International Journal of Macro and Nano Physics, Vol. 3(2) 2018, pp. 1-5

RESEARCH ARTICLE

Structural and Optical Properties of Cds Thin Films Prepared at Room Temperature by Chemical Bath Deposition Technique

*S Prabahar[1], S Srikanth[1], U Karunanithi[1], R.T Karunakaran[1], T Samidurai[1]
[1]Department of Physics, Government Arts College, Udumalpet, Tamilnadu, India.

Received- 14 December 2016, Revised- 10 January 2018, Accepted- 30 January 2018, Published- 10 February 2018

ABSTRACT

A thin film of CdS is a semiconducting film material used to fabricate hetero-junction solar cell. Chemical Bath Deposition (CBD) is a simple and inexpensive technique of depositing thin films in large area. CdS thin films deposited on to a well cleaned glass substrate at room temperature by chemical bath deposition method, using aqueous solutions of cadmium chloride and thiourea. At higher deposition time period, polycrystalline films of preferential orientation along (101) and other planes with hexagonal structure is observed. As the deposition time period increases the grain size as well as the intensity of preferential orientation along (101) and other planes increases. This optical study on the films shows the absorption spectra mechanism as a direct transition.
Keywords: Thin Films, Solar cell, Chemical Bath Deposition, Grain Size, Absorbance.

1. INTRODUCTION

At present extensive researches are carried out to develop varieties of binary and ternary semiconductor thin films, this is because of their vast applications in solar cells, gas sensors and photoconductive, optoelectronic and infrared detector devices. CdS thin films are widely used since they are simple, cost effective, abundantly available, non-toxic, eco-friendly and semi-conductive. CdS thin films can be prepared by several techniques like pulsed laser and electro-deposition, CBD, vacuum evaporation, electrochemical atomic layer, molecular beam epitaxy and photochemical methods. The integral components can be prepared easily and the required apparatus are commonly available in laboratories. [1-10]. X-ray diffraction and UV-Vis spectroscopy methods are used to find out the results of this survey on structural and optical characteristics of CdS thin films respectively. [11] systematically investigates the structural and optical characteristics, and synthesis of CdS thin films using CBD technique. It uses cadmium chloride, thiourea and ammonia as Cd^{2+}, S^{2-} and complexing agent respectively. And the XRD study reveals that the resulted films are nano-crystalline with hexagonal structure. Scanning electron microscopy result shows that Cds films exhibit smoothness and homogeneity. [12] Preparation of cubic CdS thin films by CBD method is carried out and the structural properties are analyzed using XRD. As per the electrical characterization, it is confirmed that deposition time or bath temperature can control the dark conductivities of CdS films. [13] Deposition of CdS nano-crystalline thin films onto glass medium is done and the study validates that the nano particles are sized between 3.8 and 8nm, which are nano-crystalline with cubic structure. [14] has studied the impact of thiourea on structural and optical characteristics of CdS thin films and has found out that there is increase in optical band gap of films with respect to increase in thiourea concentration. Comparing to the literature studies, our proposed method using CBD method has yielded high deposition rate and thus it has the potential to be applied in cost effective solar devices.

2. MATERIALS AND METHODS

CdS thin films deposition is based on the reaction of Cd^{2+} and S^{2-} in deionised water solution. Cadmium chloride, thiourea, triethanolamine and ammonia are used in chemical baths to deposit CdS thin films, where the role of ammonia is to adjust the pH of the solution. Thin film deposition normally occurs at room temperature and

*Corresponding author. Tel.: +918056012970
Email address: prabusr80@gmail.com (S.Prabahar)
Double blind peer review under responsibility of DJ Publications
http://dx.doi.org/10.18831/djphys.org/2018021001

the preferred pH value is 12. The present work uses the molar proportion of cadmium chloride and thiourea as 1:1. The substrates are positioned vertically 12 to 24 hrs in the bath.

3. RESULTS AND DISCUSSION

The X-ray diffraction patterns are imdomitable to find the structural constraint information of thin film. The XRD patterns of the chemically deposited CdS thin films for different deposition time periods 12 and 24 hrs at room temperature are shown in Figure 3.1 and 3.2.The deposited CdS film is empirical to be in hexagonal structure.

3.1. X-ray diffraction studies

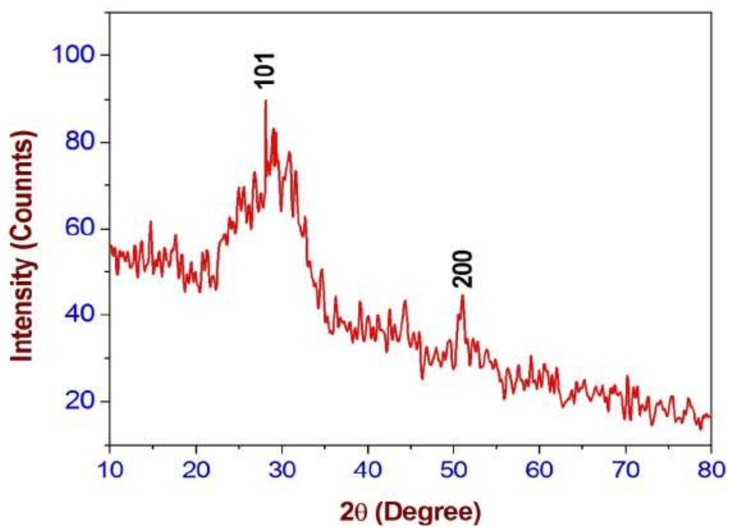

Figure 1.XRD pattern of CdS thin films of deposition time period 12hours at room temperature

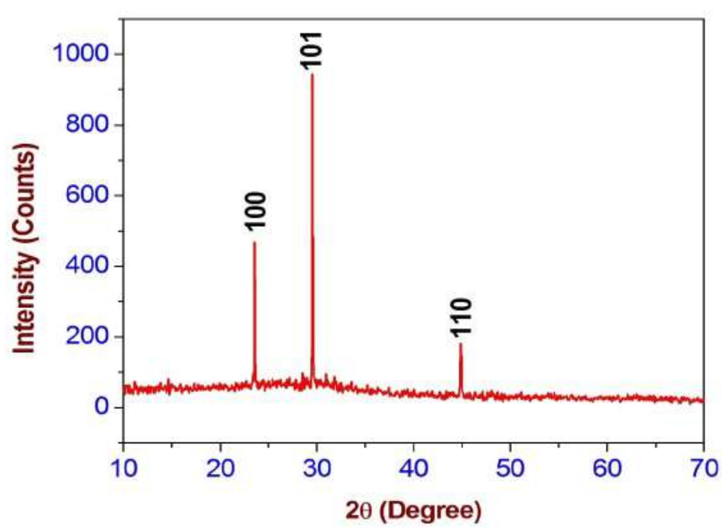

Figure 2.XRD pattern of CdS thin films of deposition time period 24 hours at room temperature

The intensity of the leading peak (101) increases with increase in deposition time period, demonstrating the higher degree of privileged orientation towards this direction [15]. The lattice parameters are determined from the peaks in diffractograms happen together comparatively well with the standard JCPDS data [80-0006] and are tabulated in table 1. Table 2 shows a qualified study of the grain size, dislocation density and strain of the CdS films of two different deposition time periods. It is experiential that grain size increases with increasing deposition time

Table 1.Comparison of calculated and standard 'd' and '2θ' values of the CdS thin films for different deposition time period 12 and 24 hours at room temperature

pH value	Time Period (hrs)	Thickness (Å)	hkl planes	2θ values (degree) JCPDS	(degree) EXPT	d-spacing values (Å) JCPDS	(Å) EXPT	FWHM (β)
12	12	1520	101	28.32	28.88	3.09	3.08	1.108
			200	51.15	51.81	1.79	1.76	0.7872
	24	3500	100	24.92	23.39	3.80	3.82	0.1476
			101	28.33	29.55	3.02	3.02	0.1476
			110	43.91	44.88	2.01	2.01	0.1968

Table 2.Structural parameters of CdS thin films for different deposition time period 12 and 24 hours at room temperature

pH value	Time Period (hrs)	Thickness (Å)	hkl planes	Grain size D (Å)	Strain (ε) (Lines^{-2} m^{-4}) 10^{-4}	Dislocation Density (Lines/m^2)10^{15}
12	12	1520	101	72.60	49.860	18.97
			200	117.2	39.220	7.276
	24	3500	100	574.4	6.301	0.303
			101	581.7	6.222	0.295
			110	456.6	7.928	0.479

period from12 to 24 hrs. Due to the increase in particle size corresponding to the increase in the deposition time period, the defects in the lattice decrease which in turn reduce the internal micro strain and dislocation density.

3.2. Optical studies

Optical properties of thin films are significant in the science, technology and industrial sectors in developing novel optical devices. Optical absorption studies enable analyzing certain attributes with respect to the band structure of materials. Optical properties of CdS thin films are reported with the help of absorption spectra in the UV–visible region. Figure 3.3 illustrates the UV visible absorbance spectra of CdS thin films of deposition time period 24 hours at room temperature with pH 12.

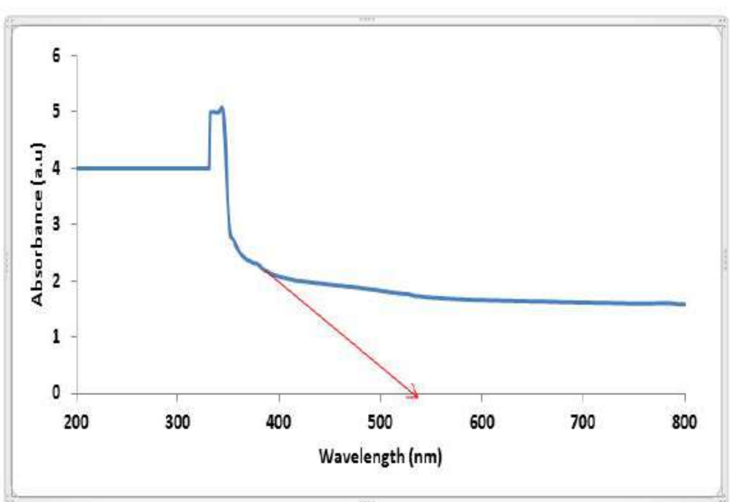

Figure 3.UV Visible absorbance spectra of CdS thin film of deposition time period 24 hours at room temperature

The absorbance characteristics of the deposited CdS thin films are analyzed in the wavelength range 200 to 800 nm. The sharp absorption edge confirms that the CdS thin film has good optical band edge property. Fundamental absorption determines the characteristics of band gap and can be estimated by the direct transition between the edges of valance and conduction band. The resultant energy gap value obtained with the sample prepared at pH 12 in 24 hours deposition time period is 2.45eV, which is a good concord with those reported for CdS thin films prepared by other techniques [16].

4. CONCLUSION AND FUTURE RECOMMENDATION

CdS thin films fabricated by CBD method shows that the film is polycrystalline with hexagonal structure. The grain size predictable is in the range of 72 to 581nm. This grain size and large surface area may be applied for the solar cells as well as in large area electronic devices. The optimum condition for the attainment of CdS band gap is 2.45eV. The investigational results declare that the CdS thin films with this band gap suits well for the design of optical devices. Still further studies can be elaborated with the aim of its application in high throughput of solar modules.

REFERENCES

[1] D.K.Kaur, K.L.Pandya and J.Chopra, Photovoltaic Effect of Chemically Deposited Cu2S/CdSi Heterojunctions, Electrochemical Soceity, Vol. 127, 1980, pp. 943-946.

[2] P.K.Nair, M.T.S.Nair, V.M.Garcia, O.L.Arenas, Y.Pena, A.Castillo, I.T.Ayala, O.Gomezdaza, A.Sanchez, J.Campos, H.Hu, R.Suarez and M.E.Rincon, Semiconductor Thin Films by Chemical Bath Deposition for Solar Energy Related Applications, Solar Energy Mater and Solar Cells, Vol. 52, 1998, pp. 313-344.

[3] R.Brindha and K.B.Renuka Devi, Fundamental Properties of Chemical Bath Deposited Bi2S3 Thin Films, International Journal of Macro and Nano Physics, Vol. 1, No. 1, 2016, pp. 70-76, http://dx.doi.org/10.18831/djphys.org/2016011007.

[4] W.E.Howard, C.R.Kagan and P.Andry, Thin Film Transistors, Editors, Marcel Dekker Inc, New York 2003.

[5] V.L.Chandraboss, J.Kamalakkannan and S.Senthilvelan, Synthesis and Characterization of UV Active Photocatalyst Cd@SiO2 and its Photovoltaic Performance, DJ Journal of Engineering Chemistry and Fuel, Vol. 2, No. 2, 2017, pp. 25-35, https://dx.doi.org/10.18831/djchem.org/2017021003.

[6] B.Subash and M.Shanthi, Photocatalytic Detoxification of NBB Dye Over Cerium Loaded Ag–ZnO Photocatalyst Under UV-A Light Irradiation, DJ Journal of Engineering Chemistry and Fuel, Vol. 2, No. 1, 2017, pp. 30-40, https://dx.doi.org/10.18831/djchem.org/2017011004.

[7] A.Romeo, M.Terheggen, D.Abou-Ras, D.L.Batzner, F.J.Haug, M.Kalin, D.Rudmann, and A.N.Tiwari, Development of thin-film Cu (In, Ga) Se2 and CdTe Solar Cells, Progress in Photovoltaics: Research and Applications, Vol. 12, 2004, pp. 93-111.

[8] O.V.Salata, P.J.Dobson, P.J.Hull and J.L.Hutchinson, Fabrication of CdS Nanoparticles Embedded in a Polymer Film by Gas-Aerosol Reactive Electrostatic Deposition Technique, Thin solid films, Vol. 251,No. 1, 1994, pp.1-3.

[9] T.Arai, T.Yoshida, and T.Ogawa, Photoacoustic and Luminescence Spectra of CdS Fine Particles, Japanese Journal of Applied Physics, 26, 1987, pp. 396.

[10] U.Karunanithi, S.Prabahar, S.Srikanth and R.T.Karunakaran, Structural and Optical Properties of Zinc Doped CdS Thin Films Prepared at Bath Temperature 80^{o}C by Chemical Bath Deposition Technique, International Journal of Macro and Nano Physics, Vol. 1, No. 2, 2016, pp. 8-13, http://dx.doi.org/10.18831/djphys.org/2016021002.

[11] Sachin Rondiya, Avinash Rokade, Bharat Gabhale, Subhash Pandharkar, Madhavi Chaudhari, Abhijit Date, Minakshi Chaudhary, Habib Pathan and Sandesh Jadkar, Effect of Bath Temperature on Optical and Morphology Properties of CdS Thin Films Grown by Chemical Bath Deposition, Energy Procedia, Vol. 110, 2017, pp. 202-209, https://doi.org/10.1016/j.egypro.2017.03.128.

[12] H.Moualkia, S.Hariech and M.S.Aida, Structural and Optical Properties of CdS Thin Films Grown by Chemical Bath Deposition, Thin Solid Films, Vol. 518, No. 4, 2009, pp. 1259-1262, https://doi.org/10.1016/j.tsf.2009.04.067.

[13] Abdullah M.A. Al-Hussam and Salah Abdul-Jabbar Jassim , Synthesis, Structure, and Optical Properties of CdS Thin Films Nanoparticles Prepared by Chemical Bath Technique, Journal of the Association of Arab Universities for Basic and Applied Sciences, Vol. 11, No. 1, 2012, pp. 27–31.

[14] Rehana Zia, Madeeha Riaz, Quratul ain and Safia Anjum, Study the Effect of Thiourea Concentration on Optical and Structural Properties of CdS-Nanocrystalline Thin Films Prepared by CBD Technique, Optik - International Journal for Light and Electron Optics, Vol. 127, No. 13, 2016, pp. 5407-5412, https://doi.org/10.1016/j.ijleo.2016.02.081.

[15] P.N.Gibson, M.E.Ozsan, D.Lincot, P.Cowache, D.Summa, Modelling of the Structure of CdS Thin Films, Thin Solid Films, Vol. 36, 2000, pp. 34-40.

[16] S.Prabahar, M.Dhanam, CdS Thin Films from Two Different Chemical Baths Structural and Optical Analysis, Journal of Crystal growth, 2005, Vol. 285, pp. 41-8.