Research Journal of Engineering Sciences ISSN 2278 – 9472
Vol. **2(1),** 1-4, January **(2013)** *Res. J. Engineering Sci.*

Effects of Deposition Time on the Absorbance of Chemical Bath deposited CuS Thin Films

Ezenwa I.A.
Department of Industrial Physics, Anambra State University, Uli, NIGERIA

Available online at: www.isca.in
Received 18th October 2012, revised 3rd November 2012, accepted 20th November 2012

Abstract

The chemical bath deposition technique was used to deposit thin films of copper sulphide onto glass substrates. The bath composition included copper chloride which was the source of Cu^{2+} and thiourea which supplied the S^{2-} ions. X- ray diffraction and optical microscopy were used to investigate structural and morphological characterization respectively. The influence of deposition time was studied to determine its influence on the absorbance of the deposited films. The deposited CuS films showed hexagonal structure.

Keywords: Chemical bath, absorbance, thin films, CuS.

Introduction

Due to their structural, electrical and optical properties, copper sulphides (Cu_{2-x}, x=0-1) thin films are widely used as semiconductor and/or absorber materials with application in electronics, photovoltaic cells and tubular solar collectors. Among these, CuS (covellite) thin films are known to exhibit metal-like electrical conductivity and to possess near-ideal solar control characteristics. All these make copper sulphide thin films deposited onto different substrates (glass, polymers) promising materials for either electric or electronic devices or radiation control coatings (filters)[1]. Researchers are working on various methods to prepare good quality films as thin film semiconducting materials are now being widely used. Various methods have been employed for deposition of CuS thin films, which include electro – deposition[2], pulse laser deposition[3], spray pyrolysis[4], chemical bath[5]. Chemical bath deposition technique for preparation of thin films from aqueous solution is a promising technique because of its simplicity; by this method a large area of thin film can be deposited without sophisticated instruments. The properties of the deposited material can be varied and controlled by proper optimization of the chemical baths and deposition conditions[6].

This paper reports the chemical bath deposition of CuS thin films from an aqueous solution bath containing copper chloride and thiourea, using TEA ($N(CH_2CH_2OH)_3$) as a complexing agent and ammonia solution as a pH adjuster at 300K and the effect of deposition time on the absorbance of the deposited films.

Material and Methods

Chemical bath deposition technique was used to deposit copper sulphide thin films on glass substrates which had been previously degreased in concentrated HNO_3 for 48 hours, cleaned in cold water with detergent, rinsed with distilled water and dried in air. The deposition of CuS thin film by CBD was based on the reaction between cupric sulphate ($CuSO_4.5H_2O$) and thiourea ($SC(NH_2)_2$), in an alkaline medium using TEA ($N(CH_2CH_2OH)_3$) as a complexing agent and ammonia solution as a pH adjuster at 300K. In this experiment, five reaction baths (50mls beaker) were used. 5.0mls of cupric sulphate was measured into a 50ml beaker using burette, 5.0mls of TEA was then added to it, the solution turned sky blue and after a few seconds became deep blue. 5.0mls of thiourea was then added, on addition of thiourea, the solution turned brown. 5.0mls of ammonia solution (ligand) was then added and the solution remained brown. The mixture was then topped to 50mls level by addition of distilled water and stirred gently to ensure uniformity of the mixture. A glass substrate was dipped vertically into all of the five reaction baths with the aid of a synthetic foam cover. Each bath was allowed to stand for various time intervals as shown in table 1, after which the slides were removed and dried in air. The experiment was conducted at 300K temperature. Janway 6405 UV/visible spectrophotometer was used to determine the spectra absorbance. Structural and surface characterization of the films was carried out using an x-ray diffractometer with Cukα radiation and Olumpus optical microscope respectively. Other solid state and optical properties of the films had been investigated in our earlier publication[7].

The reaction mechanism is of the form:

$$CuSO_4.5H_2O + TEA \longrightarrow Cu(TEA)^{2+} + (SO4)^{2-} + 5H_2O$$
$$Cu(TEA)^{2+} \longrightarrow Cu^{2+} + TEA$$
$$SC(NH_2)_2 + OH^- \longrightarrow CH_2N_2 + H_2O + HS^-$$
$$HS^- + OH^- \longrightarrow H_2O + S^{2-}$$
$$Cu^{2+} + S^{2-} \longrightarrow CuS$$

Table-1
Bath constituents for the deposition of copper sulphide Thin Film

Slide NO.	Volume of complexing agent(TEA) (mls)	Volume of $CuSO_4.5H_20$ (mls)	Volume of thiourea (mls)	Volume of ammonia solution	Time (hours)
Cu1	5.00	5.00	5.00	5.00	1.00
Cu2	5.00	5.00	5.00	5.00	2.00
Cu3	5.00	5.00	5.00	5.00	3.00
Cu4	5.00	5.00	5.00	5.00	4.00
Cu5	5.00	5.00	5.00	5.00	5.00

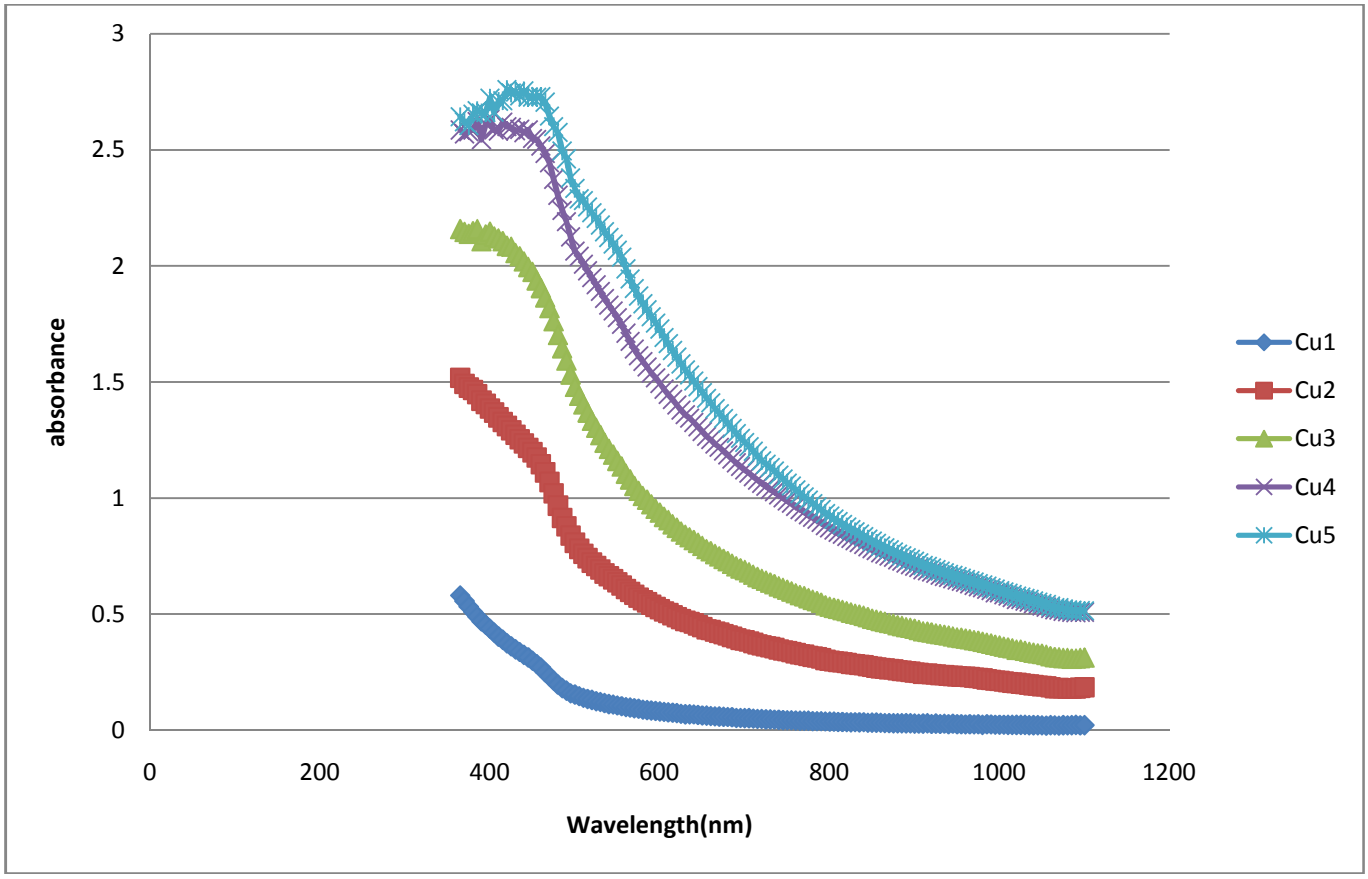

Figure-1
Spectral absorbance of CuS films (slide Cu1, Cu2, Cu3, Cu4, Cu5)

Results and Discussion

Figure-1 is a plot of absorbance of CuS thin film as a function of wavelength. The optical absorption spectra of CuS films deposited onto a glass substrate were studied at room temperature in the wavelength range of 365nm-1100nm. The optical absorbance spectra were obtained for the film deposited at different dip time. The curves show a decay of absorbance with longer wavelength. The absorbance tends to be very high in the uv region for all the samples. It also shows a moderate absorbance in the visible region for all the samples. In the near infra-red region, the curves reveal a very low absorption of energy. A critical look at the graph shows a progressive increase in absorbance as the dip time increased from 1hour to 5hours. From this experiment one can infer that increase in the dip time in the chemical bath deposition of CuS thin film increases the absorbance of the film. The deposited films with high absorbance in the UV region and low absorbance in the visible region, have useful application in the coating of windscreens and driving mirrors to prevent the effect of the dazzling light into driver's eyes from oncoming and following vehicles. It could also be useful in p-n junction solar cells.

The morphology of CuS thin film deposited on glass substrate on examination using an optical microscope shows that the film is smooth and covers the glass substrate well. The grain size of CuS thin film was found to be 0.1μ.

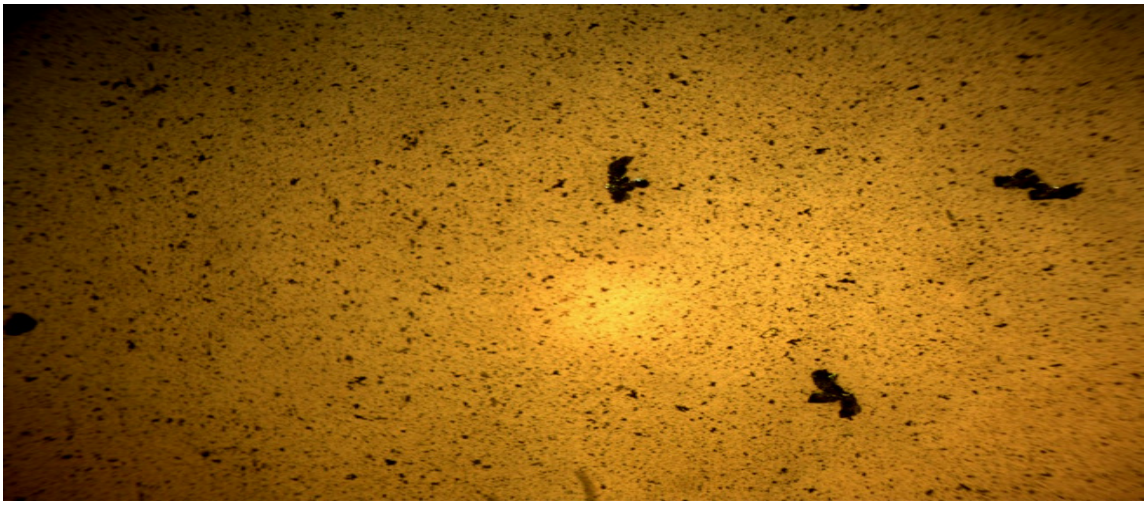

Figure-2
Optical Micrograph of CuS Thin Film

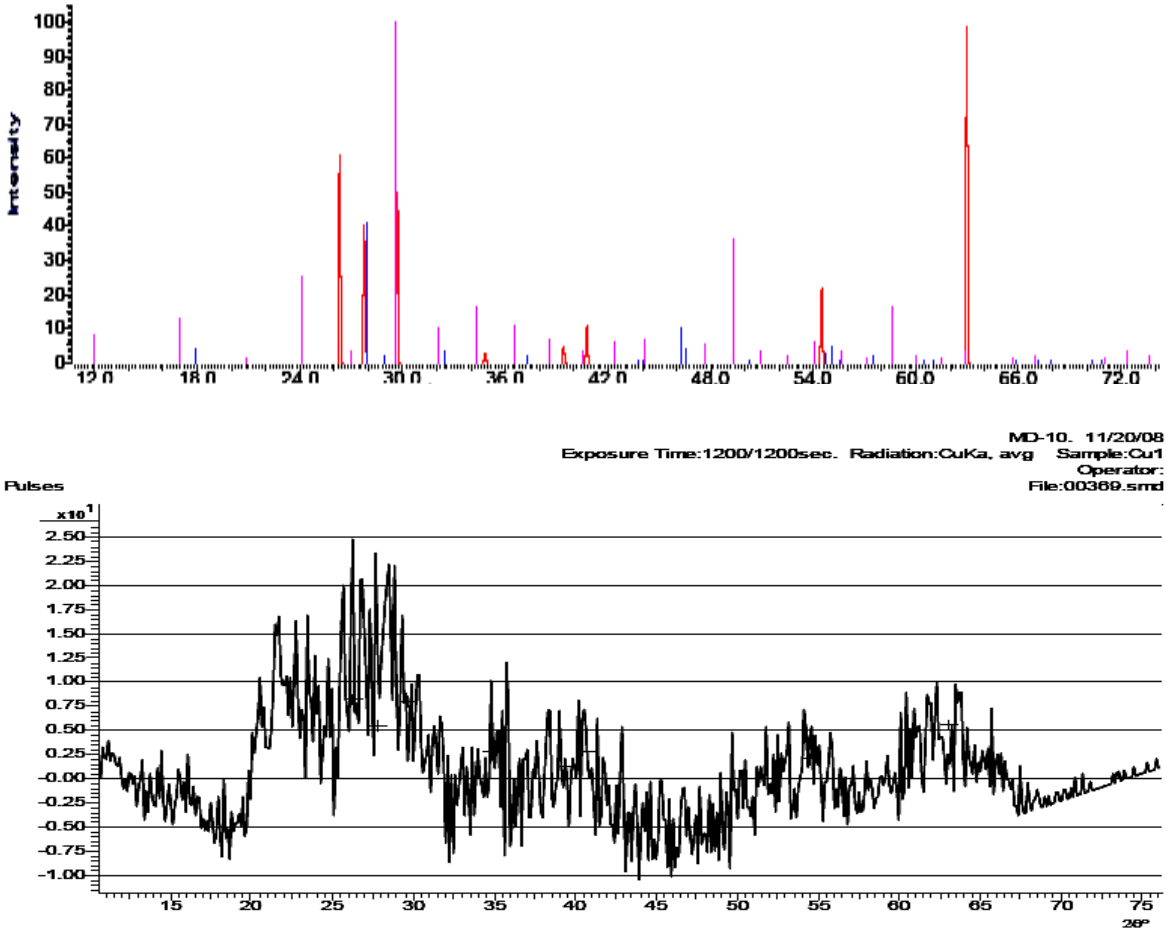

Figure-3
X-ray diffraction spectra for CuS thin film (slide Cu_1)

Figure 3 shows the X-ray diffraction spectra of CuS thin film. According to XRD result, the chemically deposited film of CuS have tetragonal structure. From the XRD result, a lattice constant of 5.434Å was calculated for CuS thin film in the [112] plane, at maximum intensity of $2\theta = 27.8757$ from Bragg's law, given by: $n\lambda = 2d\sin\theta$.

Conclusion

CuS films were successfully deposited using chemical bath deposition technique. Good quality films of copper sulphide with tetragonal structure were deposited. The films have high absorbance in the UV region of the electromagnetic spectrum. We also established that increase in the dip time in the chemical bath deposition of CuS thin film increases the absorbance of the film.

References

1. Cruz-Vasques C., Inoue M., Inoue M.B., Bernal R. and Espinoza-Beltran F.J., *Superficies Y Vacio,* **9**, 219 **(1999)**

2. Thanikaikarasan S., Mahalingam T., Kathalingam A., Hosun M. and Yong D.K., Characterization of Electrodeposited Copper Sulphide Thin Films, *Journal of New Materials for Electrochemical Systems*, **13(1)**, 29-33 **(2010)**

3. Satoshi K., Yohei S., Shotaro K., Kouichi T. and Kaoru S., Synthesis of Non-stoichiometric (LaO)CuS Thin Films by Pulse Laser Deposition, *Applied Physics A: Materials Science and Processing*, **93(3)**, 741 **(2008)**

4. Isac L.A., Duta A., Kriza A. Enesca I.A. and Nanu MThe growth of CuS thin films by Spray Pyrolysis, *Journal of Physics: Conference Series*, **61,** 477 **(2007)**

5. Nair M.T.S., Laura G. and Nair P.K., Conversion of Chemically Deposited CuS Thin Films to $Cu_{1.8}S$ and $Cu_{1.96}S$ by Annealing, *Semicond. Sci. Technol.,* **13,** 1164 **(1998)**

6. Ezema F.I., Nnabuchi M.N. and Osuji R.U., Optical Properties of CuS Thin Films Deposited by Chemical Bath Deposition Technique and Their Applications, *Trends in Applied Sciences Research,* **1**, 467-476 **(2006)**

7. Ezenwa I.A., Ekpunobi A.J. and Ekwo P., Growth and Characterization of CuS thin film by Chemical Bath Deposition, *Nat. and Appl. Sc. Jour*., **11(2)**, 157–164 **(2010)**