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Study of Structural and Morphological Properties of Vacuum Coated Copper Oxide (Cuo) Thin Film by Thermal Evaporation Technique

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ABSTRACT

In this present study Copper and Copper oxide thin film deposited on a glass substrate by vacuum coater. Thermal evaporation deals with the evaporation of the source materials in a vacuum chamber and condensing the evaporated particles on a substrate. This process is conventionally called vacuum deposition. The structural, morphological studies of Copper (Cu) and copper oxide (CuO) thin films prepared by thermal evaporation method have been studied. Structural analysis results of Cu thin films demonstrate that the single phase of Cu with high a crystalline structure with a preferred orientation (111). X-ray diffraction results confirm the formation of pure (CuO) phase in thermal evaporation method. The SEM images of CuO thin films shows morphology of CuO thin films prepared at 100°C. The images show that the grains are not highly homogeneous in shape and size there is shape cubic, spherical and others.

Key Words: Copper Oxide, Morphology, Structural properties, Thin Films, Thermal Evaporation etc.,

INTRODUCTION

Copper has attractive properties like good corrosion resistance, attractive colour, excellent workability and also good mechanical properties. Copper thin films have been synthesized by the various methods like chemical vapour deposition, evaporation, sputtering, pulsed laser deposition, electrode position .In the present study the copper thin films were prepared at 100^0C temperatures by vacuum coating unit 12A4D. The purity of copper material 99.999% (from sigma Aldrich) was evaporated from a molybdenum boat at a pressure of $5x10^{-5}$ m bar. The thickness of the film monitored in situ by quartz crystal thickness monitor.

METHODS AND MATERIALS

Copper and Copper Oxide Thin Films:

The Copper and Copper oxide thin films were prepared by the physical vapour deposition technique. Since it involves relatively low capital expenses and is technically undemanding, this method has been popularly used. Thermal evaporation deals with the evaporation of the source materials in a vacuum chamber and condensing the evaporated particles on a substrate. This process is conventionally called vacuum deposition. A slice (7.2cm × 2.4cm) of glass is taken and then cleaned gently using acetone and buffing is made on the surface and fixed in the chamber, the Copper material loaded with in molybdenum boats and $3X10^{-5}$ vacuum level is maintained and the deposition is done at room temperature. The structural and morphological properties were studied with **XRD** and **SEM** analysis and the results are presented in the following section. Using the SEM images, the dimension of the assembly of nanostructures in the thin films has been estimated.

Scanning Electron Microscopy (SEM)

The SEM photograph with a magnification of 289.54 KX for Copper and Copper oxide thin film at 100°C is shown in

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Fig 1 and 2. It is observed that the film is smooth and well defined spherical crystallites with grain size 100 nm.

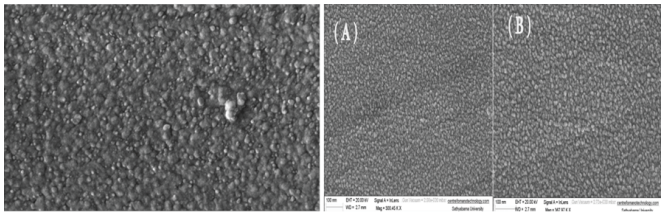

Figure 1: SEM image of Copper &Copper oxide at 100°C.

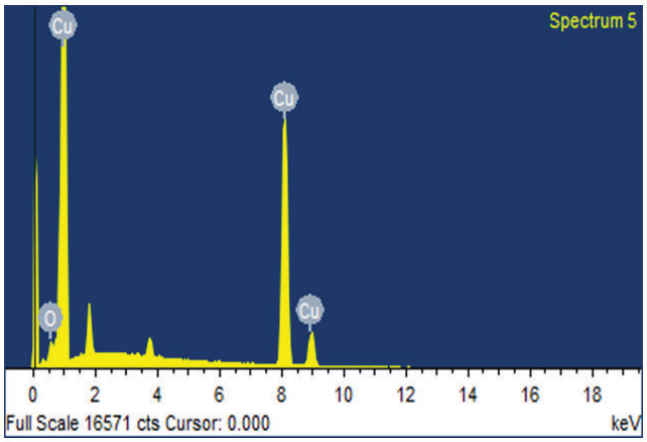

Figure 2: EDX Spectrum of Copper at100°C.

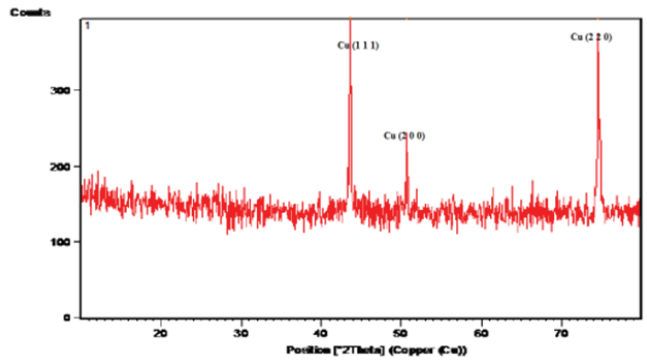

Figure 3: XRD Pattern of Copper.

XRD PATTERN OF COPPER THIN FILM AT 100°CTEMPERATURE:

Figure 1 shows the XRD pattern of diffraction of Copper thin films deposited on glass substrate at room temperature. The peaks are shown from 43.605(degree) to 74.530 degree). The full width half maximum (FWHM) indicates the range from 0.0019 (radian) to 0.0026 (radian) and the diatomic spacing of the copper thin films 2.07398A° to 1.27216A°. The maximum height of the peaks were 210(cts) at 43.605(degree) to 180(cts) at 74.530(degree).From XRD pattern of Copper thin film indicates three peaks , which having hkl parameters like (111),(200),(220).

Table 1: XRD Data of Copper Thin film:

Position (2θ) (Deg)	Height (cts)	FWHM(2θ) (deg)	d-Spacing (A°)	Relative Intensities (%)
43.605(7)	210(59)	0.11(2)	2.07398	100.00
50.73(1)	80(32)	0.09(2)	1.79830	38.19
74.530(8)	180(67)	0.15(3)	1.27216	85.44

The above table gives details about three peaks of copper. The three peaks of Copper have d-spacing values like 2.07398, 1.79830 and 1.27216 with corresponding relative intensities values like 100, 38.19 and 85.44. The relative intensities are decreased with increasing peak position and decreasing d-spacing.

Peak Indexing

Table 2: Simple Peak Indexing

Peak Position (2θ) (deg)	1000 x $\sin^2\theta$ (deg)	1000 x $\sin^2\theta/46$ (deg)	Reflection (hkl)	Remarks
43.605	137.94	2.9	(1 1 1)	$1^2+1^2+1^2=3$
53.73	183.51	3.9	(2 0 0)	$2^2+0^2+0^2=4$
74.530	366.72	7.9	(2 2 0)	$2^2+2^{2+}0^2=8$

The peaks were obtained by using above indexing methods. The data are in Table 2 & Table 3. In table 2, one need to find a dividing constant and the values in the 3rd column becomes integers (approximately). Here, the constant is 45.5 (= 183.51-137.94). Moreover, the high intense peak for Face Centre Cubic (FCC) materials is generally (1 1 1) reflection, which is observed in the sample.

Table 3: Peak indexing from d – spacing:

Peak Position (2θ) (deg)	d-Spacing (A°)	1000/ d^2	$(1000/d^2)/77.32$	hkl
43.605	2.07398	232.48	3.006	(1 1 1)
53.73	1.79830	309.22	3.999	(2 0 0)
74.530	1.27216	617.89	7.991	(2 2 0)

Three peaks at 2 **θ** values of 43.605, 50.73, and 74.530 deg corresponding to (111), (200), and (220) planes of copper were observed with respect to their peak indexing from d-spacing. The XRD study confirms / indicates that the resultant particles are (FCC) Copper. The particle size calculation was performed by using scherrer formula. From these calculations, this indicates the size of particle is less than 97 nm.

Table 4: Particle Size of Copper

2θ of The Intense peak (deg)	hkl	θ of The Intense peak (deg)	FWHM of Intense Peak (β)(rad)	Size of The Particle (D) nm	d-Spacing nm
43.605	(1 1 1)	21.80	0.0019	78.56	0.2073
53.73	(2 0 0)	25.36	0.0015	97.94	0.1797
74.530	(2 2 0)	37.26	0.0026	66.72	0.1271

From the above table the grain size of copper were calculated with corresponding to the values of FWHM of intense peak values.

Finally XRD pattern indicates the copper has face centre cubic structure and their morphology also identified.

CONCLUSION

The structural, morphological studies of Copper (Cu) and copper oxide (CuO) thin films prepared by thermal evaporation method have been studied. Structural analysis results of Cu thin films demonstrate that the single phase of Cu with high a crystalline structure with a preferred orientation (111). The SEM images show that the grains are not highly homogeneous in shape and size there is shape cubic, spherical .

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