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Research paper

Growth of spray pyrolysis deposited copper oxide thin film

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Abstract

Copper oxide thin film is deposited on the glass slide using aqueous solution of copper chloride and hydrogen peroxide by using spray pyrolysis deposition technique. The deposited CuO thin film is adherence and homogeneity with high transparency in visible region. Investigation of CuO thin film for physical properties is done. By using UV –Visible Spectrophotometer optical properties like absorption, transmission, energy band gap, Absorption coefficient and extinction coefficient in the visible region (380 – 1000 nm) are studied. The X-ray diffraction of CuO thin film is polycrystalline in nature with monoclinic crystal structure. The resistivity of Cuo thin film is studied using four probe methods.

Keywords: *Cuo Thin Film; XRD; Electrical Properties; Absorption Coefficient and Extinction Coefficient.*

1. Introduction

Copper oxide belongs to I –VI compound of semiconductor material [1]. CuO is a p-type semiconductor material with band gap of 1.21–1.51 eV having monoclinic crystal structure [2]. Cu_2O thin film exhibited good electrical and optical [3]. Copper oxide thin films are used in solar cell application [4], thin film batteries [5], gas sensing [6] etc. various method are used to deposition copper oxide thin film like sol-gel [7], magnetron sputtering [8],successive ionic layer adsorption and reaction [1], spray pyrolysis [9-10], Spin coating[11] etc.

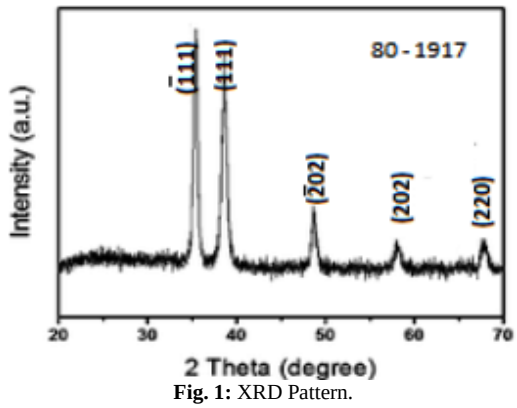

Fig. 1: XRD Pattern.

In the present work copper oxide thin film is deposited using spray pyrolysis method. Optical, Structural and electrical properties of deposited CuO thin film are studied by using UV- VIS spectrometer, X- ray diffraction pattern and electrical resistivity by four probe method. Absorption spectrum of CuO thin film is carried out in optical range (380 – 1000nm). The energy band gap of thin film is observer at 1.5 e V.

2. Experimental detail

Glass slide used deposition of CuO thin film is cleaned in conc. Nitrate acid, alcohol, double distilled water and ultrasonic cleaner for several times to remove the impurities on the surface. To calculate the thickness of deposited CuO thin film the glass slide is weigh before and after deposition using electron unipan microbalance of accuracy 10^{-4} gm. Copper chloride of 0.1N is prepared in double distilled water and Conc. hydrogen peroxide of 3.5 cc was mixed to formed aqueous and clear solution of copper oxide precursor in spray. Cleaned glass slide was arranged on metal plate with heating coil at 350^0C.After deposition glass slide was allow to cool down at room temperature.
Deposited CuO thin film is used to study structural, optical, and electrical properties [12-16]. Structural studied of CuO thin film was carried out on X- ray diffractometer using Cu- kα radiation. Optical absorption & percentage transmission were measured by UV – VIS Spectrophotometer Elco (SL- 159) in the wavelength range 380 – 1000 nm.

3. Result and discussion

3.1. Structural observation of the CuO thin film

Fig. 1 show X- ray diffraction pattern to find the structural information of CuO thin film. The nature of CuO thin film is polycrystalline with monoclinic crystal structure. The 2θ angle peaks are shown at 35.504^0, 38.735^0, 48.660^0, 58.372^0, 68.057^0 with oriented (-111) (111) (-202) (202) (220) direction and agreement with Card Number 80 – 1917

3.2. Optical properties of CuO thin film

Optical absorption spectra of thin film were studied on ELCO – SL159 Spectrophotometer in optical range of 380 – 1000nm.Absorbance (A) and % transmission variation with wave-length are shown in Fig. 2 and Fig. 3. The band gap of the CuO thin film is calculated by equation no.1 of stern [11-14].

$$(\alpha.h\nu)^2 = K(h\nu - Eg)^n \quad (1)$$

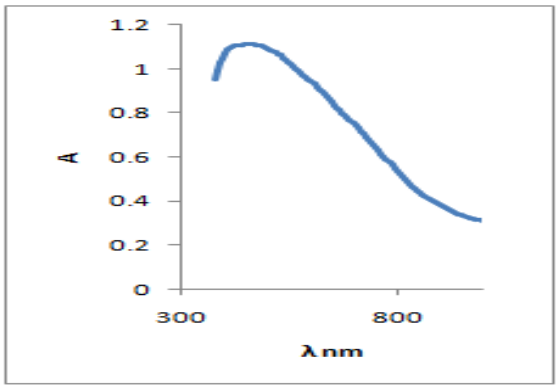

Fig. 2: Absorption Spectra.

Where ν = the frequency of radiation, h = Planck's constant, K = constant, n=1 for direct band gap material. Fig 6 shows the variation of absorption coefficient with linear function of frequency. Band gap energy of grown CuO film is studied and observer. The thickness of thin film is calculated by using weight different density method which is most convenient method to calculate the thickness of thin film [16].The absorption coefficient (α), extinction coefficient (K) of CdS thin films are studied and shown in Fig. 4, 5.

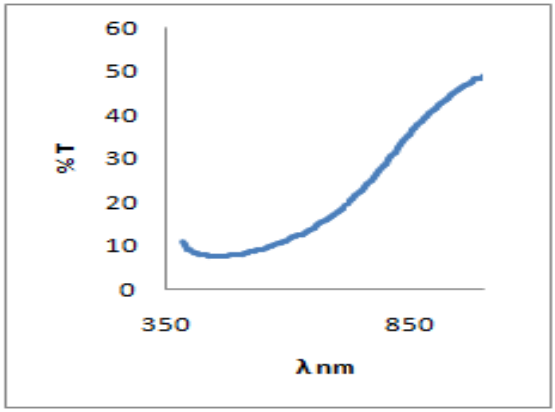

Fig. 3: Transmission Spectra.

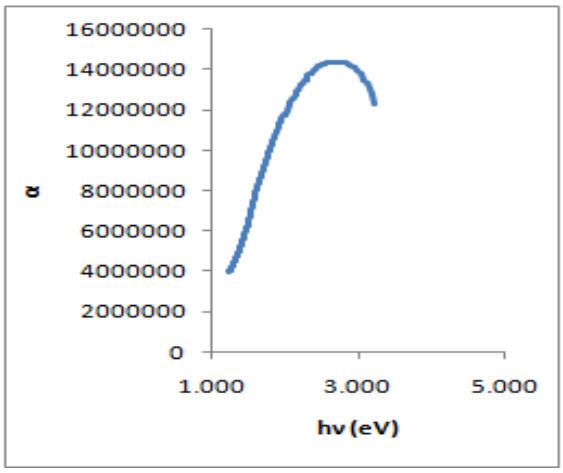

Fig. 4: Absorption Coefficient.

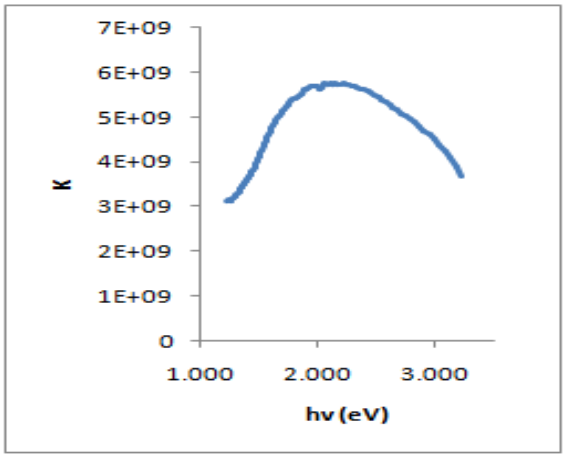

Fig. 5: Extinction Coefficient.

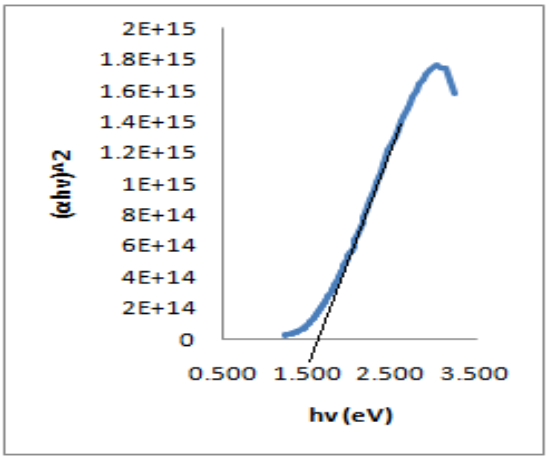

Fig. 6: Optical Energy Gap.

3.3. Electrical studied

Electrical studied of CuO thin film are carried out using four probe methods. Due to the combination of current and voltage probe correction factor is applied to determine resistivity of the thin film. Fig. 7 and Fig. 8 show the resistivity and conductivity as a function of temperature. Electrical conductivity as a function of inverse of temperature for thin films is show in Fig.9. Resistivity of the thin film is decreases with the increases in temperature and conductivity is increased with increase in temperature.

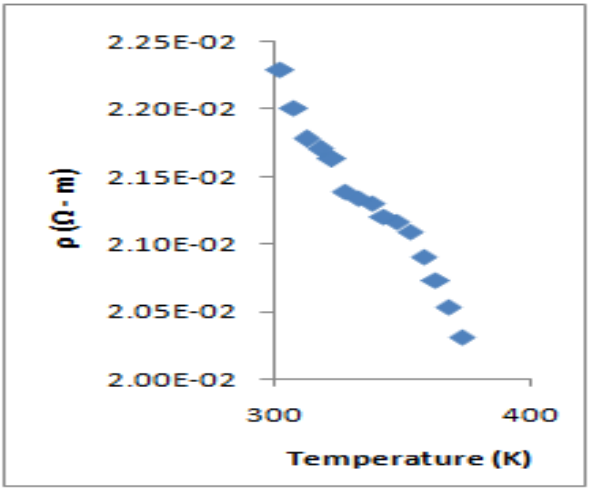

Fig. 7: Electrical Resistivity.

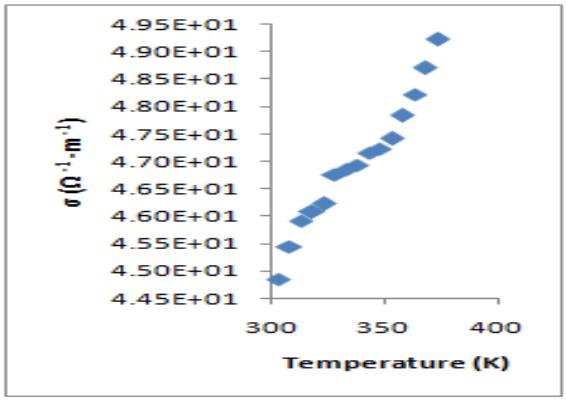

Fig. 8: Electrical Conductivity.

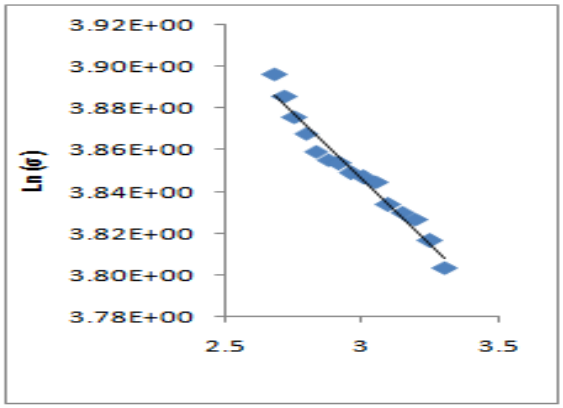

Fig. 9: Ln (Ó) Vs. 1000/T (K^{-1}).

4. Conclusion

By using spray pyrolysis technique CuO thin film are successfully deposited at 350^0C. The structural properties were studied by XRD pattern which examine thin film is polycrystalline in nature. Optical studied of CuO thin film are carried out by using UV – Visible Spectrophotometer in the visible region (380 – 1000 nm). Different variation of optical properties shows that CuO thin film is suitable for application of solar devices. Absorption coefficient (α), extinction coefficient (K) of thin films is studied. The direct band gap of thin films is obtained at Eg = (1.5 eV). Variation of resistivity, conductivity shows that deposited material is semiconducting and charge carrying material

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