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RESEARCH ARTICLE

THE PREPARATION AND CHARACTERIZATION OF CUS FILMS WITH CHEMICAL BATH DEPOSITION METHOD

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Abstract

Thin films of copper sulphide deposited on glass substrates at 65 ^{0}C temperature by the chemical bath deposition technique. Effect of deposition temperature on copper sulphide thin films were studied. UV- VIS spectrophotometer in the wavelength range of 200 nm to 1100 nm was used for optical characterization. Energy band gap was calculated and it is 2.24 eV and so the films can applicably be recycled in the solar cell formation. XRD study shows hexagonal structure and definite the quality of crystallinity. Thickness of the films and crystallite size were also calculated and it was found 310 nm and 28.5nm respectively. Film deposited at 65 °C showed as good as uniform structure of SEM and EDAX pictures. Electrical transport readings exhibited that the films are semiconducting in nature. Highest room temperature electrical conductivity of 2.19 × 10^{-3} was observed for the film. Thermo power indicated that the samples show n-type conduction.

Keywords: UV-VIS spectrophotometer, XRD study, SEM and EDAX, electrical conductivitconduy.

Introduction

The Copper sulfide a semiconducting material which belongs to I-VI compound semiconductor metals is a base material for the formation of novel quaternary compounds. Chalcopyrite thin film of copper sulfide have received particular attention of the heterojunction solar cell. Additional applications of CuS thin films include laminated glazing, photo-thermal conversion, electro-conductive electrode, microwave shielding and solar control coatings ((Grozdanov and Najdoski, 1995; Suarez and Nair

1996; Ottih and Ekpunobi 2010; Nascu *et al.*, 1997; Osuwa and Onyejiuwa, 2013; Guan-Ting Pan et al., 2010). It is also used in photo-detectors and photovoltaic applications. In this paper, the effects of temperature on the electrical resistivity, conductivity and optical properties of CuS thin films prepared by CBD technique have been investigated. The associated microstructure and crystalline properties of the as-prepared films were examined. Nano images of high resolution were obtained and demonstrated the nanocharacter of the samples. Electrical measurements show good electrical properties and n-type CuS semiconductors and optical characterization reveals good transmittance values ((Pathan, *et al.*, 2001; Anuar *et al.*, 2011; Raniero *et al.*, 2010; Anuar *et al.*, 2010; Ubale 2010).

Experimental Procedure and Characterization

$CuSO_4$ (AR grade) used as the precursor for copper ions to deposit the CuS thin film. Triethanol amine (TEA) as a complexing agent, thiourea (H_2NCSNH_2) as the precursor for sulfur ions and to adjust the pH ammonia used. Glass slides were degreased with hydrochloric acid (HCl) for 48 hours, wash away in cold water with detergent, cleaned with distilled water and dried in air for some minutes. An aqueous solution containing copper sulfate(0.5M, 10mL), thiourea (0.5 M,10mL), triethanolamine (3.0 mL), sodium hydroxide (5.0mL) and ammonia 10 M). Distilled water was used for the preparation of solution. The pH of resultant solution was adjusted to 10. (Suryawanshi *et al.*, 2022). Glass substrates were then implanted steeply into the reaction container with the help of a synthetic holder, which also partially covered the top of the beaker containing the bath. The bath was left without interruption for 45 minutes at a 65 ^{O}C temperature. Then deposited samples were taken out, cleaned in distilled water, dried in air and characterized with weight difference method for the thickness measurement UV-V spectrophotometer for optical study, XRD for the crystalline structure, EDAX for chemical composition of the films. SEM (Scanning electron microscopy) indexation was envisioned for the as deposited sample. Electrical conductivities and Thermovoltages of the film were experienced by a two point probe method in the temperature range of 300 - 500 K.

Results and Discussion

The film thickness was determined using weight difference method and obtained thicknesses of the CuS thin films deposited by chemical bath deposition method on glass substrate is 310 nm. Chemical composition of the as deposited CuS thin films were resolute with the help of EDAX (energy dispersive X-rays spectroscopy). The spectrum of EDS of the CuS thin films is shown in figure 1.The elemental analysis confirms the presence of copper (Cu), sulfur (S) along with along oxygen (O) as an impurity (Arthur Ekpekpo, 2019).

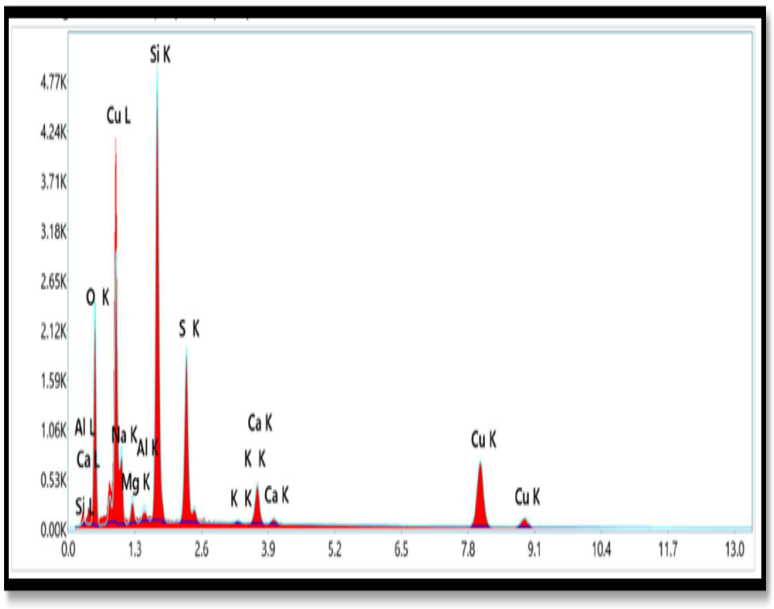


Fig. 1 : EDAX analysis of CuS Thin film

Using scanning electron microscopy (SEM) the surface morphology of thin film was studied. The SEM images of the Copper Sulfide thin film obviously expose that CuS nanoparticles are uniformly distributed. The sample has a compact flat surface morphology with a few irregularities and there is no growth of popcorn-like structure. The squashed smooth surface of CuS agglomerate to form a dense and rough surface then a tiny popcorn-like structure growth which initiate crystallinity to improve as shown in figure 2.

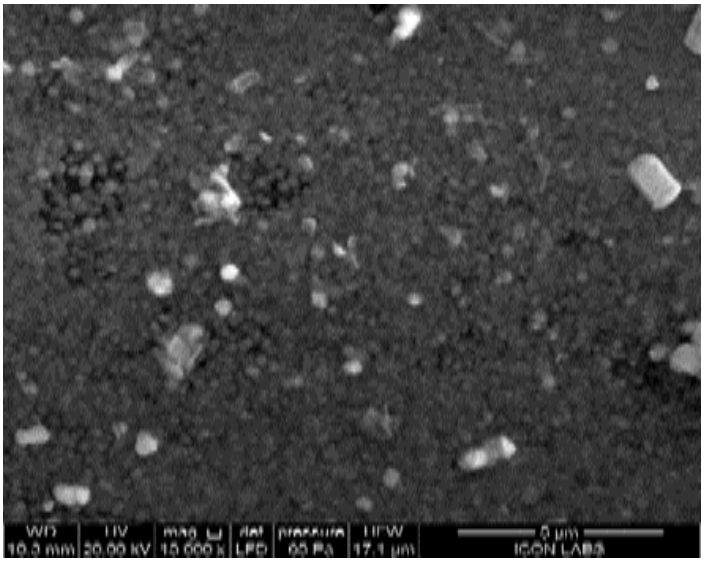


Fig. 2: SEM image of CuS thin films at 65 ^{0}C temperature

The optical properties of the CuS thin films were studied using the absorbance spectra obtained employing spectrophotometer in the range of 200 to 1100 nm wavelength range. Absorption data was observed for near edge optical absorption of semiconductor. The optical gaps were then determined and an energy bandgap (Eg =2.24 eV) as shown in figure 3.

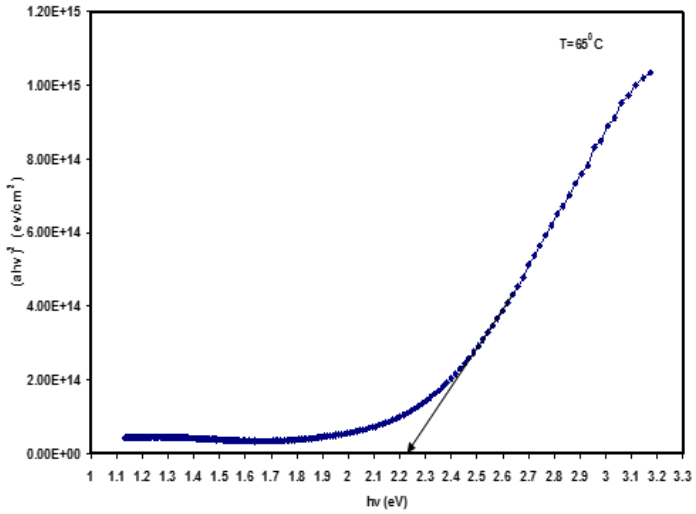
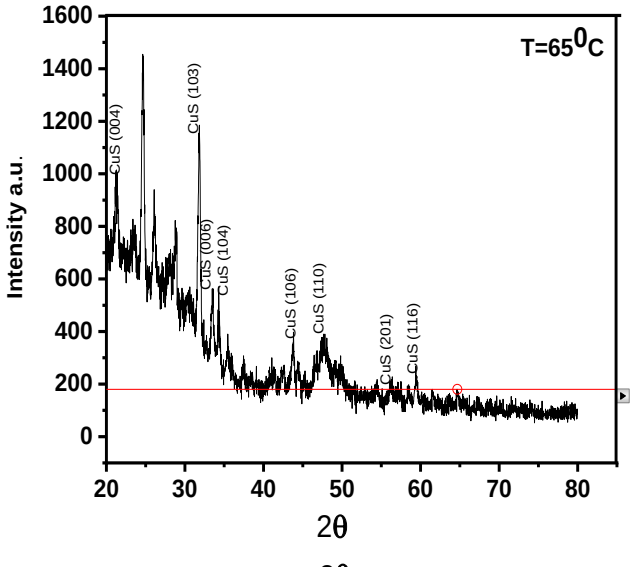


Fig. 3: The optical band Eg =2.24 eV

The film resistivity resolute with the sheet resistance obtained from two points probe method. The measured electrical resistivity at room temperature was 2.88x10^4 Ω-cm and 45.71 Ω-cm at 500K. The film shows n-type of conductivity. X-ray diffraction patterns for Copper sulfide thin film obtained at 65 °C by using copper salt sources with chemical deposition method is shown in fig. 4. The different diffraction peaks (006), (104), (110), (201) and (116) are observed at degrees of $2\theta = 31.84°$, 32.86°, 34.98°, 47.92°, 56.40° and 59.4° By using these angle crystallite size D value between atom planes which are responsible from these peaks, are calculated with Bragg diffraction equation it is 28.5nm (Suryawanshi et al., 2022; Arthur Ekpekpo 2009).



Conclusion

CuS thin film have been deposited on glass substrate using CBD technique at the 65 ^{O}C temperature and characterized through EDAX, SEM, and Spectrophotometer. The characterization analyses of the as deposited sample have been carried out successfully. Thickness of the deposited film is found to be 310 nm. XRD results reveal nano-crystallite structures and its crystallite size (D) is 28.5 nm. The resistivity of the CuS thin film showed 2.88x10^4 Ω-cm (at room temperature) and 45.71 Ω-cm (at 500K). The energy band gap of the film obtained is 2.24eV.

Room temperature electrical conductivity of 3.47 × 10^{-5} $(\Omega\text{-cm})^{-1}$ and 2.19 × 10^{-2} $(\Omega\text{-cm})^{-1}$ at 500K was observed for the film.

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