cd, Cl, K,C and O elements is presnet in the thn films.it is thought that these elements may probably result from chlorite used as substrate.

3.2. Fourier transform infrared spectroscopy

The FT-IR spectra of CdS thin films are shown in Figures.1 and FT-IR spectrum, using Perkin Elmer Spectrophotometer in the frequency range 400-4000 cm^{-1} with KBr pellet techniques.

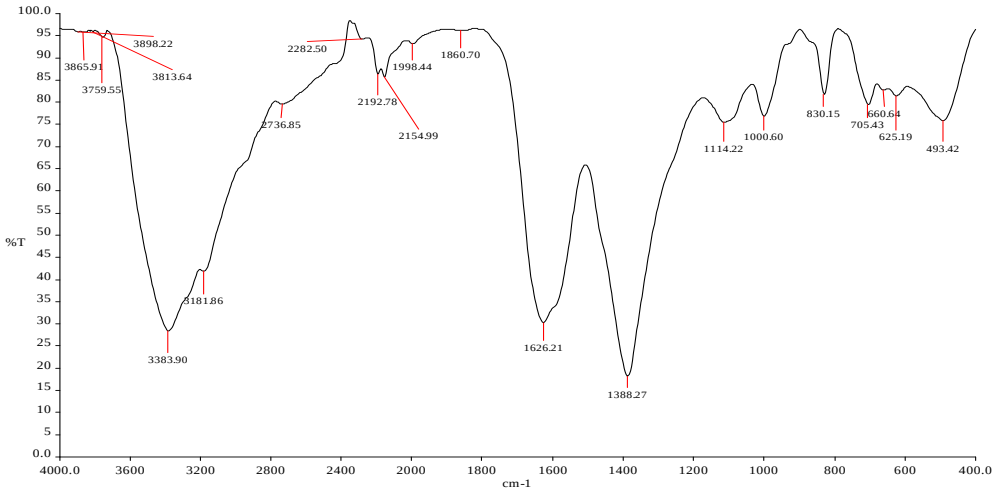

Fig.2. Analysis of CdS thin film sample

Figure .2 shows that are the frequency 3383.90 cm^{-1} is due to - OH stretching. The frequency of 3181.86 cm^{-1} is N-H stretching mode is due to NH^2 group in ammonium nitrate. The presence of thiourea in the sample is identified by the frequency 1388.22 and 1114.22 cm^{-1} for the stretching of C-N and N=O respectively. The frequency of 1000.60 cm^{-1} is due to stretching mode of S=O present in sulphate compounds and finally the frequency of 750.43 to 625.25cm^{-1} are due to stretching mode C-X (X is halogen) in cadmium chloride. Above all the frequency are confirmed in the form of CdS is presented the in this study.

3. 3. Structural properties

3. 3. 1. Crystal structure and size

XRD analysis is carried out on CdS films and typical diffraction patterns of as grown CdS thin films prepared by CBD technique on glass substrates with different thickness.

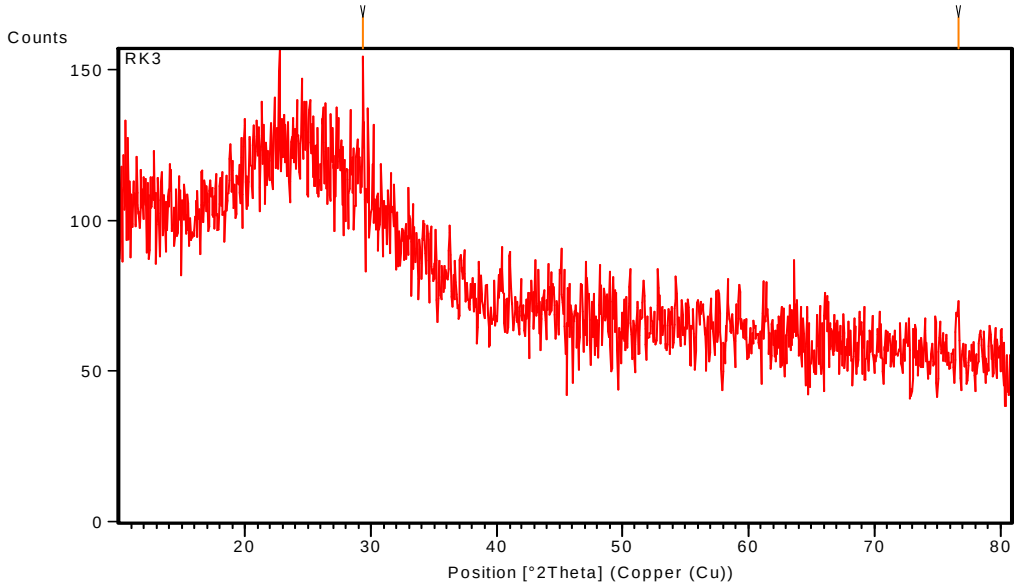

Fig.3. X-ray diffractogram of CdS thin film

The spectra are obtained by scanning 2θ in the range 10 - 80^o. The XRD pattern to confirm and presented the CdS thin film on glass substrate. The other smaller peaks were observed (21, 22, 29, 39 and 41) corresponding to the (113,111,100,200 and 110) planes respectively. It is clear from the high intensity peaks which indicate a significant increase in crystallite size with the cubic modification (worscheech et al 1995 and Hjelt et al 1997).

Table.1. X-ray diffractogram of CdS thin film data

Pos. [°2Th.]	Height [cts]	FWHM Left [°2Th.]	d-spacing [Å]	Rel. Int. [%]
29.3286	88.79	0.1949	3.04531	100.00
76.6340	19.58	0.3600	1.24239	22.05

3.4. Scanning Electron Microscopy

The scanning electron microscopy is a convenient technique to study the microstructure of thin films. It shows that most homogeneous film was obtained in the bath with (5:3:2:1) solution for 4 hours. In this case the slow deposition rate led to small uniform grain size and shape and the good adhesion to the substrate. We estimated the grain sizes from different grains within the films and found to be about 10 to 500nm.The SEM micrograph shows a cubical morphology and an irregular pattern without any void. It is clearly observed that the glassy nature along with amorphous phase of CdS thin films (nair et al 1987b). The grains are found to be thickly packed and also indicate that the grains are dense, smooth and without any visible pores.

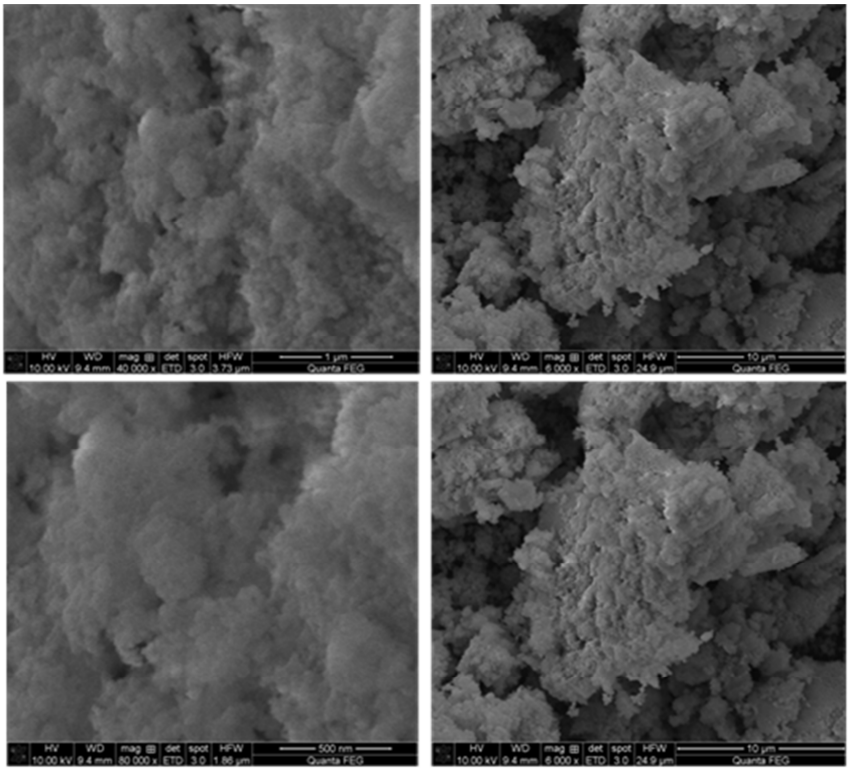

Fig.4. SEM images of CdS thin film at different magnitudes

3.5. Analysis of Photoluminescence spectroscopy

Preliminary investigations show that photoluminescence (PL) spectra of the obtained CdS thin films have two distinct bands at ca. 465 nm and ca. 549 nm, respectively.

The typical PL spectrum is presented in Fig.3 as reported; the PL spectra of thin films growth by the spray pyrolysis technique consist of a characteristic red band centered at about 465 nm. The apparition of this red band may be assigned to the excess of Cd^{2+} which leads to increase the defect quantity in the films, while the chemical bath deposited CdS thin films reported in has the PL band around 2.61 eV due to sulfur vacancies, without the corresponding excite band. Yet, in any cases, the PL spectrum of the CdS thin film under investigation has no red emission band. One might say that the obtained films are more or less stoichiometric. However, the Energy Dissipative X-ray (EDX) characterization is to be investigating for further detailed information in this regard.

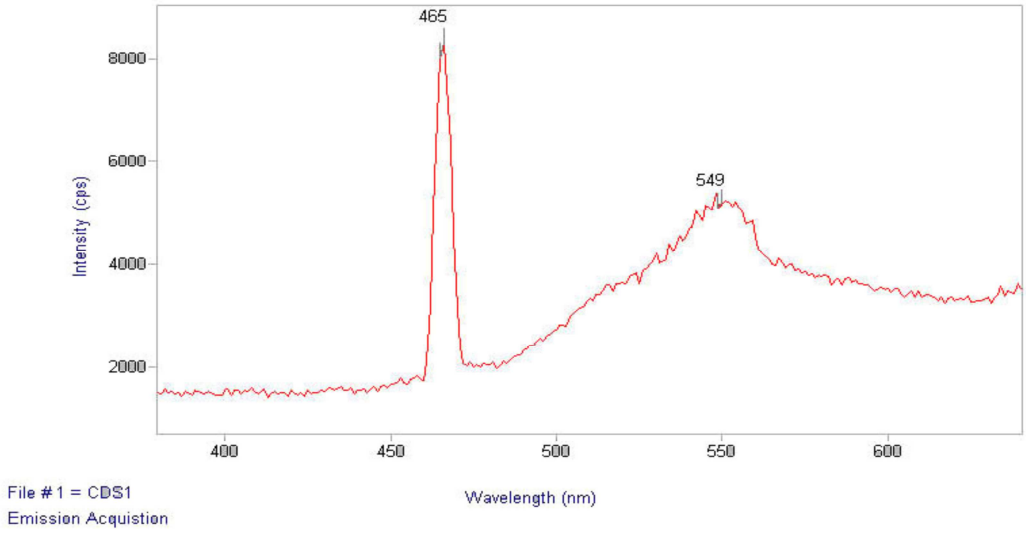

Fig.5. Photoluminacence spectra of CdS thin film

CONCLUSION

Cds thin film was obtained using the chemical bath depoition method. Which is simplest, least expenses to produce unifrom, adherent and reproducible large area thin film for solar related applications. The particle structure and size were determined using XRD. X-ray pattern showed that the CdS thin film deposited without any complexing agent was grown on an amorphous phase. The band energy gap value calculated from analysis of Photoluminescence spectra was found as 2.61 eV. SEM image showed that the CdS thin film deposited homogeneous, uniform grain size and good adhesion to the substrate.

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REFERENCES

[1] Irepins.S.Glynn, J.goutts, *Thin film Solar Technology*., **2009**, 520, 46235.
[2] M.A.islam M.S Hossain, M.M.Aliyu, P. Chelvanathan, Q. Huda M.R, Karim, K.Sopian, N.Amin, *Energy Procedia.*, **2013**, 33, 203.
[3] L.martil de laplaza, *Thin Solid Films*., **1984**, 120, 31.
[4] A. Punnoose, M.Marafi, G. Prabu, F.E. Akkad, *Phys, Status Solid A.*, **2000**, 453, 353.
[5] F.Ouachtari, *J. Mod. Phys*., **2011**, 02, 1073.
[6] A.Ashour, N. El-Kardry. S.A Mahmoud, *Thin Solid Films*., **1995**, 269, 117.
[7] D.Albin, H. Moutinho, K.Jones, NCPV Program Review Meeting., **2000**, 289.
[8] S. Petillon, A.Dinger, M.Gru, M. Hetterich, V. kazukauskas, C.Klingshirn, J,Liang, *J. Cryst.Growth*., **1999**, 202, 453.
[9] A.Ashour, *Turk.J. Phys*., **2003**, 27, 551.
[10] D.Barreca. A. Gasparotto, C. Maragno, E. Tondello, *J. Electrochem. Soc*., **2004**, 151.
[11] Worschech, L. Ossau, landwehr, *Physics review*., **1995**, 52, 13965-13974.
[12] K.Hjelt, M. Juvonen,T. Tuomi,S. Nenonen, E.E. Eissler, *Physica Status Solid*., **1997**, 162, 747-763.
[13] Nair, P.K, Nair, M.T.S, Campos, J. Sansores, *Solar Cells*., **1987**, 22, 211-227.
[14] H. Cachet, H. Essaaidi, M. Froment, *Journal of Electroanal Chemistry*., **1995**, 396, 175-179.
[15] Gibson , P.N. Ozsan, M.E. lincot, D. Cowache, *Thin Solid Films*., **2000**, 34, 361-362.
[16] V.Bilgin, S.kose, F.Atay, I.Akyuz, *Mater. Chem. Phys.*, **2005**, 94, 103.
[17] Ikhmayies sj ahmed bitar RN, Thickness Dependence of the bandgap energy and urbach tail for Cds thin films prepared by vacuum evaporation In: proceedings of the eleventh world renewable energy congress and exhibition., **2010**, 79-84.
[18] P. Sahay, P. Nath, S.Tewari, *Cryst. Res. Technol*., **2007**, 42, 80.