NOVATEUR PUBLICATIONS
International Journal of Research Publications in Engineering and Technology [IJRPET]
ISSN: 2454-7875
VOLUME 3, ISSUE 10, Oct. -2017

PREPARATION, CHARACTERIZATION AND OPTICAL PROPERTIES OF CDSE THIN FILMS

H. R. KULKARNI
K J College of Engineering and Management Research, Pune. Email: hrkulkarni@rediffmail.com, Mob: 9822757075
(Author for correspondence)
S. D. CHAKANE
Arts, Science and Commerce College, Indapur, Maharashtra, India.

ABSTRACT:

CdSe thin films were deposited by pulsed electrodeposition technique onto stainless steel substrates in galvano statics mode by using an aqueous acidic bath containing CdSO4 and SeO2 in optimized proportion. The growth progress of the film was studied. The deposition parameters such as concentration of electrolyte, time of deposition of film, current density and pH of electrolyte are optimized. The analysis of such deposited filmwas done with electron dispersive spectra (EDS) and X-ray Diffraction (XRD), showed presence of polycrystalline nature of the deposited film.The Scanning Electron Microscope (SEM) gives the surface morphology of the deposited filmsand is observed well adherent and grains are uniformly distributed over the surface of substrate.

KEY WORDS: Electrode position, SEM XRD, EDS, CdSe.

INTRODUCTION:

The current scenario in the study of thin films shows special interest of researchers due to the versatile expected applications of such thin films in the fields of science and engineering which helps to develop promising semiconductor devices, and photovoltaic devices as well as to find different metallic coatings with good results, testing techniques of surface morphology in different fields of engineering etc. This technology is developing aggressively due to its promising applications. Due to large number of applications of photo electrochemical solar cells, many researchers are working to develop new thin film with polycrystalline materials having acceptable efficiency.[1-4]

Researchers are obtaining the CdSe thin films deposited by using different techniques viz. Electrode position, SILAR, chemical bath deposition, molecular beam epitaxy, thermal evaporation, metal oxide chemical vapor deposition, spray pyrolysis [5-14] etc.

Among the elements of group II-VI, CdSe compound is observed a promising semiconductor material for obtaining hetero junction solar cells [15]. This material can be advantageously used for low cost applications only due to its high photosensitivity in the wide visible range of the solar spectrum and their suitable band gap,.Many researchers have studied the growth techniques with different conditions to deposit these thin films and showed its remarkable use in device fabrication[16-17]. The special interest of researchers is seen to find the use of photo electrochemical (PEC) solar cells with low-cost energy conversion by using such semiconducting materials[18-22].

In present study, we have developed polycrystalline thin films of CdSe by using electrode position technique onto stainless steel substrate from an acidic bath. The structural, optical and photo electrochemical properties of such deposited CdSe thin films have been studied and the results are discussed.

METHODOLOGY FOR THE DEVELOPMENT OF CDSE THIN FILMS:

CdSe thin film was developed onto stainless steel substrate by using pulsed electrodeposition technique. The stainless steel substrates were used as the cathode in three electrodes cell along with graphite as the counter electrode and saturated calomel electrode (SCE) as a reference electrode. CdSe thin films were cathodically electro-depositedonto stainless steel from aqueous bath containing 0.05M CdSO4 and 0.05M SeO2 solutions. The pH of the electrolyte was adjusted by using appropriate concentration of H2SO4. The electrodeposition potentials were determined by using polarization curves. All potentials were measured with respect to SCE. The effects of ratio of composition of electrolytes used, temperature of bath, pH of bath, etc. on deposition potentials were studied. The stainless steel substrates were cleaned by using double distilled water. The distance between the electrodes was kept 1cm constant during all the depositions. The CdSe film was observed well deposited on stainless steel substrate at optimized condition. The growth kinetic of film was studied in detail by varying pH of bath and remaining deposition parameters.

RESULTS AND CONCLUSION:

The polarization curve was plotted for the determination of exact optimized deposition potential,. The correct optimized potential observed is 1700mV with respect to SCE and was adjusted to develop the films where the current density observed is1.6 mA/cm2. The film developed with this potential was found

uniformly thick and is shown in Fig1.A fine CdSe thin film formation occurred on the surface of substrate used. The formation process of the film is time dependent. The developed films are dried and well preserved in desiccators for further study. The observed current density is varying from 0.7 to 5.1 mA/cm2. The thickness of film was observed less at other deposition conditions other than 1.6mA/cm2.

The PEC cell in n-CdSe / polysulphide /C is illuminated with 200W tungsten filament lamp. The photons with energy equal to or greater than the energy band gap of CdSe are absorbed on semiconducting material resulted into formation of the electron-hole pairs. These electron hole pairs are separated by local electric field present across the interface between semiconductor and poly sulphide electrolyte caused for the development of photo voltage under open circuit condition. The variation of Isc and Vocis shown in Fig 2. The value of Isc and Vocare observed relatively higher at deposition time 50sec having pH of bath1.5.The observedoptimum thickness of CdSe thin film at this conditionis shown in Fig 3.Such developed CdSe thin film under optimizedcondition was further characterized with X-ray diffraction (XRD) pattern is shown in Fig 4. The XRD analysis shows that film is polycrystalline, where some sharp peaks are identified at (1 1 1), (2 2 0), (3 1 1) and (4 2 2) planes of CdSe. The standard 'd' values and observed 'd' values for CdSe are in close agreement with each other and are mentioned in Table 2. The elemental analysis was performed for the optimized CdSe film deposited using electrodeposition technique. The obtained electron dispersive spectra (EDS) shows the presence of both Cd and Se, which gives the qualitative confirmation of electrodeposition of CdSe film which is shown in Fig5. This is an agreement with the structural analysis discussed above in XRD study. This confirms the material deposited is CdSe.

The surface morphology of CdSe thin film under optimized condition was studied by SEM. The SEM micrograph shows that the film is well adherent and smooth. The surface morphology of CdSe film prepared under optimized condition exhibits grain of uniform size about 15Å spread all over the surface shown in Fig6 and Fig7. Atomic composition observed is given in Table3.

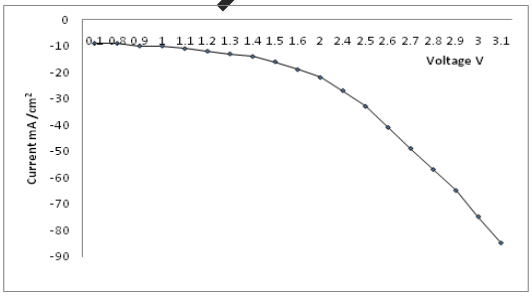

Fig 1: Optimization of deposition potential

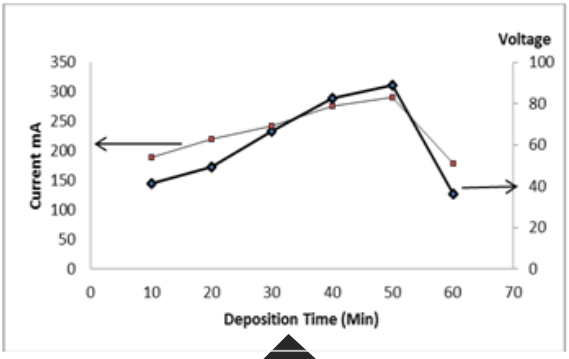

Fig 2.IscvsVoc reported for the film at pH 1.5

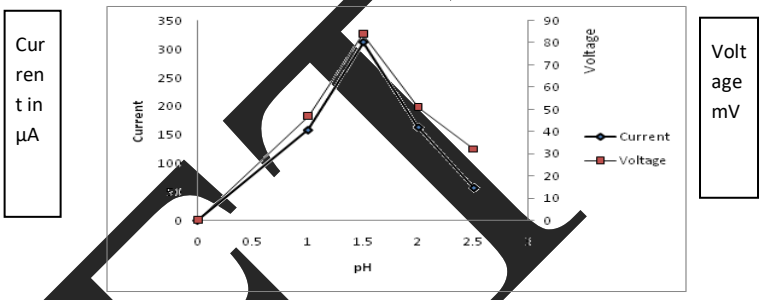

Fig 3A pH

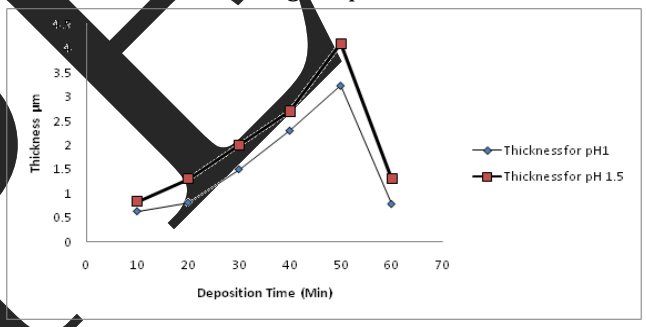

Fig 3B. Thickness of film at different pH

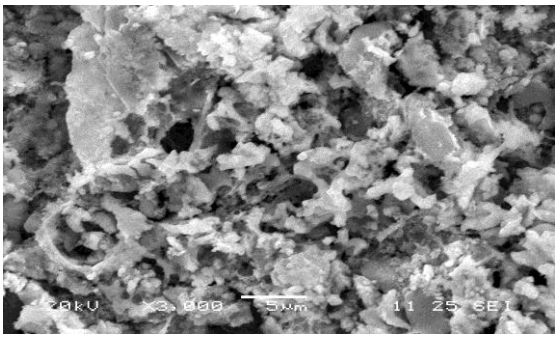

Fig 6: SEM of CdSe film

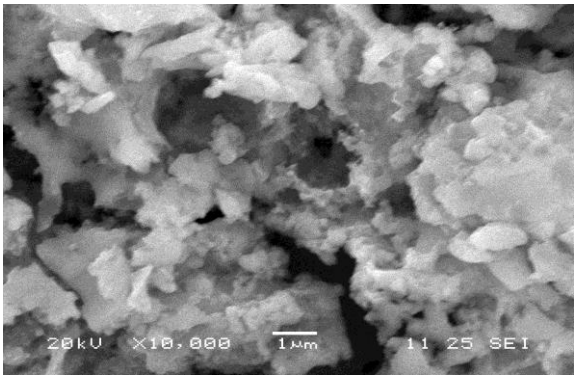

Fig7: SEM of CdSe thin film

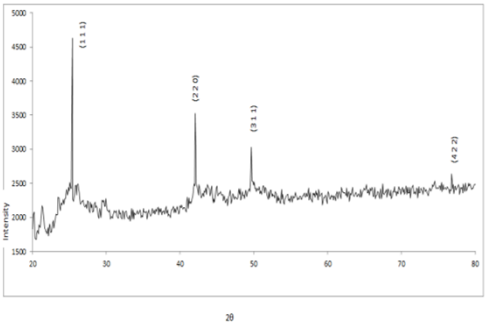

Fig 4 XRD

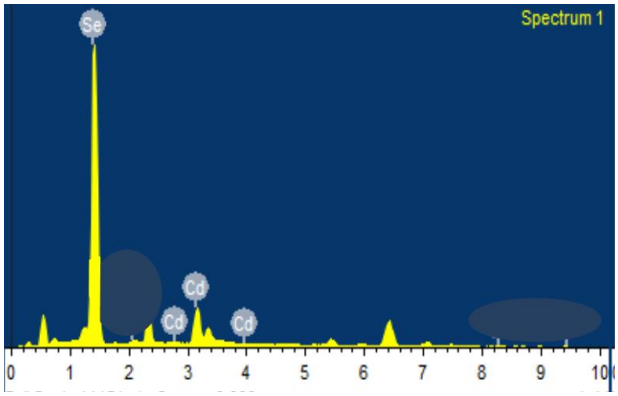

Fig 5. EDS

Table 1: Optimized parameters of CdSe film

Sr No	Optimized Parameter	Values
1	Deposing potential	1.7V
2	Current Density	1.6mA/cm2
3	Deposition time (min)	50
4	pH of both	1.5
5	Temperature of bath	50 C

Table 2: Some Standard and observed values of 'd' for CdSe film by using ASTM data

2θ	Plane (hkl)	Standard 'd' A°	Observed 'd' A°
25.37	1 1 1	3.51	3.68
42.08	2 2 0	2.15	2.37
49.65	3 1 1	1.83	2.03
76.81	4 2 2	1.24	1.33

Table 3: Atomic composition of Cd and Se recorded from EDS of CdSe film

Sr No	Element	Weight %	Atomic %
1	Se	52.27	51.37
2	Cd	47.73	48.63
		Total = 100	100

CONCLUSION:

Stoichiometric CdSe thin film formed by electrodeposition technique was taken by using acidic bath. The film was developed at optimized pH, temperature of bath and deposition time is polycrystalline with cubic structure and the particle sizes are found to be 15Å.

ACKNOWLEDGEMENT:

We would like to thank Management of Arts, Science and Commerce College, Indapur for providing laboratory facility to complete the experimental work mentioned in this paper.

REFERENCES:

1) V. L. Mathe, K. Y. Rajpure and C. H. Bhosale *Bull Mater.Sci.* 22:927 (1999).
2) K. Y. Rajpure, C. D. Lokhande and C. H. Bhosale.*Mater. Chem. Phy*252:51 (1997)
3) N. G. Patel., *Solid State Electrochem*. 35:1269 (1992).
4) H. J. Goldsmid and J. E. Giutornich, M. M. Kalia., Solar energy 24: 435 (1980).
5) D. Y. Chae, K. W. Seo, S. S. Lee, S. H. Yoon, W. Shim, *"CdSe thin films grown by MOCVD method using new single-source precursors,"* Bull. Korean Chem. Soc, vol. 27, pp. 762-764, 2006.
6) R. I. Chowdhury, M. S. Islam, F. Sabeth, G. Mustafa, S. F. U. Farhad, D. K. Saha, F. A. Chowdhury, S. H. and A. B. M. O. Islam, "*Characterization of electrodeposited cadmium selenide thin films,"* Dhaka Univ. J. Sci., vol. 60, pp. 137-140, 2012.
7) P. Nemec, M. Simurda, I. Nemec, D. Sprinzl, P. Formanek and P. Maly, "*Highly luminescent CdSe nanocrystalline films prepared by chemical bath deposition",*Journal of Crystal Growth, vol. 292, pp. 78-86, 2006.
8) S. M. U. Ishiwu , M. N. Nnabuchi and C. N. Ezea, "*The effects of deposition and annealing temperature and time on the optical and solid state properties of cadmium selenide (CdSe) thin films grown by chemical bath deposition technique*" Chalcogenide Letters, vol 8 no 1, pp 59-64 Jan 2011.
9) N. Gopakumar, P. S. Anjana and P. K. Vidyadharan Pillai, *"Chemical bath deposition and characterization of CdSe thin films for optoelectronic applications,"* J. Mater. Sci. vol. 45, pp. 6653-6656, Dec. 2010.
10) G. Bakiyaraj and R. Dhanasekaran, *"Effect of annealing on the properties of chemical bath deposited nanorods of CdSe thin films,"* R. Cryst. Res. Technol., vol. 47, pp. 960, 2012.
11) V. Qiumin Yang, Jie Zhao, et.al., "*Growth and annealing of zinc-blende CdSe thin films on GaAs (0 0*

1) by molecular beam epitaxy," Applied Surface Science, vol. 257, no. 21, pp. 9038-9043, Aug. 2011.

12) N. T. Talele, M. S. Kale and D. S. Bhavsar, "*Structural and optical properties of thermally evaporated CdSe thin films,"* IOSR Journal of Applied Chemistry (IOSR-JAC), vol. 9, no. 7, pp. 62-65, July 2016.
13) Fekadu Gashaw Hone, Francis Kofi Ampong, Tizazu Abza, Isaac Nkrumah, Robert Kwame Nkum and Francis Boakye, "*Synthesis and characterization of CdSe nanocrystalline thin film by chemical bath deposition technique,*" vol. 4, no. 2, pp 69-74 2015.
14) A. A. Yadav, M. A. Barote and E. U. Masumdar, "*Studies on cadmium selenide (CdSe) thin films deposited by spray pyrolysis*," Materials Chemistry and Physics, vol. 121, no. 1-2, pp. 53-57, May 2010.
15) C. D. Lokhande, R . V. Dabhade, P. S .Patil and S . H.Pawar, *Bull. Electrochem* 7 (1991) 319.
16) R. A. Boudrau and R .D .Rauh, *Solar Energy Mater.* 7 (1982) 835.
17) D. J .Miller and D. Hanemann, ibid. 4 (1981) 223.
18) N. Samarth, H. Luo and J . K. Furdyna, J*. Electron. Mater.*19 (1990) 543.]
19) X. Mathew J. Phy D. Appl. Phy. 33: 1565 (2000).
20) P. P. Hankare, S. D. Delekar, V. M. Bhuse, P. A. Chate, K. M. Goradkar, semiconductor Sci. Tehnolo 20:251 (2005).
21) Y. Wade. Nishimatsl. J. Electrochem. Sco.125: 1499 (197).
22) X. Mathew and P. J. Sebastian, Solar Energy Mater., Solar Cells 59: 85 (1999).