ChemTech

International Journal of ChemTech Research
CODEN (USA): IJCRGG ISSN: 0974-4290
Vol.8, No.7, pp 292-296, 2015

Investigation of Optical Properties for Zinc Sulphide Nanocrystalline Thin Flim Grown on Glass Plate through Silar Method

T.R.Raghavarshini[1], D.Maragatham[2], V.Selvaraj*

[1]Department of Chemistry, IFET College of Engineering ,Gangarampalayam, Villupuram, India
[2]Department of Physics, IFET College of Engineering ,Gangarampalayam, Villupuram, India
Department of Chemistry, University college of Engineering, Villupuram, India

Abstract: Zinc sulphidenanocrystalline thin film has been grown on glass plate through successive ionic layer adsorption and Reduction by SILAR technique at ambient conditions, which involves multiple dipping of a substrate in the cationic and anionic precursors. The nanocrystalline thin film has beencharacterised by X-Ray diffraction (XRD), scanning electron microscopy (SEM) and UV-Vis spectrometer. From the result, it has been noticed that the particle size has found to be ~13.75nm. The surface morphology observed from SEM image reveals that the ZnS particles are cubical in shape, densely aggregated and are free fromthevoids and cracks. UV-Vis spectral studies showed that the spherical grains have the lower cut off wavelength (357nm) and the band gap energy is 3.45eV. Hence, the thin film can be used in electronic applications.
Keywords: Optical Properties, Zinc Sulphide, Nanocrystalline Thin Flim, Silar method.

Introduction

Zincsulphide is a combination of II and IV group inorganic compound used in an infrared optical material and in optoelectronic devices such as Antireflection coating for heterojunction solar cells [1], blue light emitting diode[2,3,4], electro luminescence devices andphotovoltaic cells which were widely applied in the field of displays[5,6], sensors andlasers[7]. In a present year ZnS nanocrystalline thin film has much properties innano form which were differ from their bulk counter parts. ZnSnano thin flims transmit the radiation from visible wavelengths to 12 micrometers. These structures are used as semiconductors; ZnS nanothin films havehigh potential[8] .This were prepared by using SILAR method based on the solvated cationic and anionic components between solution-solid interfaces. In this research exploration; the synthesisof ZnS nanothin films obtained at an ambient temperature by SILAR technique[9].This will leads to the development of semiconductor nano particles and films. For deposition of ZnS nanothin films, zinc acetate has consider as a zinc ion releasing source (cation) and Sodium sulphidehas taken as a sulphur ion releasing source (anion). Bothanionic and cationic precursors were kept at an ambient temperaturerespectively. The aim of the presentwork is to createinterest in the SILAR technique which were used to prepare nanocrystalline powders of ZnS because its arrangement is simple andeconomical. Their preparative parameters and structural, optical are described. The structural and opticalCharacterizations of the synthesized powders were carried out using x-ray powder diffractometer and UV-VIS spectrophotometer.Its high resistance to rain erosion and high-speed dust and particulate abrasion makes it particularly suitable for exterior IR windows on aircraft frames and also in electronics.

Experimental method

For the synthesis of ZnSnano thin flims using SILAR technique, we have taken zinc acetate as cationic precursor and sodium sulphide as anionic precursor. The concentration of both precursor solution were kept as 0.1 M. The amount of precursor and demonized cleaning solution is taken as 60ML.

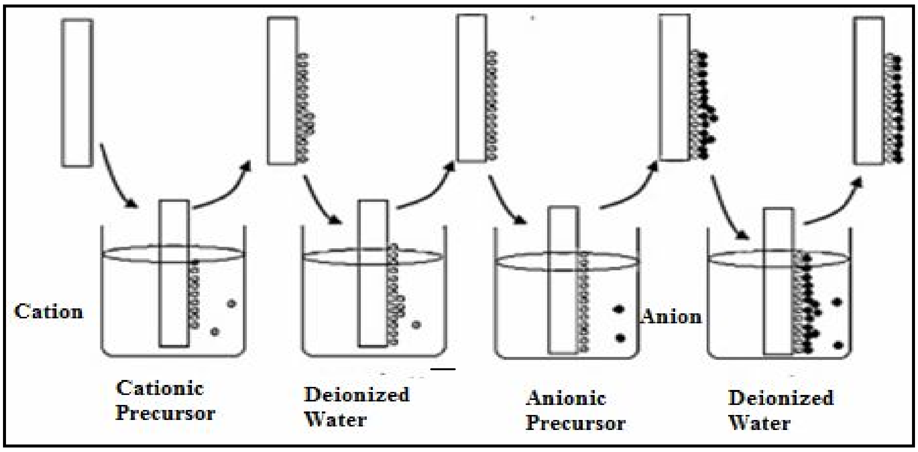

Fig.1. Schematic representation of the deposition of ZnS

The immersion time is 45 seconds and the immersion cycle is 17. Well cleaned glass plate which is soaked in distilled chromic acid for overnight is taken as the substrate for ZnSnanothin film coating. The dimension of the glass slide is75×25×2×mm and the weight has to be measured. The glass slide is first immersed in cationic solution ($Zn(CH_3COO)_2$) for 45 seconds and then immersed in deionised water for the same amount of immersion time. This will help to remove the loosely bond atoms from the substrate. After this, the substrate is immersed in anionic solution (Na_2S). At this stage the Zn^{2+} already available in the substrate will react with the S in the solution to form ZnS nanoparticle on the substrate. After the immersion time, the substrate is again placed in the deionised water for removing the loosely bound ZnS atoms from the substrate. Now one cycle of coating of nanoZnS by SILAR technique is over. The process is reappeared for number of immersion cycles. The obtained substrate is cleaned with distilled water and then it should be dried.

Results and discussion

Structural Study

X-Ray diffraction

Powder X-ray diffraction analysis has been carried out to confirm the crystalline structure and the particle size of ZnS.

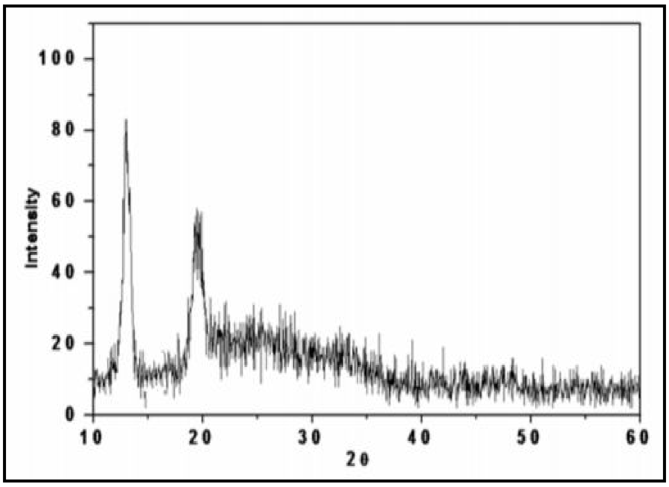

Fig.2. XRD patterns of ZnSnano thin films

From **Fig. 2**the observed peaks for the 2θ values and by comparing the data with JCPDS data, the structure of nanoZnS was confirmed as cubicwurtzite with the orientation of (111) [10,11].The average size of the particle was calculated using thedebye-scherrer's formula, [12]

$$D = \frac{0.9\,\lambda}{\beta\,\cos\theta}\ \text{(nm)}$$

The particle size for each peak was found out and the average particle size is 13.75 nm.

Surface morphological studies

Scanning electron microscope (SEM):

To verify the morphology scheme obtained by XRD, the data from the scanning electron microscope was studied.

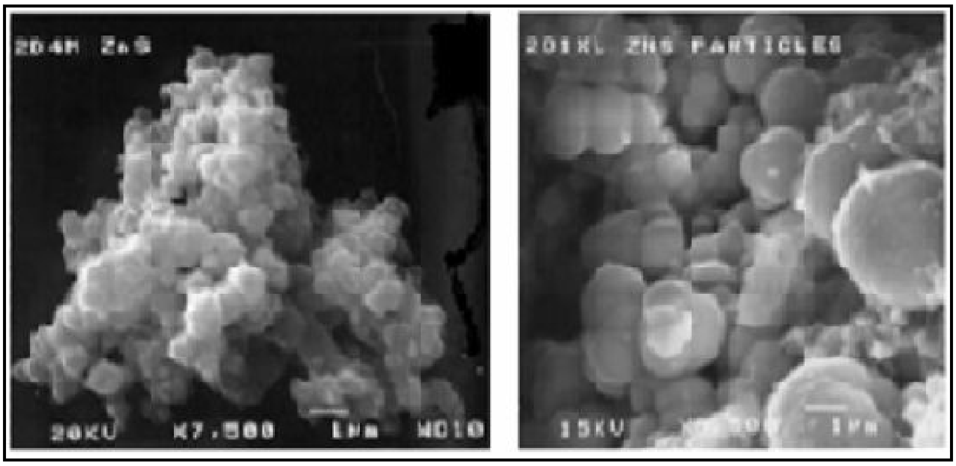

Fig.3 The surface morphology of ZnS by scanning electron microscopy studies

Fig. 3 shows a scanning electron microscope of ZnS nanothin films. It is observed that particles are spherical and agglomerated to form larger particles.SILAR technique forms a uniform layer over the substrate.

Optical properties

UV-VIS Visible Spectrocopy

The transmittance of the films increases with increase in wavelength from UV- VIS regions (300nm to 600nm). Transmittance increases rapidly in the UV –VIS region, but increased slowly and constantly towards NIR regions. Transmission spectrum was recorded in a UV-VIS-NIR spectrophotometer (JASCO V-570).

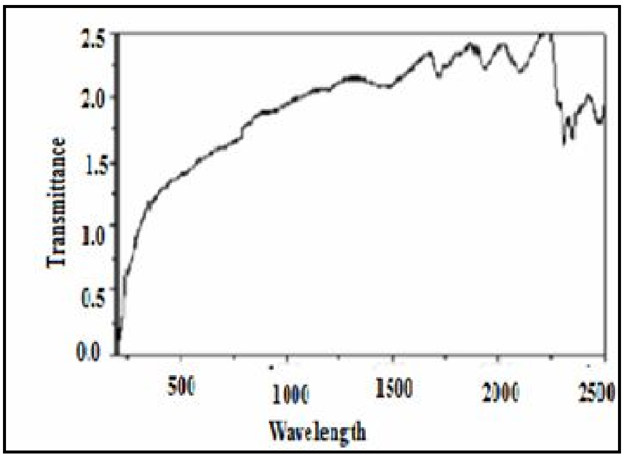

Fig.4. Optical transmittance

Fig.4. Shows that the transmission spectrum of ZnS. The analysis shows that the maximal value of the optical transmission have the ZnSnano thin films obtained at the substrate temperature T_s = 373 K, the minimal value corresponds to the T_s = 573 K.These indicate high transmission of absorption in visible region which are used in optoelectronic devices [13] and lenses for high power IR laser [14].

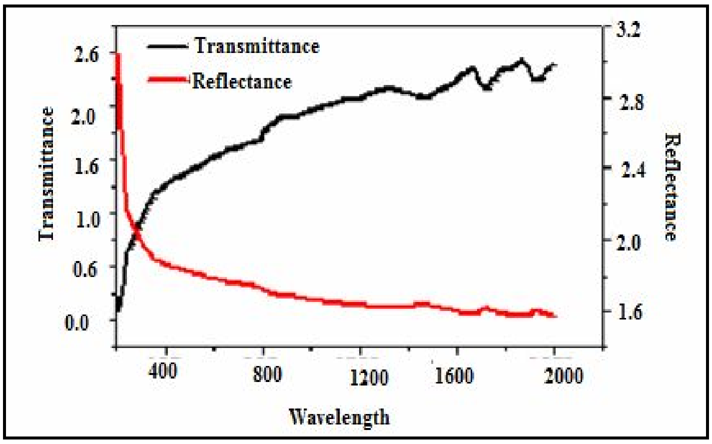

Fig.5. Optical Reflectance and Transmittance of ZnS

Fig.5. When the reflection and transmission of a thin film coated on a substrate are investigated; two interfaces must be taken into consideration, leading to the expressions of R and T being a little more complicated. It was seen that transmittance of ZnS is greater in visible region. In general, except the reflection losses one must take into account losses of light absorption in an accessory layer of photovoltaic devices.

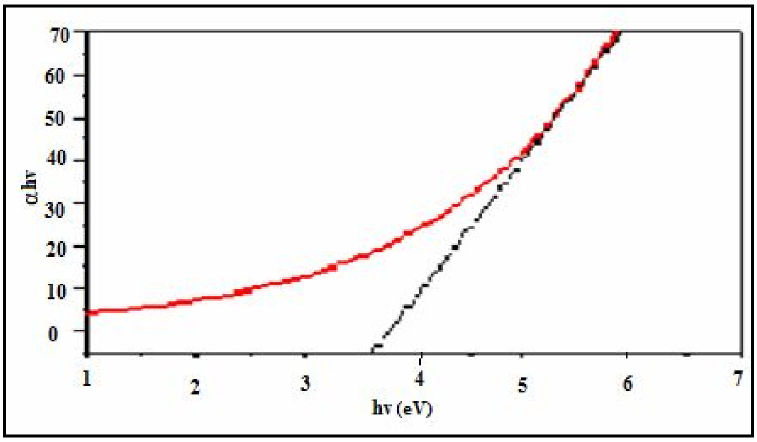

Fig.6. Tauc plot of nanocrytalline ZnS nanothin film

From the **Fig.6**Tauc plot the band gap energy formed ZnS nanothin films is 3.45eV. By using SILAR technique the band gap energy can be increased or decreased by varying the concentration of the precursor.

Conclusion

In conclusion, zinc sulphide nanothin film was deposited on glass substrates using the SILAR method at an ambient temperature. The Uniform thin film is obtained by using SILAR techniques. The results of optical absorbance, transmittance and band gap studies were discussed with the structural morphologies using XRD and SEM images. In the deposited zincsulphidenanothin film, optical band gap energy is 3.45 evand confirms that is used in electronic devices.

4. 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. Ortega Borges R, Lincot D and Vedel J 1992 Paper presented at11th European photovoltaic solar energy conference, MontreauxPadam G K, Malhotra G L and Rao S U M 1988J. Appl. Phys.63 770
9. B. Guzeldira, M. Saglamaand A. AtesbaDepartment of Physics, Faculty of Sciences, University of Atatürk, Erzurum, TurkeybDepartment of Material Eng., Faculty of Eng. and Nature Sciences, University of YıldırımBeyazıtAnkara, Turkey Proceedings of the International Congress on Advances in Applied Physics and Materials Science, Antalya 2011.
10. NagalingamSaravanan , Geok Bee Teh,Samuel Yong Peen Yap (1)KarMun Cheong (1)Department of Bioscience and Chemistry, UniversitiTunku Abdul Rahman, Bandar Barat, 31900, Kampar, Perak, Malaysia Journal of Materials Science: Materials in Electronics Volume 19, Issue 12 , pp 1206-1208 .
11. B. Guzeldira, M. Saglamaand A. AtesbaDepartment of Physics, Faculty of Sciences, University of Atatürk, Erzurum, TurkeybDepartment of Material Eng., Faculty of Eng. and Nature Sciences, University of YıldırımBeyazıtAnkara, Turkey, Depositionand Characterization of CdS, CuS and ZnS Thin Films Deposited by SILAR Method, Vol. 121 (2012) ACTA PHYSICA POLONICA A, Proceedings of the International Congress on Advances in Applied Physics and Materials Science, Antalya 2011.
12. New Method of Preparation ZnS Nano size at low pH Nada K.Abbas1 , Khalid T. Al- Rasoul2 , Zainb J. Shanan1 1 College of science for Women, University of Baghdad, Jadriya, Baghdad, Iraq 2 College of science, University of Baghdad, Jadriya, Baghdad, Iraq * E-mail: nadabbs@yahoo.com Received: 3 December 2012 / Accepted: 25 December 2012 / Published: 1 February 2013.
13. Nada M. Saeed Department of Physics, College of Science, University of Baghdad, Baghdad-Iraq. Structural and Optical Properties of ZnS Thin Films Prepared by Spray Pyrolysis Technique, Journal of Al-Nahrain University Vol.14 (2), June, 2011, pp.86-92 Science.
14. Ezenwa I. A. and Okereke N. A. Department of Industrial Physics, Anambra State University, Uli, Nigeria, Effects of Ligand on the Absorbance and Transmittance of Chemical Bath Deposited Zinc Sulphide Thin Film, Pelagia Research Library Advances in Applied Science Research, 2012, 3 (5):2821-2825.

*****