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Effect Of Annealing Temperature For CuO Thin Films Properties Prepared By Simple Chemical Methods

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***Abstract*—In this work, copper oxide have been prepared by chemical method and deposition as thin films on glass substrates at different annealing temperatures (as-prepared, 100, 200 ,300) °C then, studied the effect of temperature on the structural properties, The structure of the deposited CuO thin films characterized by X-ray diffraction, Atomic Force Microscope AFM (topographic image) showed that the surface Characteristics, All thin films prepared appeared as multi-polarization with type unilateral inclination and direction of the prevailing (110), increasing the size of Crystallography rate with increasing temperature as well as the picture an atomic force (AFM) showed that the values of average particle size increase from (73.25nm) to (nm106.93) also the values of the surface roughness and the values of the square root and the average square roughness (RMS) increases with elevating of temperature, from observed the rate values of granular size conclude appear some compositions of nanoparticles on thin films.**

Keywords—CuO, Thin Films, structure properties, AFM,

1. Introduction

Copper oxides are considered important semiconductor of metal oxides, it nanomaterial because have the benefit of a low surface potential barrier which effects on electron field emission properties. There are two types of copper oxide formed from copper include : cupric (CuO) and curprous (Cu2O) were p-type with narrow band gap energy 1.21 to1.51 eV and 2.1 to 2.6 eV respectively [1-3] Potential field emitter has been copper oxide which a good gas sensing material as well as an efficient catalytic agent. It also perform an essential role in optoelectronics and solar cell [4-10]. It has recently studied demonstrated the nature and their reasonably good electrical and optical properties by Cu2O. while CuO with different Nano shape has been formed by different methods in many research papers [11-17] CuO is attractive as a selective solar absorber since it has high solar absorbency and a low thermal emittance [18]. These oxides can concur with copper, annealing Cu2O films in air at 300^{o}C converts it to copper oxide [19]. So, the aim of study preparing CuO NPs using the chemical reaction method and studies the structural , topographical and optical properties.

2. Experimental

Re-distilled water was used throughout the experiment. In a typical procedure, 1.5 g of Cu(NO3)2.H2O (BDH Chemicals Ltd Pool England) was dissolved in 50 mL of PVP (Sigma Aldrich USA) 1 WT. %. The solution was added into a round-bottom flask with stirring. The color of the mixture was blue. About 15 ml of NaOH

(1M) was rapidly added to the mixture, and a Nano powder suspension was formed . The suspension was kept at 75 °C for 1 h. A large amount of black precipitate was produced. After cooling to room temperature, the particles were separated by centrifugation and were washed with distilled water to remove any contaminations. The particles were then dried in an oven at 80 °C.

Thin film deposition by drop casting method

Glass slides of (1.00 x1.50) cm2 area, were used as a substrate. They were cleaned with alcohol in an ultrasonic bath in order to remove the impurities and residuals from their surface. 5 drops of the colloidal were used in preparing the CuO thin films on glass by drop casting method .The structural properties of the deposited thin films at room temperature were studied by using X-ray diffractometer (XRD-6000,Shimadzu X-ray Diffractometer) The optical absorption of the colloidal CuO NPs was measured using spectrophotometer (CARY,100 CONC plus, UV-Vis-NIR, Splitbeam Optics, Dual detectors) in the range of (200-900nm), using quartz vessel. The shape and size of CuO nanoparticles were investigated by using AFM (A A 3000 Scanning Probe Microscope)

3. Results and Discussion

The XRD diffraction patterns of synthesized CuO thin films deposited on glass at as prepared are shown in figure (1). The XRD patterns of CuO contain six main peaks at diffraction angles : 29.400 , 31.908, 35.417, 38.714, 48.731 and 66.674 corresponding to (110), (110), (002), (111), (20¯2) and (¯311) planes .This result shown Cu2O at peak in 29.400, while other peaks shown CuO.

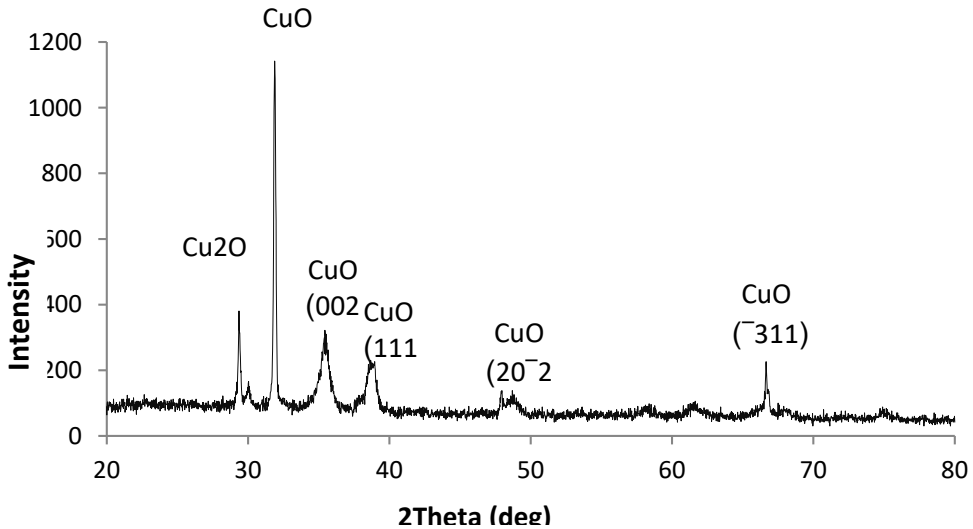


Fig. 1. XRD pattern of CuO thin film at as prepared

When at 100 °C the XRD patterns of CuO contain ten main peaks at diffraction angles:29.404, 31.856, 35.419, 38.737, 48.663, 58.200, 61.543, 66.262, 68.051 and 74.949. From figure 2 appear Cu2O at peak in 29.404 and remained peaks shown CuO.

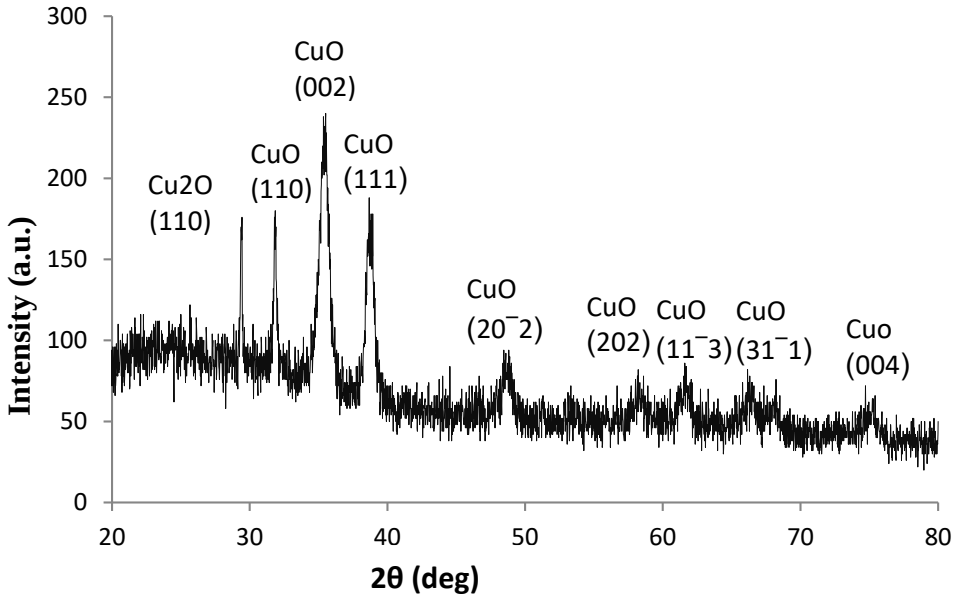


Fig. 2. XRD pattern of CuO thin film at 100°C

At 200 °C the XRD patterns of CuO contain eight main peaks at diffraction angles: 29.462, 30.143, 31.921, 35.823, 38.914, 45.554, 48.468 and 66.687. Figure 3 illustrated the XRD pattern of Cu2O at peak in 29.404 and 30.143, and other peaks shown CuO.

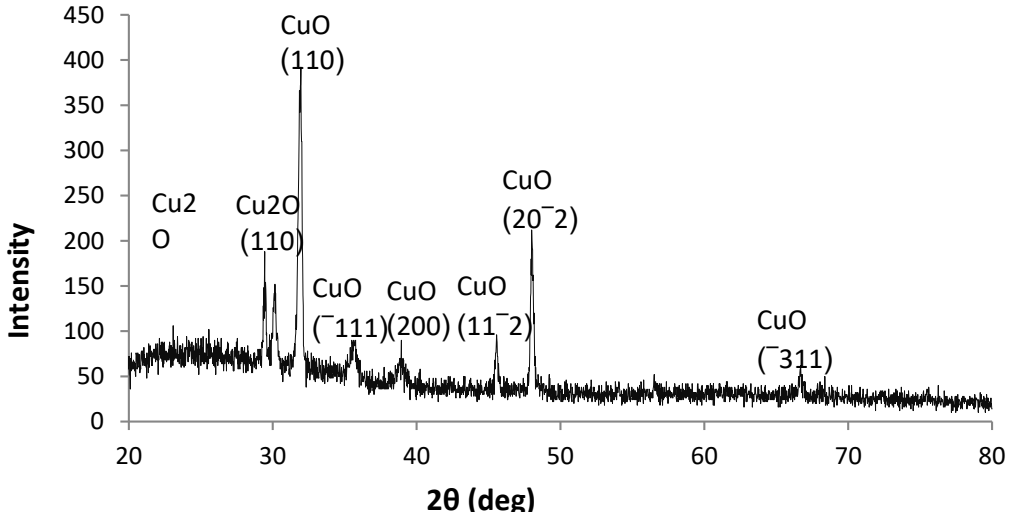


Fig. 3. XRD pattern of CuO thin film at 200°C

The XRD patterns of CuO at 300 °C contain seven main peaks at diffraction angles:29.325, 29.763, 30.061, 31.811, 47.869, 62.586 and 66.582.This result shown in figure 4 which refer Cu2O at peak in 29.325,29.763 and 30.061 while other peaks refer to CuO

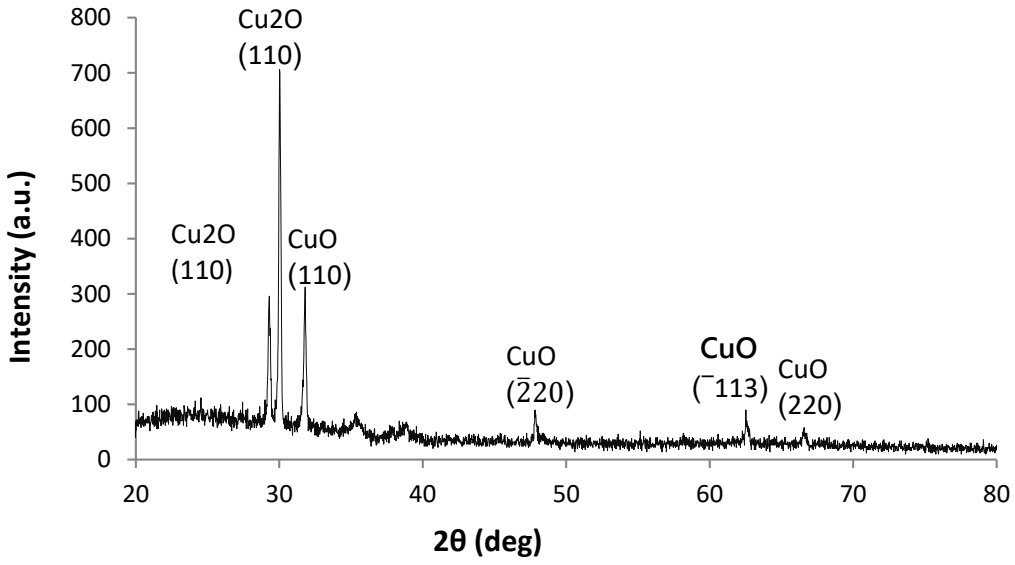


Fig. 4. XRD pattern for CuO thin film at 300°C

Tabel 1: parameters of XRD for CuO thin film at deferments annealing temperatures.

	2 Theta (deg)	β (deg)	D (nm)	δ x10^{14} lines .m^{-2}	η x 10^{-4} lines $^{-2}$.m^{-4}
As prepared	31.8995	0.1592	51.63262	3.75104	6.710874
	29.3913	0.1616	50.55841	3.91213	6.85346
	66.665	0.1637	57.87756	2.985242	5.986776
100°C	35.41	0.8633	9.611093	108.2566	36.05209
	38.7373	0.715	11.71933	72.81057	29.56654
	31.8561	0.57	14.41932	48.09615	24.03025
200°C	31.9212	0.3005	27.35562	13.363094	12.66650373
	48.0234	0.216	40.07888	6.2254213	8.645450195
	29.462	0.2189	37.33018	7.1759571	9.282034043
300°C	30.061	0.1556	52.59033	3.615665	6.588664
	31.8112	0.1628	50.47964	3.924347	6.864153
	29.3253	0.1794	45.53508	4.822896	7.609518

AFM depicts the surface morphology of the copper oxide thin films analyzed by (AFM). The surface of the (CuO) thin films as observed from the (AFM) micrograph confirms that the grains are uniformly distributed within the scanning area (2000nm x 2000 nm) .Which combine to make denser films significantly with the increased temperatures. From the images ,it was observed that the surfaces of the films exhibited ascertain degree of roughness and the film came rougher when the temperatures increases as shown in table (2).This result indicates that the growth of larger

grains with increasing temperatures leads to an decrease in the surface roughness It is observed that the average grain size decreases with increasing of temperatures and the values of the average grain size variable from (106-73) nm depending on film temperatures as shown in presented in Table (1) .. The average grain size results (listed in Table) disagree with those estimated from XRD due to the fact that the AFM measurement directly visualizes the grains The results obtained from the (AFM) of the nanostructure for different temperatures as of (CuO) thin film show that the histogram of the percentage of (CuO) as a function of the grain size are shown in figure (2). From this figure, the percentage of minimum grain size were (130-362)% for film temperatures of (as,100,200 and300) C° respectively. Also, it is clear from the figure, that the average grain size were (106, 99,79 and73) nm with for the previous temperatures. This structural films are very important for many novel applications such as optoelectronic devices, gas sensors and biological science.

Table 2: characterization on CuO thin films

Sample	Average Diameter (nm)	Roughness (nm)	(RMS) (nm)
CuO(AS. prepeared)	106.93	40.3	47.1
CuO(100°C)	99.50	37	43.4
CuO(200°C)	79.80	0.568	0.682
CuO(300°C)	73.25	2.26	2.71

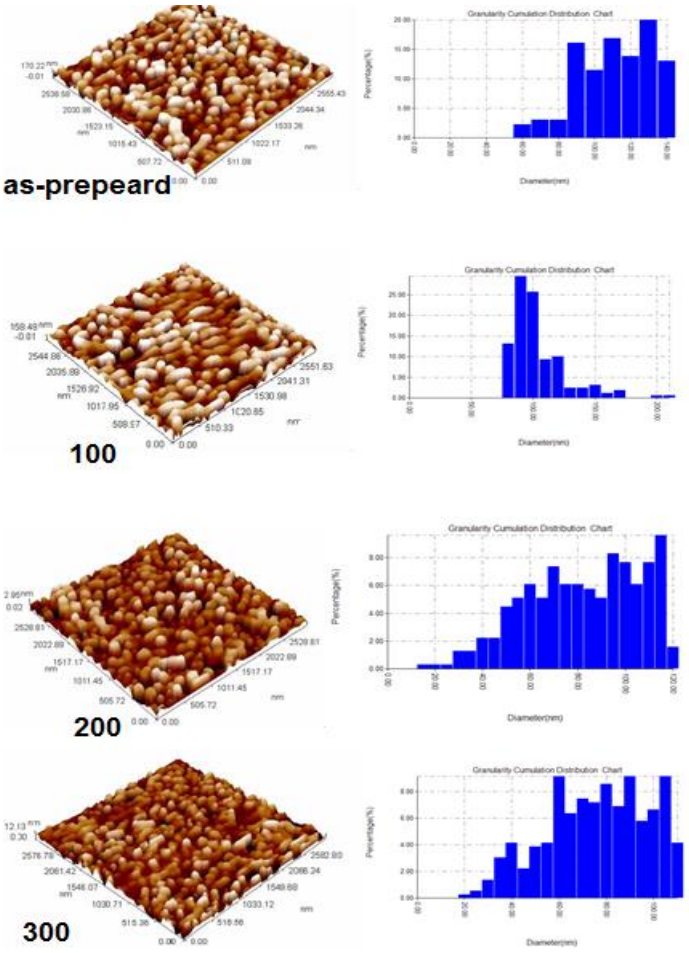
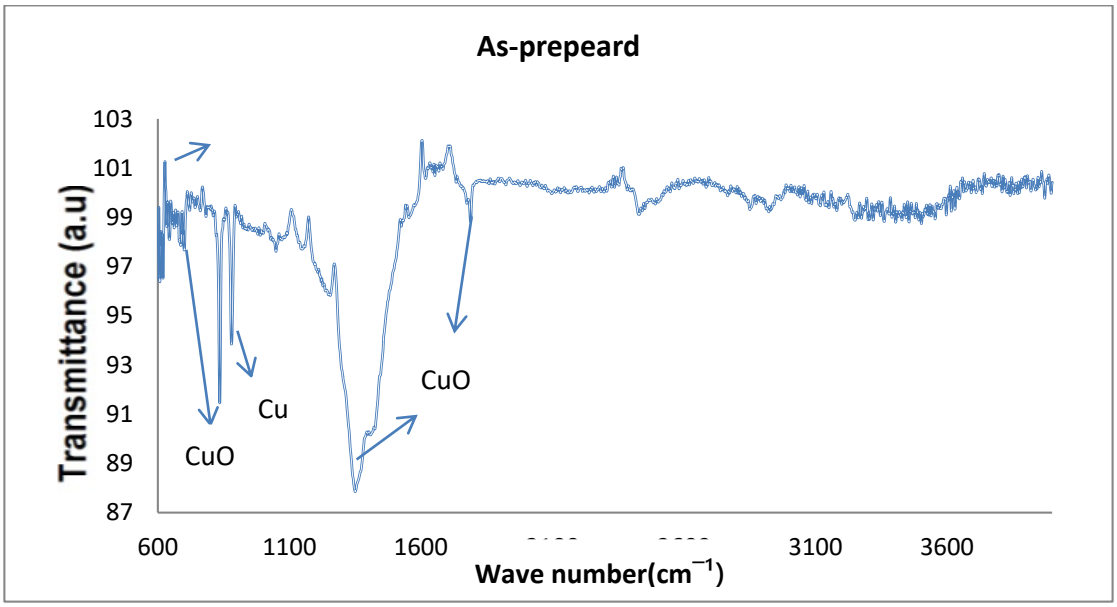
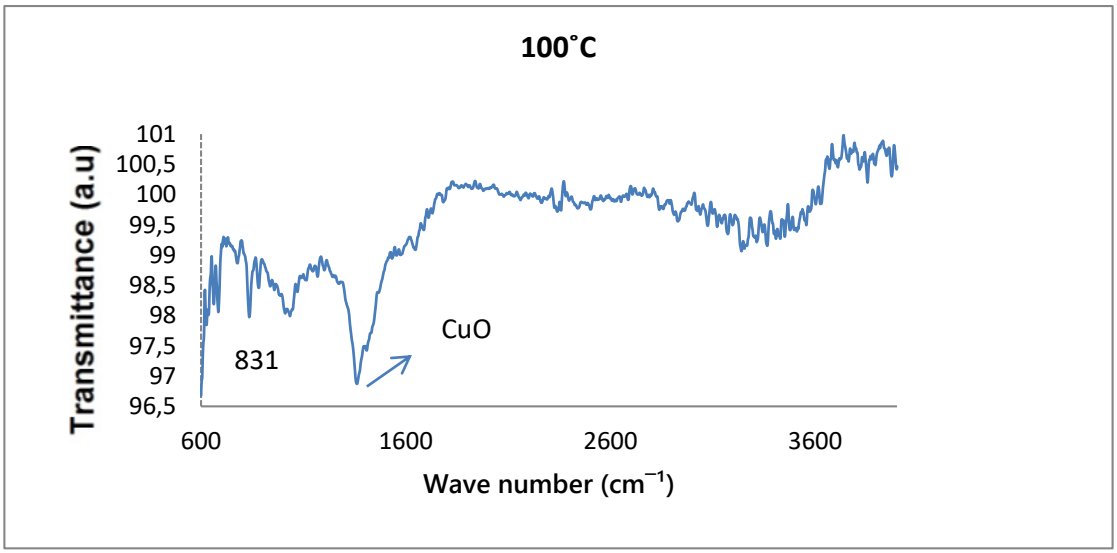


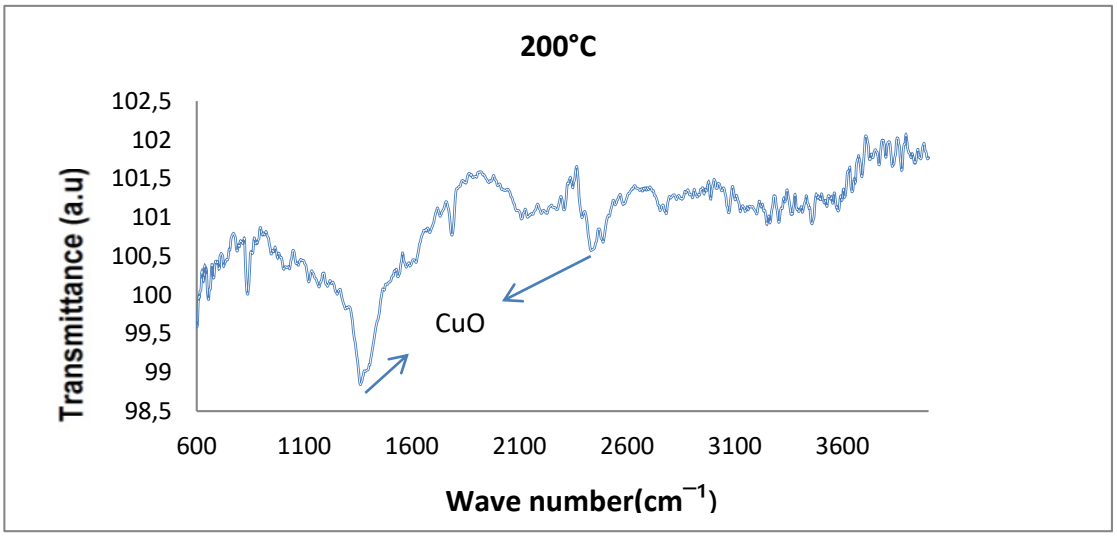
Fig. (5)AFM images of CuO thin film

FTIR analysis of CuO nanoparticles

From FTIR data as shown in Figure (6) for PSi /p-Si respectively, synthesized by 15 mA/cm2 etching current density and different etching times, clearly there are three distinct peaks with different intensities. The peak with intensity at 1080 indicates the presence of Si-O-Si wagging. A a small peak at 624 can be associated with the Si-H Waggener mode. While a peak at 2854 suggests the C-H stretching. A strong broad band is observed at about 1080 due to Si-O-Si asymmetry stretching vibrations mode in p-Si and n-Si type. The weak absorption bands centered at about 624 are attributed to the wagging modes of the species. Absorption at 2854 and 2924 is due to the plane C–H angle deformation.It can easily replace a silicon atom, leading to the presence of carbon in the porous structure, since carbon is located in the same column of the periodic table as silicon [21].Upon anodization in air, new chemical bonds appear on the surface as a wide transmission band due to different Si-H and Si-O chemical bond configurations in the IR spectra. Also note that if a molecule is so symmetrical that the stretching of a bond does not produce any change in dipole moment, then no IR peak will be found in the spectrum [8-10].


As-prepeard
Transmittance (a.u)
103
101
99
97
95
93
91
89
87
CuO
Cu
CuO
600
1100
1600
3100
3600
Wave number(cm⁻¹)


100˚C
Transmittance (a.u)
101
100,5
100
99,5
99
98,5
98
97,5
97
96,5
831
CuO
600
1600
2600
3600
Wave number (cm⁻¹)


200°C
Transmittance (a.u)
102,5
102
101,5
101
100,5
100
99,5
99
98,5
CuO
600
1100
1600
2100
2600
3100
3600
Wave number(cm⁻¹)

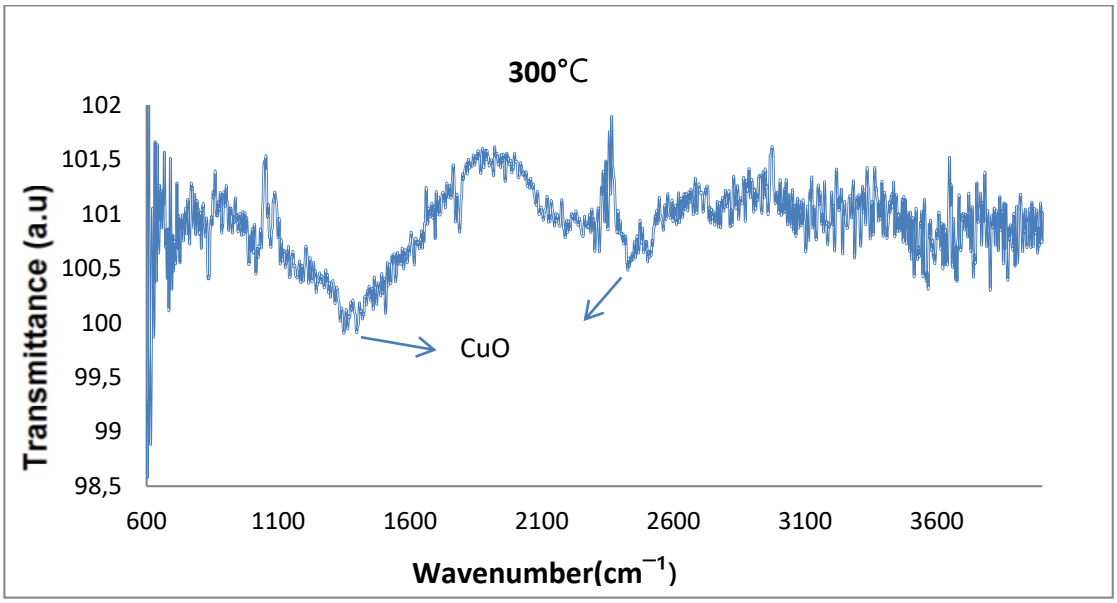


Fig. 6: FTIR spectra of the CuO thin films at different annealing temperatures

Conclusions

The synthesized CuO NPS were in nanosized 73nm at high annealing temperatures which prepared by simple chemical reaction method. The optical properties revealed that the band gap of CuO NPS indicated by the effect of quantum size. X-ray diffraction (XRD) measurement disclosed that the CuO NPS are polycrystalline and has tetragonal crystal structure and no other phases were noticed.

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