Volume 2 No.4, April 2012 ISSN 2224-3577
International Journal of Science and Technology

©2012 IJST. All rights reserved

http://www.ejournalofsciences.org

Effect of Complexing Agent (Tea) on Chemically Deposited Silver Selenide Thin Films

N. A. OKEREKE[1], I. A. EZENWA[2] AND A .J. EKPUNOBI[3]
[1,2]Department of Industrial Physics, Anambra State University,Uli, Nigeria.
[3]Department of Physics and Industrial Physics, Nnamdi, Azikiwe University, Awka, Nigeria.

ABSTRACT

Thin films of silver selenide have been prepared by chemical bath deposition technique at substrate temperature of 300K. The films were characterized by X-ray diffraction and UV-VIS spectrophotometer. Silver selenide thin films are polycrystalline with orthorhombic structure, confirmed by x-ray diffractogram. The deposition parameters were optimized to obtain good quality thin films. The film deposited with 10.0ml TEA showed good uniformity, good surface coverage with bigger grains and produced higher absorbance value. The band gap energy varies with the variation of TEA concentration which ranged from 2.00eV - 2.15 eV. Deposition at concentration of 10.0ml TEA proved to offer a reasonably good Ag_2Se thin film. The quality of thin film is influenced by the presence of complexing agents.

Keywords: *Thin films, Silver selenide, Chemical bath deposition, Complexing agent, Characterization*

1. INTRODUCTION

Silver selenide, a group II-VI semiconductor compound is a mixed ionic conductor (1). The synthesis and characterization of semiconductor thin film of different groups have attracted attention due to their applications such as in solar cells, sensor and laser materials. A variety of techniques have been used for the preparation of silver selenide thin films. Ag_2Se films were prepared by (2) using chemical bath deposition technique. The growth of Ag_2Se using flash evaporation technique was reported by (3). Reactive evaporation was used to prepare silver selenide thin film by (1). Thermal evaporation and pulsed laser deposition techniques were adopted by (4) to deposit the film.

In the present case, we prepared thin films of silver selenide by chemical bath deposition technique. The chemical bath deposition technique is a time saving, cost effective and economically reproducible technique that can be applied in large area deposition at low temperature. The use of complexing agent is very common in the preparation of thin films through chemical bath deposition. Researchers use various complexing agents such as thiourea (5-6), ammonia (7-8), triethanolamine(9-10), disodium ethylene diamine tetra-acetate (11), ammonium hydroxide (12), hydrazine (13), sodium citrate (14) and tartaric acid (15-16) during deposition of thin films.

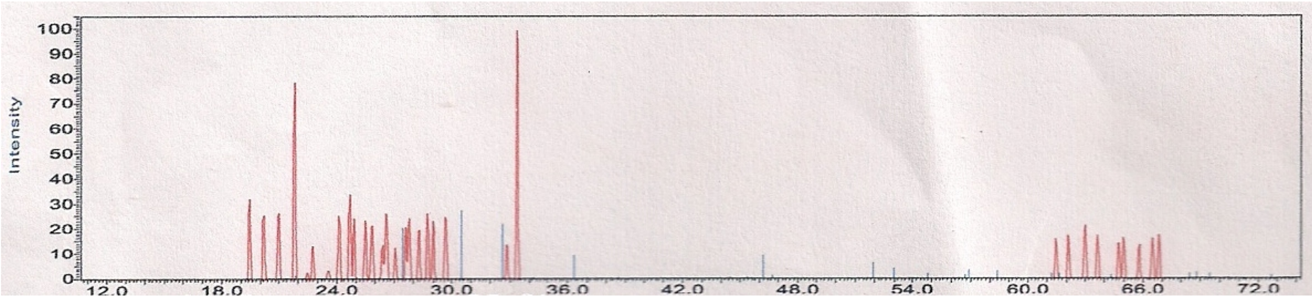
The influence of TEA on the properties of thin films was studied. The structural analyses of prepared Ag_2Se films are performed by means of X-ray diffraction technique. Optical properties of the films were examined by an UV-Visible spectrophotometer.

2. MATERIALS AND METHODS

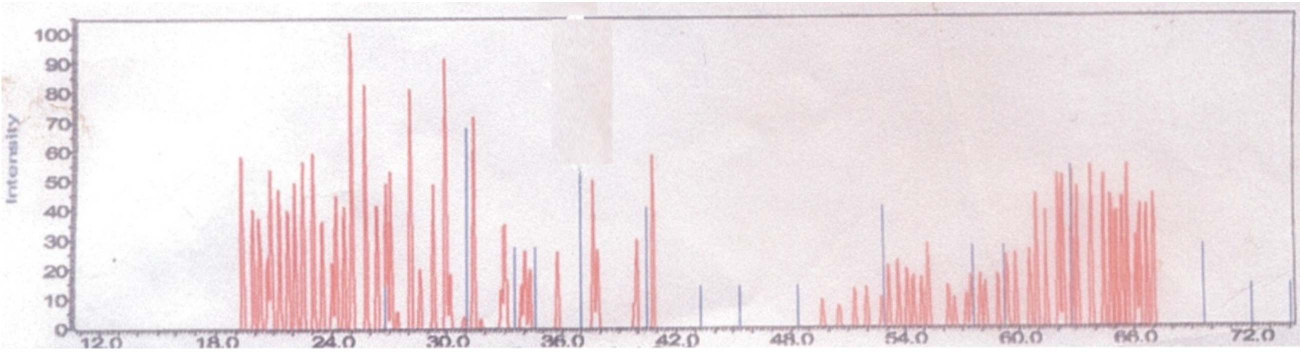
Silver selenide thin films were deposited on glass substrate using chemical bath deposition method. The substrates were previously degreased in trioxonitrate (V) acid, washed with detergent, rinsed with distilled water and dried in air. The effect of the complexing agent on the chemical bath deposited films was investigated under different volume concentrations of TEA ranging from 2.5ml to 10ml. All the solutions were prepared in deionised water. During deposition process, 10ml of 0.5M silver trioxonitrate (V) was complexed with 0.5M triethanolamine agent of different concentrations (5mls -10mls). To this, 10ml of 1M selenium trioxo sulphate (V) was added slowly to the reaction mixture. The pH of the chemical bath was maintained at 11.0 by addition of 10ml 30% ammonia. The resultant solution was stirred for few minutes. The cleaned glass substrate was vertically immersed in the reaction bath at room temperature for 10 hours. After the deposition time of 10hrs, the substrate was taken out of the reaction bath, washed with distilled water and dried in air. The structural properties of the films were investigated by X-ray diffraction using CuKα (λ=1.5406A) radiation. The optical properties of the film were measured with a UV-Vis Spectrophotometer in the wavelength range of 0.36μm to 1.10μm. From the analyses of absorption spectra, the band gap energy (E_g) was determined.

©2012 IJST. All rights reserved

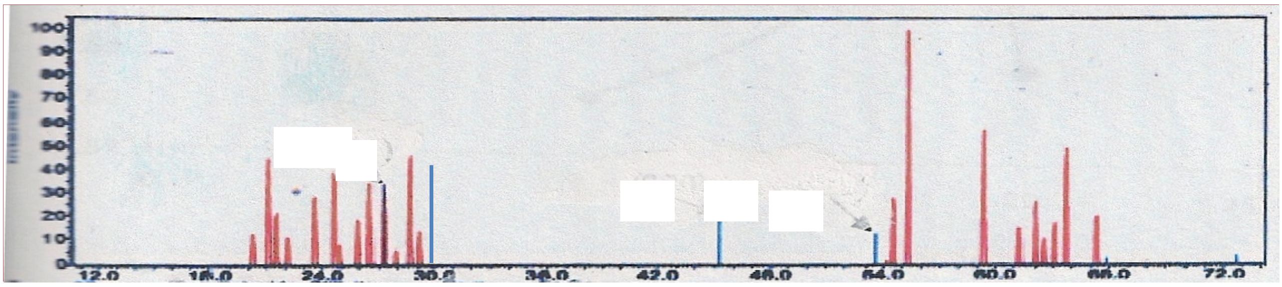
3. RESULTS AND DISCUSSIONS



(a)



(b)



(c)

Figure- 1 X-ray diffraction patterns of the Ag_2Se thin films deposited at different volume concentrations of TEA. (a) 5ml, (b) 10ml, and (c) 15ml

Figure 1 depicts the samples showed a polycrystalline nature. The peaks in the film deposited with 10ml of 0.05 TEA (Figure 1b) are identified at 2Θ = 31.0°, 36.9°, 62.7°, 40.4°, 52.8°, 69.0˚, 33.5°, 34.6°, 57.5°, and 59.1˚. The obtained Ag_2se films show similar crystalline aspects as those reported by (1) using other precursors. The number of Ag_2Se peaks decreased to five and the XRD patterns of Ag_2Se films deposited at different concentrations of TEA. All four as shown in figure 1a and figure 1c for the films deposited with 5ml and 15ml TEA, respectively. From the XRD patterns, it is observed that the intensities of the Ag_2Se peaks are decreased as the concentration of TEA exceeds 10ml. The strongest peak for all samples occurred at 2Θ= 31.0° with *d*-spacing value of 2.95Ǻ. This indicates that the preferred orientation lies along (311) reflections of orthorhombic structure which showed improvement upon film thickness increment. However, the (311) plane showed the highest intensity peak for the film deposited using 10ml of 0.05M TEA indicating more favourable condition for the formation of thin film.

©2012 IJST. All rights reserved

The thickness of the films was studied using optical method by (17). The thickness of thin film ranged from 0.750µm to 0.807µm as the volume concentration of TEA was increased from 5ml to 15ml. However, the thickness of the thin films was reduced (0.807µm) as the concentration of TEA was further increased to 15ml. It is probably due to the fact that the complexing reaction was complete with high volume concentration (15ml) of complexing agent. Therefore, hinders the deposition of thin films (18).

The optical properties of thin films were measured in the wavelength range of 0.36µm-1.10µm by using UV-Visible spectrophotometer. Figure 2 shows the absorption spectra of the samples deposited with different concentrations of TEA, ranging from 5ml to 15ml. With increasing concentration of TEA from 5ml (Figure 1a) to 15ml (Figure 1b), the absorption value of the films increased and then decreased at higher TEA concentration (Figure 1c). This could be due to more Ag_2Se thin films (thicker film) deposited onto the surface of substrate using 15ml of TEA providing better absorption properties.

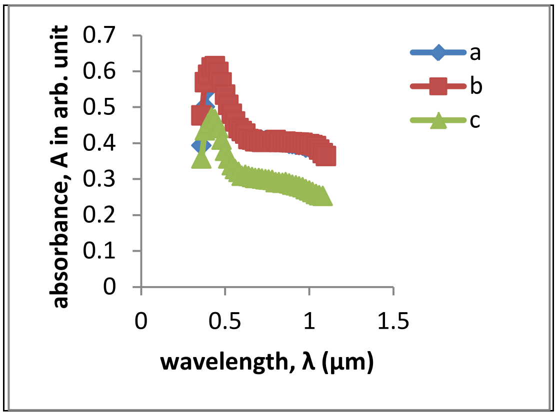


Figure 2: The absorbance versus wavelength of the Ag_2Se thin films deposited at different volume concentrations of TEA. (a) 5ml, (b) 10ml, and (c) 15ml

Figure 3 shows the plot of absorption coefficient square versus photon energy for Ag_2Se thin films deposited with different concentrations of TEA. The band gap values were determined from the intercept of the straight-line portion of the α^2 against the hυ graph on the hυ-axis. The linear part shows that the mode of transition in these films is of direct nature. The band gaps deduced for all thin films increased from 2.10eV (Figure 3a) to 2.15 eV (Figure 3b) as concentration of TEA was increased from 5ml to 10ml, which decreased to 2.00eV (Figure 3c) as the concentration of TEA was further increased to 15ml.

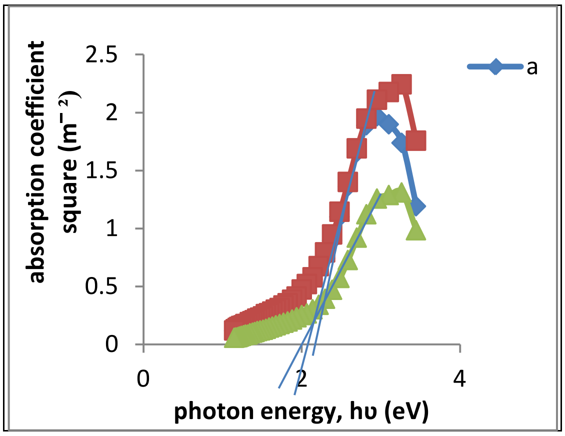


Figure 4: Plot of α^2 versus hυ of the Ag_2Se thin films deposited at different concentrations of TEA (a) 5ml, (b) 10ml, and (c) 15ml.

4. CONCLUSIONS

The Ag_2Se thin films were prepared by the chemical bath deposition method onto glass substrates using aqueous solution of silver trioxonitrate(V), selenium trioxosulphate(V), aqueous ammonia and TEA. The TEA which acted as complexing agent has some influences on the structure and optical properties of Ag_2Se thin films. The XRD data showed that the films have a polycrystalline, orthorhombic structure with preferential orientation along (311) plane. According to the XRD patterns, less Ag_2Se peaks could be observed for the films deposited using 5ml and 15ml of TEA. The films deposited with 10ml TEA produced higher absorbance value. The band gap energy varies with the variation of TEA concentration which ranged from 2.00eV–2.15 eV. Deposition at concentration of 10ml TEA proved to offer a reasonably good Ag_2Se thin film.

REFERENCES

[1] Santhosh Kumar M. and Pradeep B. Transport properties of silver selenide thin films from 100 to 300K. *Bull Mater. Sci.* **25,** 407-411, **(2002)**

[2] Sharma K. C. and Sharma R. P. and Garg J. C. *Indian J. Pure and Appl. Phys.* **28,** 546. **(1990)**

[3] Okabe Toshio and Ura K. *J. Appl. Cryst.* **27**,140. **(1994).**

[4] Kreutzbruck M, Mogwitz, Gruhi F, Kienle L., Korte C, Janek, *Applied physics letters*. **86**, 072102 **(2005).**

[5] Mendoza-Perez R, Santana-Rodriguez G, Sastre-Hernandez J, Morales-Acevedo A, Arias-Carbajal A, Vigil-Galan O, Alonso J.C, and Contreras-Puente G. *Thin Solid Films* **480-481**, 173, **(2005)**,

©2012 IJST. All rights reserved

[6] Ezenwa I.A. and Okereke N.A. Optical properties of Cadmium sulphide, copper sulphide and CdS/CuS thin films and their applications in photovoltaic technology. *Nigertian Journal of SolarEnergy* **22**, 61-65, **(2011)**

[7] Antony A., Murali K.V., Manoj R., Jayaraj M. K. *Mater. Chem. Phys.* **90**, 106. **(2005)**

[8] Pradhan B., Sharma A.K., Ray A. K. *J. Cryst. Growth* **304**, 388, **(2007**)

[9] Dhanam M., Prabhu R.R., Manoj P.K. *Mater. Chem. Phys*. **107**, 289, **(2008**)

[10] Lin L.H., Wu C.C., Lai C.H., Lee T.C. *Chem. Mater.* **20**, 4475, (**2008**)

[11] Sonawane P.S., Wani, P.A., Patil L.A., Seth T. *Mater. Chem*. Phys. **84**, 221, (**2004**)

[12] Khallaf H., Oladeji, I.O., Chow L. *Thin Solid Films* **516**, 5967, (**2008**)

[13] Mathew X., Enriquez J.P. *Sol. Energy Mater. Sol. Cells* **76**, 313, (**2003**)

[14] Nasr T.B., Kamoun N, Guasch C. *Mater. Chem. Phys.* **96**, 84, (**2006**)

[15] Ladar M., Popovici E.J., Baldea I., Grecu R., Indrea E. *J. Alloys Compd.* **434-435**, 7, **(2007)** 16. Roy P.,

[16] Srivastava S. K. *J. Phys. D: Appl. Phys.* **39,** 4771, (**2006**)

[17] Theye M. Optical properties of thin films in Chopra K.L. and Malhotra L. K. (eds.), Thin film technology and applications, Tata McGraw Hill Pub. Co., New Delhi, 163-173, **(1985)**

[18] Whang T. J., Hsieh M.T., Kao Y.C., Lee S.J. *Appl. Surf. Sci.* **255**, 4600, **(2009)**