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Research Article

THE GROWTH AND CHARACTERIZATION OF COPPER SULFIDE THIN FILMS PREPARED BY CHEMICAL BATH DEPOSITION TECHNIQUE

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ABSTRACT
Nanostructured copper sulfide (CuS) thin films were deposited onto glass substrate by using chemical bath deposition method. The structural and morphological characterizations of the thin films were carried out by using X-ray diffraction and scanning electron microscopy respectively. The grown thin films are confirmed by X-ray diffraction (XRD) and it reveals that, CuS thin films are polycrystalline in nature with hexagonal crystal lattice. Scanning electron microscopy (SEM) was used to characterize the morphological studies and it indicate that, CuS thin films uniformly covered the substrate with tiny grains and nanorods over the surface throughout the sample area.

Keywords: *Thin Films, Nanostructures, Chemical Bath Deposition, XRD, SEM*

INTRODUCTION
Nowadays, nanomaterial has attracted a great deal of attention in researches and some technical uses. Copper sulfide, as an example of nanomaterial, can play an important role in optoelectronic applications, solar cells, photoconductors, laser materials and sensor materials. Many methods such as spray pyrolysis (Nascu *et al.*, 1997), successive ion layer adsorption and reaction method (Ubale *et al.*, 2016), photochemical deposition (Podder *et al.*, 2005), electrodeposition (Anuar *et al.*, 2002) and chemical bath deposition (Gadave and Lokhande, 1993) have been developed to prepare copper sulphide thin films. Among these techniques, chemical bath deposition method is said to be commonly used to deposit metal thin films onto glass substrates. This is because of this method is cost effective, time saving and precise control of the deposition process. Some researchers have reported chemical bath deposition method for depositing PbSe (Ibrahim and Salame, 2016), SnS (Jayasree *et al.*, 2013), and CdSe (Zhao *et al.*, 2013) thin films from aqueous solution.

MATERIALS AND METHODS
Nanocrystalline CuS thin films were deposited onto glass substrate using copper (II) chloride dihydrate ($CuCl_2.2H_2O$), triethanolamine ($C_6H_{15}NO_3$),ammonia solution (NH_4OH), sodium hydroxide pellets (NaOH) and thiourea (NH_2CSNH_2) (provided by Sd-fine chemicals, Mumbai) using chemical bath deposition method. Copper (II) chloride dihydrate and thiourea are source of $Cu^{2+}$and S^{2-} ions respectively.
Triethanolamine and sodium hydroxide is the complexing agent during the deposition process whereas ammonia solution was used for adjusting pH of the solution to achieve the medium. Glass slides were first immersed into dilute hydrochloric acid for 24 hours which were then washed thoroughly with constant rubbing by soft tissue papers, after that glass slides were put into freshly prepared chromic acid for a few minutes for further fine cleaning. After that the glass slides were rinsed with doubled distilled water several times and dried. 1M of copper sulphide solution was added with triethanolamine (TEA) solution in a 100 mL glass beaker and stirred for 10 min. After that 8 mL of aqueous ammonia solution was mixed under constant stirring. Then, 1M of sodium hydroxide solution wasadded in to the solution under continuous stirring. Finally, 1M of thiourea solution was mixed andstirred for 5 min. The pH of the solution was 11.5. Then, cleaned glass slides were immersed vertically in the solution. After the

deposition time of 330 min, the glass slide were taken out of the bath, washed with doubled distilled water and dried in desiccators for further characterization.

RESULTS AND DISCUSSION

Structural Analysis

X-ray diffraction is a powerful non-destructive method for characterization, by which, the crystal structure, grain size and orientation factor can be determined.

The structural identifications of CuS thin films were carried out using Philips PW 1710 diffractometer, with Cu–Kα radiation of wavelength 1.5405 Å. The XRD peaks of CuS thin films corresponding to (002), (103), (006), (008), (108) and (116) planes confirm that the films have hexagonal structure (JCPDS reference code 06-0464).

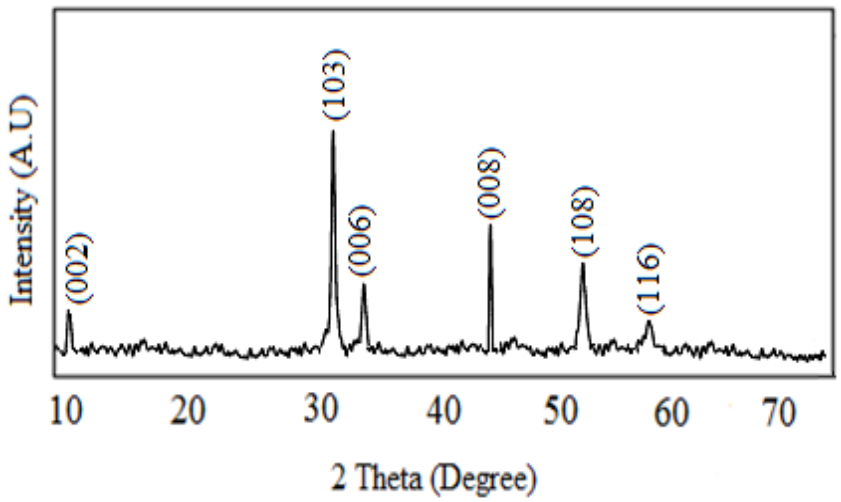

Figure 1: XRD Pattern of Copper Sulphide Thin Film

Table 1: Comparison of Observed and Standard XRD Data of Copper Sulphide Thin Films

Film	Observed Data		Standard Data		
	2θ (degree)	**d (A^0)**	**2θ (degree)**	**d (A^0)**	**h k l**
CuS	10.934	8.101	10.806	8.180	0 0 2
	31.987	2.701	31.783	2.813	1 0 3
	32.564	2.851	32.851	2.724	0 0 6
	44.421	2.002	44.298	2.043	0 0 8
	52.908	1.682	52.712	1.735	1 0 8
	58.031	1.682	59.342	1.556	1 1 6

Morphology

SEM is a promising technique for the morphology of thin films. It gives as important information regarding growth, shape and size of the particles. Figure 2 shows the SEM micrographs for CuS thin film. It is observed that the CuS thin film uniformly covered the substrate with tiny grains and nanorods over the surface and mostly these grains fall in nanometer regime and also microscopic defects like voids, pinholes or peeling were not observed.

Conclusion

In the present paper, growth and characterization of copper sulfide thin films deposited by chemical bath deposition technique has been reported. The XRD pattern suggests that the CuS thin films are

polycrystalline in nature with hexagonal crystal lattice. Scanning electron microscopy (SEM) was used to characterize the morphological studies and it reveals that, CuS thin films uniformly covered the substrate with tiny grains and nanorods over the surface.

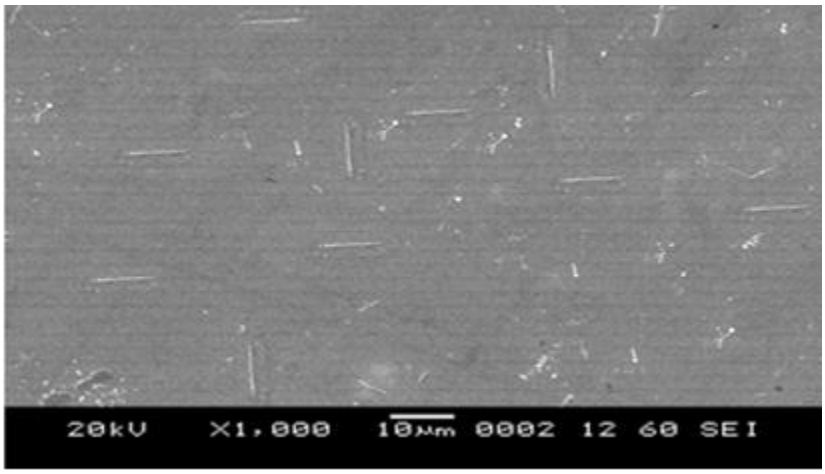

Figure 2: SEM Image of Copper Sulphide Thin Film

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