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Review Article

Absorbance in Chemical Bath Deposited CuS Thin Films

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Abstract

The CBD technique was employed to grow CuS thin films of onto clean microscope glass slide substrates in which the bath was composed of very dilute copper chloride solution as a source of Cu^{2+}ions and thiourea solution as a source of S^{2-} ions. Structural properties were investigated and characterized using X- ray diffraction. The effect of deposition time on absorbance was investigated on the deposited films.

Keywords: Chemical Bath Technique, Absorbance, CuS, X-diffraction.

INTRODUCTION

Copper sulphides thin films are used as semi conductor absorber materials in photovoltaic cells and most tubular solar collector fabrications due to their structural properties (Ezema *et al.,* 2006). Covellite (CuS) exhibit metal-like electrical conductivity and possesses near-ideal solar control characteristics. It can be deposited on both glass and polymer substrates and these properties of CuS make its thin films promising materials for either electric or electronic devices or radiation control coatings (filters). Material researchers are currently investigating various methods available to prepare high quality CuS thin films as thin-film-semiconducting materials (Ezema *et al.,* 2006). Various growth techniques have been tried to deposit CuS thin films. These include spray pyrolysis, chemical bath and wet methods (Ezenwa *et al.,* 2010). Chemical bath deposition technique has been widely used because of its simplicity and it can grow large area thin film without the use of sophisticated instruments. This method can easily vary the properties of the deposited material and easily control proper optimization of the chemical baths and deposition conditions. This study therefore reports the structural properties of chemical bath deposition of copper sulphide thin films that employed dilute aqueous solution of pure copper chloride and thiourea. TEA solution was used as a complexing agent (Isac*et al.,* 2007) while concentrated ammonia solution was used to adjust the pH of the bath. The growth was done at 300K and the effect of deposition time on the absorbance of the deposited films was also investigated.

MATERIAL AND METHODS

Preparation of Substrates

Glass substrates were degreased in concentrated HNO_3 for 48 hours, thoroughly cleaned in cold water with detergent, rinsed with distilled water and finally dried in air.

Growth of Copper sulphide thin films

Each time 5.0mls of copper sulphate solution was measured into a clean 50 ml beaker using burette and 5.0mls of TEA was added. After this addition, the solution turned blue and then deep blue. The second step was to add 5.0mls of thio urea and the solution turned brown. Finally 5.0mls of ammonia solution was added in which the solution remained brown and the mixture topped to 50mls using distilled water and stirred gently to ensure uniformity.

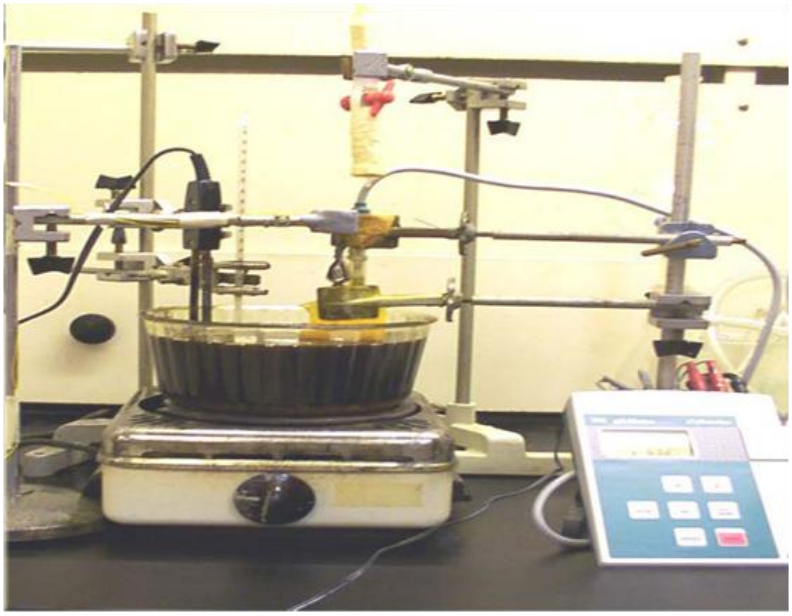

Figure 1. Chemical set up

Five reaction baths were prepared and placed in a 50mls beaker. Growth of CuS thin film by chemical bath 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. A microscope glass slide substrate was dipped lying almost vertically into all of the five reaction baths at 300K and synthetic foam was used to cover to avoid contamination. After the deposition times that was varied as 2 hrs, 4 hrs, 6 hrs, 8 hrs and 10 hrs, the microscope slides substrates were removed and dried in air. The proposed reaction mechanisms were taken as:

Copper sulphate is broken down by TEA to fom a complex copper ion (Nair *et al.,* 1998);

$$CuSO_4.5H_2O + TEA \longrightarrow Cu(TEA)^{2+} + (SO_4)^{2-} + 5H_2O$$

TEA further breaks down the copper complex ion to from copper (II) ions;

$$Cu(TEA) \longrightarrow {}^{2+}Cu^{2+} + TEA$$

Thiourea is hydrolyzed by OH^- to form HS^- ions as;

$$SC(NH_2)_2 + OH^- \longrightarrow CH_2N_2 + H_2O + HS^-$$

The formed HS^- reacts with OH^- to form sulphide ions as;

$$HS^- + OH^- \longrightarrow H_2O + S^{2-}$$

And then copper ions react ionically with sulphide ions to form copper sulphide precipitates as;

$$Cu^{2+} + S2 \longrightarrow {}^{-}CuS$$

Characterization of copper sulphide thin films

A UV/visible spectrophotometer at the University Of Nairobi, School of material Science , (Chiromo Campus) was used to determine the spectra absorbance while structural characterization of the films was carried out using an x-ray diffractometer with Cuk_α radiation.

RESULTS AND DISCUSSION

Optical Absorbance

The optical absorption spectra (figure 1, represents the device used) of CuS films deposited onto a glass substrate were studied at room temperature in the wavelength range of 200 nm-2000 nm an a plot of absorbance of CuS thin film as a function of wavelength show a decay of absorbance with longer wavelength (Satoshi *et al.,*2008). The absorbance tends to be very high in the **UV** region for all the samples. There is very low absorption of energy in the near infra-red region and thus from the results, an increase in the dip time in the chemical bath deposition of CuS thin film increases the absorbance of the film. The deposited films have high absorbance in the UV region and low absorbance in the visible region. They can therefore be used for coating windscreens, driving mirrors and in p-n junction solar cells (Thanikaikarasan *et al.,* 2010).

Figure 2. Spectrometer for spectra analysis

X-ray diffraction spectra

According to XRD results obtained, the deposited thin films of copper sulphide have tetragonal structure with a lattice constant of 5.434Å calculated in the [112] plane, at maximum intensity of 2θ = 27.8757 from Bragg's law, given by: nλ = 2dsinθ.

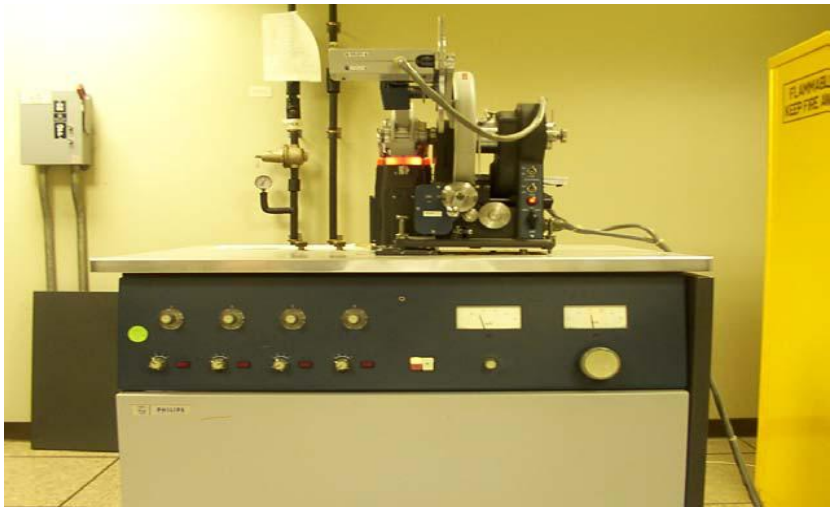

Figure 3. X-ray device used for structural analysis

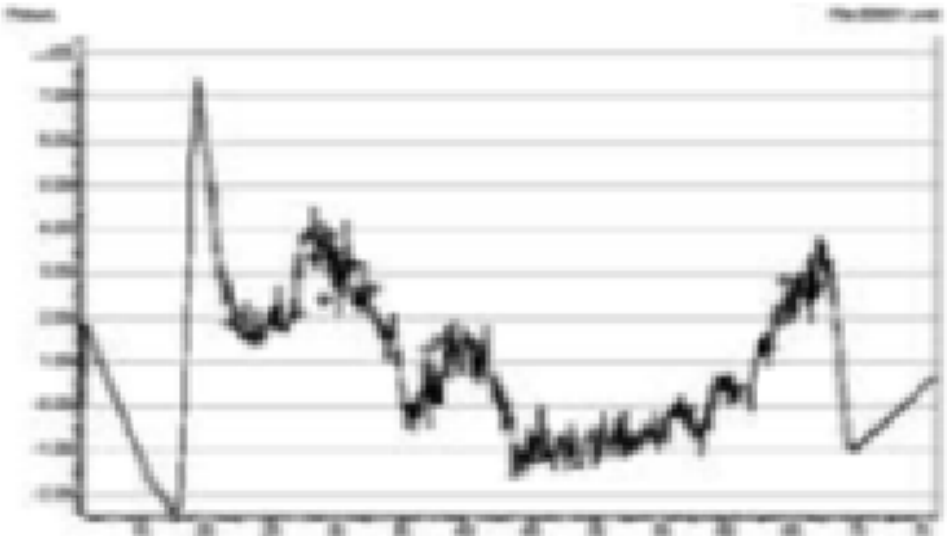

Figure 4. The XRD spectra

CONCLUSION

Copper sulphide thin films were grown using chemical bath technique with tetragonal structure. The thin films had high absorbance in the UV spectra region and an increase in the dip time in led to an increase the absorbance of radiation.

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