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STRUCTURAL AND OPTICAL PROPERTIES OF ZnS FOR STUDY OF THICKNESS DEPENDENT THIN FILMS

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Abstract: *Zinc sulphide (ZnS) thin films were deposited on glass substrate using relatively simple chemical bath deposition. method (CBD), using the mixed aqueous solution of zinc sulphate, thiourea and ammonia. The ammonia was used as the complexing agents. The preparative parameters are concentration, pH of solution, deposition time and temperature has been optimized. Thin films of ZnS with different thickness 100-350 nm were prepared by changing the deposition time from 20–100 minutes at 80^{0}C temperature. The effect of film thickness on structural and optical properties was studied. The thin films were characterized by using X-ray diffraction (XRD) and Fourier transformation, Infrared spectroscopy (FTIR). The effect of thin films thickness on optical and structural properties has been studied.*
Keywords: *Zinc Sulfide, Thin films, structural and optical properties*

Introduction

Zinc Sulfide ZnS is a semiconductor with large band gap which becomes highly efficient luminescent material belongs to II-VI group. ZnS thin films have also been widely studied due to their employment in an antireflection coating for heterojunction solar cell(1), for light emitting diode (2,3) and other optoelectronic device such as blue and green emitting laser diodes (4),electro luminescence devices and photovoltaic cells which enable wide application in the field of displays(5,6), sensors and lasers(7) There has been growing interest in developing techniques for preparing semiconductor nano particles and films.

ZnS films can be prepare by several techniques such as thermal evaporation (8, 9), spray pyrolysis (10_13) , molecular beam epitaxy (14), RF reactive sputtering (15), Pulsed Laser Deposition, Chemical bath deposition technique. In present investigation ZnS thin films have been deposited using chemical bath deposition method.The structural and optical properties of the deposited ZnS thin films were studied.

Materials and Methods:

The deposition of films was carried out by using Coring glass slide (25mm×75mm×1mm) as substrates which were initially boiled in concentrated chromic acid for 30 minutes, rinsed in acetone then double de-ionized water and finally ultrasonically cleaned. All analytical grade (A.R) reagents were used as it is without further purification. For deposition of ZnS thin films aqueous solution of 0. 1M Zinc acetate, 0.3 M thiourea and complexing agent 25 % aqueous ammonia were used. Initially 10 ml of Zinc acetate $Zn(CH_3COO)_2$ solution and 3 ml ammonia were placed in 100 ml beaker, after stirring for several minutes solution becomes colorless and homogeneous under continous stirring, 10 ml thiourea solution was introduced. The ZnS thin films were The crystallographic structure of the films was analyzed with a X-ray diffracto meter card no (010812). The thickness of thin film was measured by the weight difference method at room temperature. The variation of films thickness with deposition time is as shown in figure (1) The thickness of ZnS thin films was measured by weight difference method. This ZnS films had maximum terminal thickness of 320 mm for deposition time 60 min, after this films deposited on glass substrate by CBD technique. The process involving a controllable chemical reaction at a low rate by adjusting pH and temperature of working solution.

The experimental arrangement consists of a special substrate holder which is attached to motor having a constant speed of 60 r. p. m. The temperature of chemical bath was adjusted with a hot plate and a temperature controller ($\pm5^0$c), while magnetic stirrer is applied to promote ion by ion heterogeneous growth on the substrate. The pH value of working solution was adjusted by a pH meter above 8 for different deposition time (2**0**-100) minutes and temperature at 75 $\pm5^0$c (16**)**. After deposition the substrates were removed from the chemical bath and cleaned in DI water.

thickness starts to decreases due to peeling of the materials from the substrate [17].

Results and discussion:

Optimization of deposition time: Deposition time is optimized by taking a substrate out of bath at regular interval of 20minutes. Figure (1) shows the variation of films thickness with deposition time. Film thickness increases up to 60 minutes deposition time and then decreases. The maximum thickness obtained by constant temperature bath method is about 305 nm.

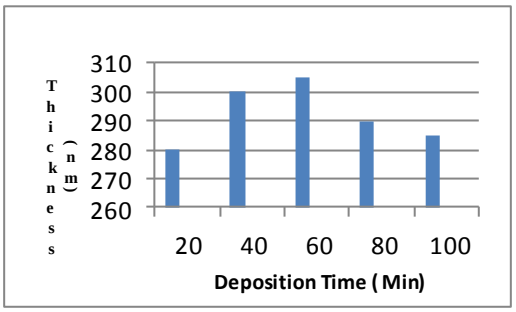

Figure (1): Variation of films thickness with deposition time.

FTIR analysis:

FTIR spectra of ZnS thin films as shown in figure (2). The spectrum has been recorded in the region 400-4000 cm. The vibrational frequencies of the various chemical bonds in the films can be assigned from FTIR spectra in terms of the peak position. By the assignment of stretching and bonding modes of vibration to the observed frequencies conformational preference of the molecule can be identified. The ZnS Stretching vibration is at 300 per cm. The FTIR spectrum has been taken in the range 400-4000 cm, the presence of chemical constituents cannot be identified using the FTIR spectrum. If the range has been widened FTIR spectrum is applicable to confirm the presence of constituents qualitatively or quantitatively, because metal sulphide stretching bonds occur within 200-400 per cm.

The water (O-H) stretching vibration is at 2928 per cm and bending vibration at 2070 per cm has been observed in ZnS thin films as reported earlier [18]. This confirms that oxygen appears as water in ZnS thin films. The two peaks at 3743 and 3408 per cm are due to hydroxyl groups [18, 19]. The absorption band at 624 per cm is Zn-OH stretching peak [20, 21]. The absorption band at 1428cm and 1361 per cm are due to Zn-O (HCO_2) as reported [22,23]. The less intense peaks at 721per cm and 461 per cm enable to conclude that a small accounts of ZnO is also present in ZnS thin films . Thus FTIR spectrum has been employed to conclude the form of the occurrence of oxygen in CBD grown ZnS thin films.

XRD Analysis: The X-ray diffraction pattern of ZnS film shown in Figure (3). The XRD pattern shows that the films are of polycrystalline in nature with a hexagonal type structure as determine from standard JCPDS data. X-ray diffracto meter card no (010812). Similar structural characterization was also reported by other researchers (24). Two diffraction peaks reflections of the cubic phase at a 2θ of 28.40 ^{0}and 32.60^0 respectively. The crystallite size of the CBD ZnS thin films is affected by deposition conditions. It is useful to obtain the information of the structural

properties of the thin film by XRD measurement.

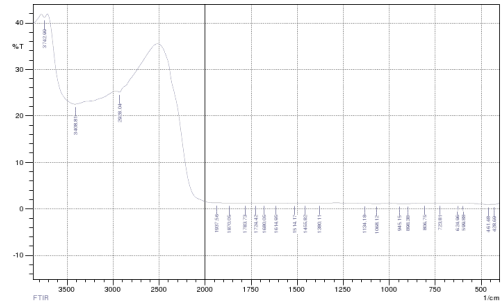

Figure (2): FTIR Spectrum of CBD ZnS thin film

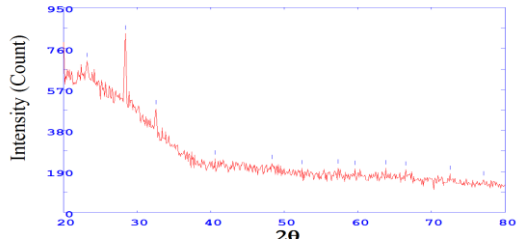

Figure (3): XRD Pattern of CBD ZnS thin film

Conclusion:

The ZnS thin films have been chemically deposited using an aqueous alkaline bath and thickness of the film increases up to 60 minutes deposition time and then decreases. The maximum thickness obtained by constant temperature bath method is about 305 nm. The structural and electrical properties of ZnS are found to be thickness dependent. FTIR spectrum is applicable to confirm the presence of constituents qualitatively or quantitatively,

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References:

[1]W.H. Bloss, F. Pfisterer, H.W.Schock "*Advances in solar energy, an Annual review of research & development* ",1988 ,Vol.4 , P-275

[2] H. Katayama, S. Oda, H. Kukimoto, *Appl. Phys. Lett.*, 1975, 27, 657.

[3] A. Antony, K.V. Mirali, R. Manoj, M.K. Jayaraj, *Mater.Chem.Phys.*,2005, 90, 106.

[4] S. Coe, W.K. Woo, M.G. Bawendi, V. Bulovic, *Nature*,2002, 420, 800.

[5] M.C. Beard, G.M. Turner, C.A. Schmuttenmaer, *Nano Lett.* , 2002, 2, 983.

[6] R.P. Raffaelle, S..L. Castro, A.F. Hepp, S.G. Bailey, *Prog. Photovoltaics* , 2002, 10, 433.

[7] V.I. Klimov, A.A. Mikhailovsky, S. Xu, A. Malko, J.A. Hollingsworth, C.A. Leatherdale,H.J. Eisler, M.G. Bavendi, *Science*, 2000, 290, 314.

[8] S.M.A Durrani, A.M. Al-shukri, A. Iob, E.E.Khawaja, *Thin Solid Films*, 2000, 199,379.

[9] V. Dimitrova, J. Tate, *Thin Solid films*, 2000, 134, 365.

[10] H.H. Afifi, S.A. Mahmoud, A. Ashour, *Thin Solid films*, 1995, 263,248.

[11] B. Elidrissi, M. Addou, M. Regragui, Bougrine, A. Kachouane, J.C.Bernede, *Mater.Chem.Phys*., 2001, 68, 175.
[12] M. C. Lopez, J. P. Espinos, F. Martin, D. Leinen, J.R. Ramos-Barrado, *J.of Cryst Growth*, 2005, 66, 285.
[13] M.A. Hernandez-Fenollosa, M Lopez, V. Donderis, M. Gonalez, B. Mari, *Thin Solid Films*, 2008, 516, 1622.
[14] M. Yoneta, M. Ohishi, H. Saito, *J.Cryst.Growth.*, 1993,127, 314
[15] L.-Z. Shaoi, K.-H. Chang, H.-L. Hwang, *Appl.Surf.Sci.*, 2003 , 305, 212-213.
[16] V. B. SANAP*, B. H. PAWAR, Chalcogenide Letters Vol. 6, No. 8, September 2009, p. 415 – 419
[17] R. S. Patil , C .D .Lokhande ,Sung-Hwan Han, et al M*aterial science and engineering*, 2006 , B129,59-63
[18] S. Lindroos, T. Kannainen and M. Leskela, Materials Research Bulletin, 32(12), 1631(1997).
[19] K.Atherton, G.Newbold and J.A.Hockey, Discuss. Faraday Society 52 (1971).
[20] W.Herlt, Langmuir 4, 594 (1988).
[21] J.W.Kauffmann, R.H. Hauge and J.L.Margrave, Journal of Materials Physics and Chemistry,89, 3541 (1985).
[22] R.Gard, Z.X.Sun and W.Forsling, Journal of Colloidal Interface Science, 169, 393 (1995).
[23] Q.Yitai, S.Yi and C.Qianwang and C.Zuyao, Materials Research Bulletin 30, 601 (1995).
[24] A U UBALE* and D K KULKARNI ,Bull. Mater. Sci., Vol. 28, No. 1, February 2005, pp. 43–47. © Indian Academy of Sciences