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Synthetization of Copper Sulphide Thin Film By CBDT

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ABSTRACT

The chemical bath deposition technique was used to deposited copper sulphide thin film on an amorphous glass substrate. Experiments was carried at 60⁰C, temperature. Morphological, structural, optical properties of CuS thin film was investigated. X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray analysis (EDAX), thermoelectric power (TEP) and optical absorption were supported in order to inspect the physical properties of the as deposited sample. X-ray diffraction patterns showed that the film is hexagonal structure. The crystal size (D) was calculated 26.7nm at 60 °C deposition temperature. The SEM micrographs showed that the nanostructure appeared in the sample. Optical property of the film was studied in the wavelength range of 200-1100 nm. It's observed that the absorption follows in visible and ultraviolet regions. The optical energy gap was calculated for the allowed direct transition, its value was 2.45 eV. The dignified resistivity and calculated conductivity was found to vary with temperature. Conductivity extent showed that CuS thin film is n-type and highest conductivity was 1.13×10^{-2} $(\Omega.cm)^{-1}$.

Keywords: - *Copper sulphide thin film, Energy dispersive X-ray analysis, Nanostructure, Direct transition.*

I. INTRODUCTION

An increasing study in semiconducting chalcogenide thin films which have been due to their extensive applications in various fields of science and technology. Copper sulfide is the most frequently used material. The copper sulfide thin film appeals the courtesy of many researchers due to its semiconducting properties. Similarly, the basic elements of this material are abundant in nature. The copper sulphide is a significant material from the socket of basic research because it is be present in several crystallographic and stoichiometric formulas. The CuS has a distinct composition with different stoichiometry and temperature is responsible for a change from one composition to another. Chemical methods have been used to develop CuS films. The shape, phase and the size of inorganic nano-crystals and micro-crystals are the determinant elements in varying their electrical, optical and other properties. The chemical methods are cost-effective and necessary structure can be obtained with them. To produce copper sulfide thin films with wanted nature and assembly, the chemical method was employed [1-4]. Numerous techniques such as Chemical Bath Deposition (CBD) [2, 5, 6], Successive Ionic Layer Adsorption and Reaction SILAR [4, 7] and Spray Pyrolysis Deposition SPD [8-10]. As a significant semiconductor with unique electronic, optical and chemical assets, CuS thin films are of inordinate apprehension due to its extensive range of application in optical and electrical devices, such as photothermal conversion of solar energy, electro-conductive electrodes, microwave shielding coatings, solar control coatings, IR detectors, temperature control of satellites, light emitting diodes and other optoelectronics [5, 7]. In this paper, copper sulfide thin film was deposited on glass substrates by chemical bath deposition technique. X-Ray Diffraction (XRD), scanning electron microscope (SEM), optical and electrical characterization were attained for thin film at 60 ^{0}C temperature.

II. EXPERIMENTAL DETAILS

Preparation and characterization of CuS thin film

In the chemical bath deposition technique method, it is important to control the preparation conditions such as the concentration of solutions, pH of the solutions time for deposition and the temperature. Good quality thin film of CuS were prepared by using aqueous solutions of copper sulfate ($CuSO_4$) and Thiourea (H_2NCSNH_2) as a source of Cu and S. The experiment was carried out for temperature 60 ^{0}C. Glass substrates have been passed through the cleaning stage before deposition in the dilute sulfuric acid. Subsequently it was then cleaned with acetone and made ready for deposition by passing through pure water. Prepared glass slides were deep vertically in an aqueous solution having copper sulfate, thiourea (0.5molarity and 10ml of each), triethanolamine, sodium hydroxide and ammonia were used as a complexing agent. The solutions were prepared in double distilled water. The pH of the solution was maintained to 10. After (45mini.) the completion of deposition, film were tough with distilled water [11, 12].The scanning electron microscopy (SEM) of the films was supported out using an energy dispersive spectrometer (EDAX). Structure was studied by an X-ray diffraction technique using XRD machine. The range of 2θ values was from 20° to 80° and emissions used were CuKα (λ=1.5406 Å). The optical absorption measurements were carried out using UV-Vis spectrophotometer in the wavelengths from 200 nm to 1100 nm. An electrical conductivity of the deposited film was verified by a two point probe method in the temperature from 300 K to 500 K. Thermovoltages were also noted on the samples in the 300 K to 500 K temperature.

III.RESULT AND DISCUSSION

3.1 EDS Analysis

As-deposited CuS thin films was sustained out using energy dispersive X-ray spectroscopy (EDS). The analysis shown the presence of Cu and S as constituent elements in the film. A typical EDS spectrum of as deposited thin films at temperature 60 °C as shown in Figure 1. The atomic percentages of constituent elements in the as-deposited films and the taken ratio of Cu and S content in the film is almost same.

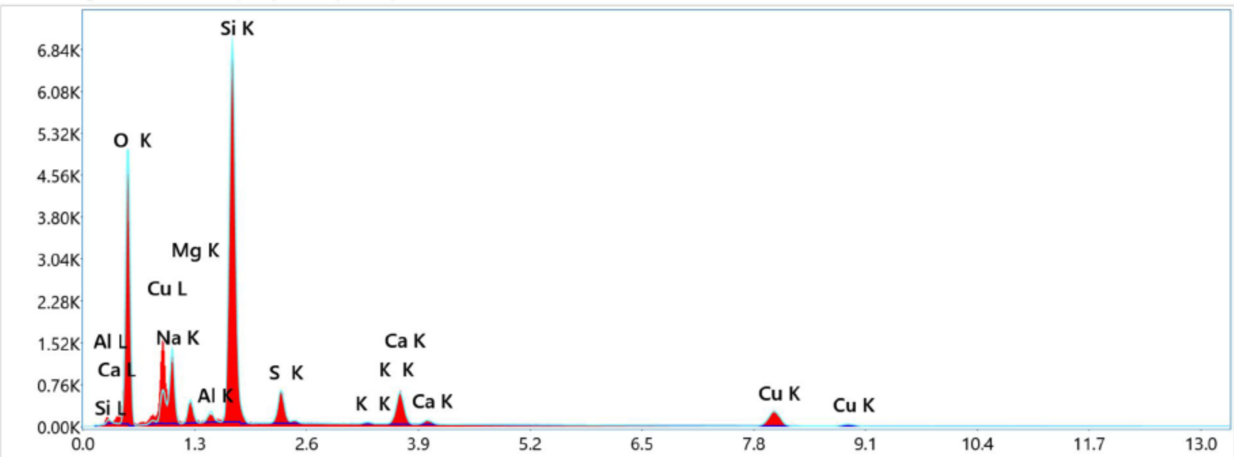

Fig. 1. EDS spectrum of CuS thin film deposited at 60 ^{0}C temperature.

3.2 Structural and Morphological Charecteristics

Figure 2 shows the x-ray diffraction (XRD) of copper sulphide thin film deposited on glass substrate for 60 ^{0}C deposition temperature. The CuS thin film was scanned in the range 20°–80°. The diffraction peaks express that the films contain well grains and are nanocrystalline in nature. The orientations, namely (004), (102), (110) (200) and (108) which indicate a covellite CuS phase with hexagonal structure. The orientations namely (102) for covellite CuS phase with 60 ^{0}C temperature as shown in Figure2 [13].Crystallite size value for this sample is 26.7 nm. at the temperature of 60 ^{0}C. Such result is effective in the development of the crystal structure of CuS thin films. The morphology of the equipped thin film was studied using SEM which shows the surfaces in high magnification and high resolution. The image of CuS thin film prepared at 60 ^{0}C deposition temperature is shown in Figure 3. It observed that the prepared CuS thin film have cauliflower-like forms with an irregular particle size [13, 14].

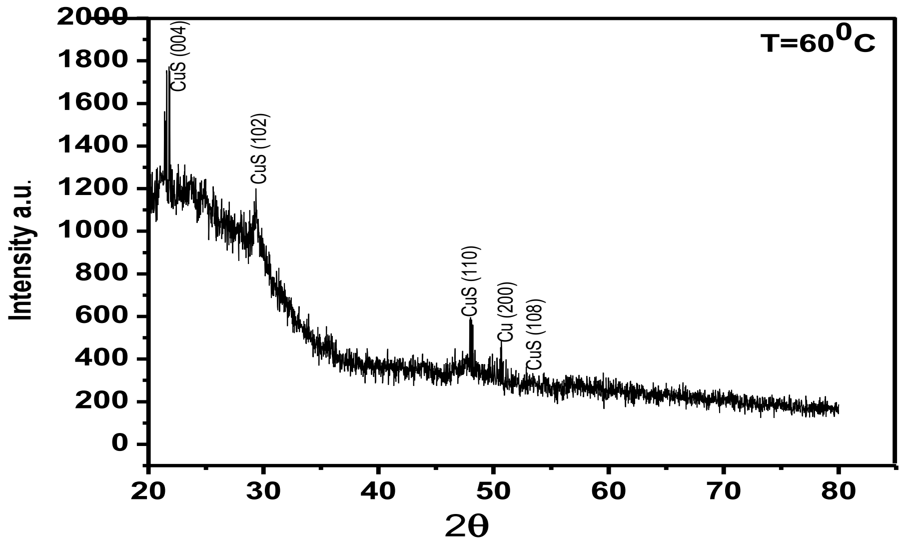

Fig. 2 The XRD of CuS thin films at 60°C temperature.

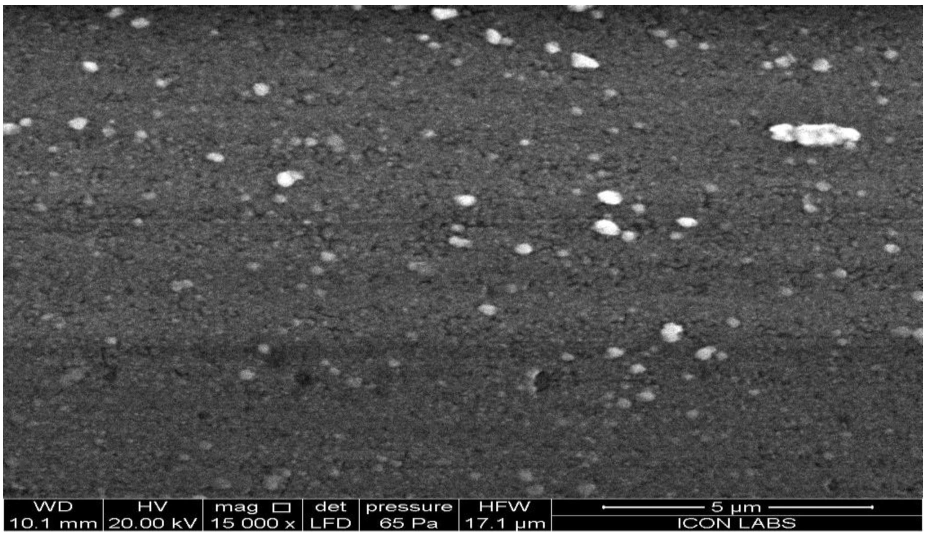

Figure 3. SEM image of CuS thin films at 60 ^{0}C temperature.

3.3 Optical and Electrical analysis

An absorption coefficient as a role of the wavelength of the CuS thin film. The result showed high value of the absorption coefficient in the visible spectrum. The energy gap value of direct electronic transitions was calculated by plotting a graphical relationship of $(\alpha h\nu)^2$ versus photon energy (hυ) figure 4. The energy bandgap value of the CuS film was found to be 2.45 eV. This value is identical together to those used for solar cell applications. The energy gap values be contingent on the crystalline structure and are affected by the deposition temperature [15-17].

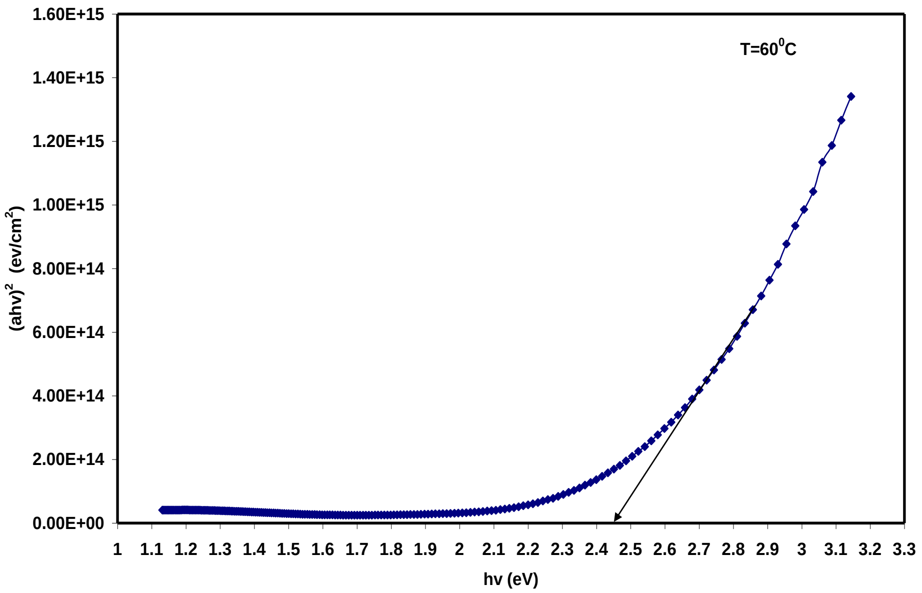

Figure 4. The relation between $(\alpha h\nu)^2$ and (hν) for CuS thin film at 60 ^{0}C temperature.

An electrical conductivity of the as deposited CuS thin film was measured using two-probe method in the range of temperature from 300 – 500 K. The film is semiconducting and nonlinear nature. The electrical conductivity value was found to be 1.13×10^{-2} $(\Omega.cm)^{-1}$for the film deposited at 60 °C. The type of conductivity shown by the CuS thin film is n-type conduction determined from TEP [18].

IV. Conclusions

Nanostructured CuS thin films were prepared by the chemical spray pyrolysis method at 60 °C substrate temperatures. From XRD analysis it was concluded that film is hexagonal structure and n-type in nature. The properties of the prepared film suggest that this may be a good candidate in solar cells.

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