Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 2458-9403
Vol. 4 Issue 5, May - 2017

Fabrication And Characterization Of P-Cuo /N-Si Heterojunction For Solar Cell Applications

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***Abstract*—In this study, P-CuO /n-she has been fabricated by the Drop casting technique at 200°C temperature.The structural, morphological and optical of Chou has been studied. XRD measurement disclosed that the CuO were of cubic crystal structure. AFM detect showed that the produced CuO films have ball-shape with perfect homogenous. The energy band gap of CuO films prepared by the Drop casting technique at 200°C temperature determined from optical properties and found to be in (1.6) eV.The responsivity photodetector after deposited could appear to increase in response.**

Keywords—CuO, structure properties, AFM, optical properties, solar cell .

1. Introduction

Solar cell technology for future energy resources has been progressing recently. Silicon is used as the semiconductor material for conventional solar cells, and the cost reduction of the solar cells is one of the most important issues. Having a relatively low band gap (1.21-1.51) eV Cu oxides such as CuO and Cu2O are one of the candidate materials [1]. The features of copper oxide semiconductors are high optical absorption and nontoxic and low cost fabrication Copper oxide thin films have attracted much interest due to their potential applications for solar cells and gas sensor [2–3] It has been widely used for diverse applications such as heterogeneous catalysts [4-5], lithium ion electrode materials [6], high Tc super-conductors [7] and field emission(FE)emitters [8–9]. It is also a promising material for fabricating solar cell, due to its photo- conductive and photochemical properties [10-11]. this work, we investigated the effect of thickness on the properties of copper oxide thin film prepared by oxidation of thermal vacuum evaporated Cu thin films. The films were characterized using Atomic Force Microscope (AFM), X-ray diffraction (XRD), UV-Vis spectro-photometer.

2. prepared of CuO Nanoparticles by chemical reaction.

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 nanopowder 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

3. 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 Cu thin films on glass by the 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- 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 (300-900nm), using the quartz vessel. The shape and size of CuO nanoparticles were investigated by using AFM (AA 3000 Scanning Probe Microscope.

4. Results and Discussion

X-ray Diffraction Analysis 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. and respectively, of Copper oxides is observed and compared with the Joint Committee on Powder Diffraction Standards the film was polycrystalline in nature. The monoclinic structure was matched with the standards peaks (ASTM - Card file No. 00-005-0661). Film [12]. Figure 1 illustrated the XRD pattern of Cu2O at peak in 29.404 and 30.143, and other peaks shown CuO.

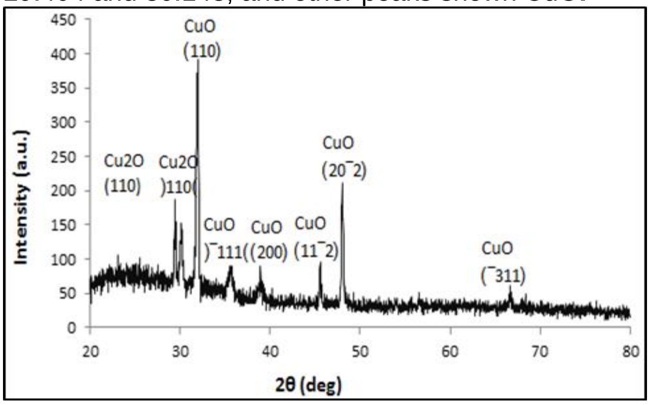

Fig. 1. XRD pattern of CuO thin film at 200°C

The crystallite size was calculated by using the Debye-Scherrer's relation [13]:

□□= $\frac{0.9\,\lambda}{\beta\cos\theta}$ (1)

Where *GS* is the crystallite size, *β* the full width at half maxima, *θ* is the angle of diffraction, and *λ* is the wave- length of X-ray. The strain value η and the dislocation density η value can be evaluated by using the relations in equation 2 and 3 [14].

η=$\frac{\beta cos\theta}{4}$ (2)

δ=$\frac{1}{G_S^2}$ (3)

Table (1) : Average grain, Roughness density and RMS of thin films CuO (200 °C)

2 Theta (deg)	β (deg)	D (nm)	δ x10^{14} lines .m^{-2}	η x 10^{-4} lines^{-2}.m^{-4}
31.92	0.3005	27.35	13.363094	12.66
48.02	0.216	40.07	6.2254213	8.64
29.46	0.2189	37.33	7.17	9.28

The optical energy gap of the CuO film was calculated from the transmission Figure (2) displays the transmission as a function of wavelength. It is observed that maximum transmittance at 200°C for wavelength 900 nm show transmission spectra of CuO thin films is which prepared by drope casting techniques and deposited on a glass substrate , The date is corrected for glass in UV-regain ,the transmission is sharply increasing because of the wide of absorbed particle size .

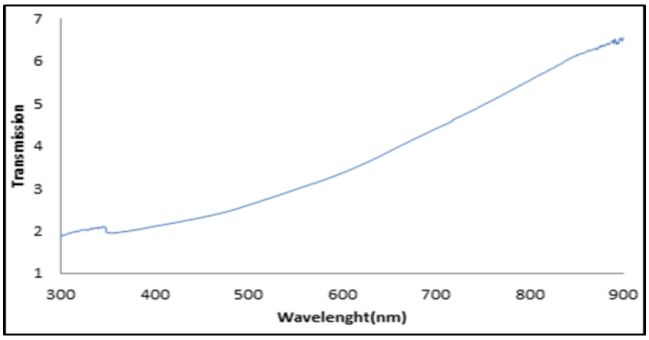

Fig .2: Transmission spectra for CuO thin film.

Figure (3) shows the band gap of CuO measured from the plot of the square of $(\alpha h\upsilon)^2$ versus photon energy hυ where α is the absorption coefficient) by extrapolating the linear part of the curve toward the photon energy axis is found to be 1.6 eV. which is due to the energy band structure and the variation of density of state with the energy level.

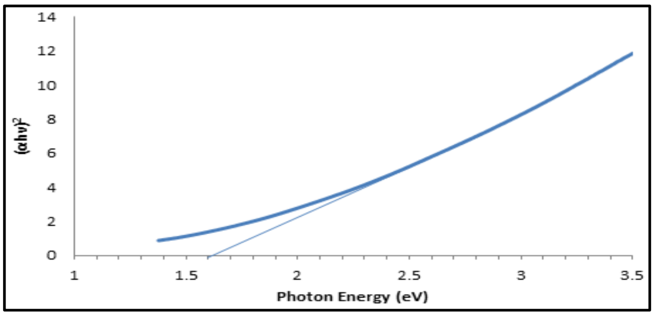

Fig. 3:(αhv)2 versus optical energy gap of CuO thin films.

Figure (4) reveals the (3-D) AFM images and the chart distribution of CuO film. AFM image proves that the grains are uniformly distributed within the scanning area(2000×2000nm) with individual columnar grains extending upwards. The average grain size of pore is measured from AFM analysis using software and is found to be around 79.80 nm depending on preparation. Table (1), it is clearly seen that the root mean square of surface roughness at(200°C)

Table (2) :Average grain, Roughness density and RMS of thin films which was prepared and annealing Sample temperature 200°C

Average. Diameter (nm)	Surface Roughness (nm)	Root Mean Square (RMS) (nm)
79.80	**0.568**	**0.682**

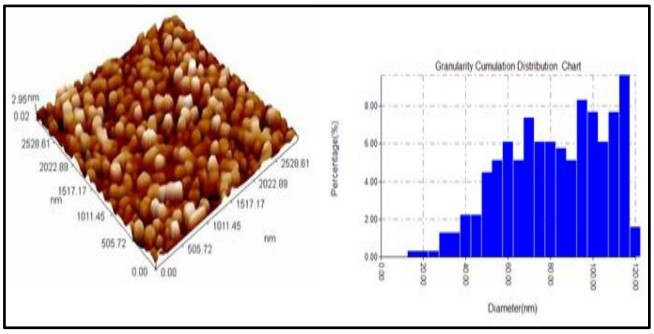

Fig.4 AFM images of CuO thin

the film Shows Figure a (5) the I-V characteristics for p-CuO /n-Si and Shows Figure b(5) The measured short-circuit current, open-circuit voltage, fill factor and Efficiency are 6.1 mA, 5.8 mV, 54.72 and 5.7% respectively .All the results relieve that the sandwich structure p-CuO/n-Si could be used as a solar cell.[15] The conversion efficiency of the solar cells depends on the morphology of interfaces in solar cells. A schematic microstructure of the present solar cells fabricated by drope casting.

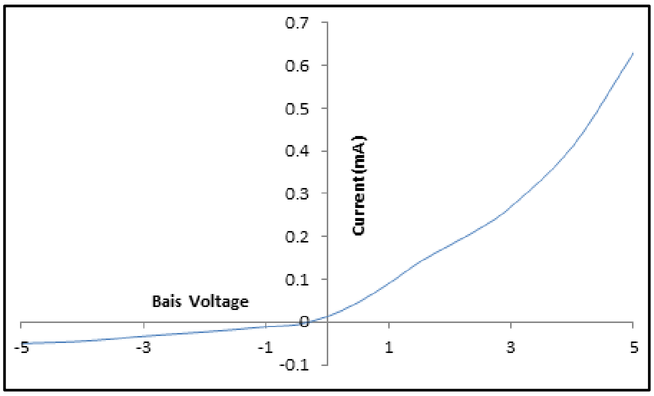

Fig. 5a: I-V of CuO thin films

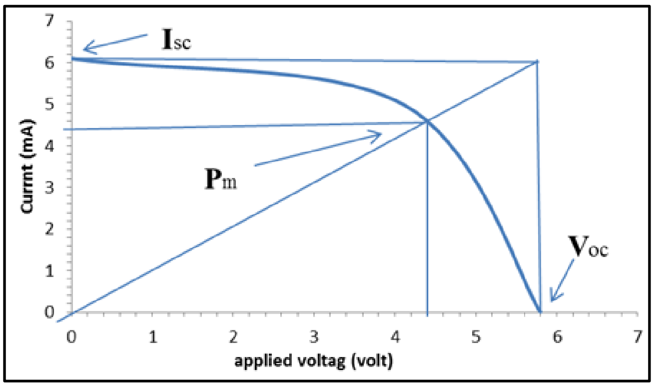

Fig.5b: open-circuit voltage of CuO thin films

Conclusions

p-CuO/n-Si heterojunction was successfully fabricated by Drop casting method has been used to deposit a CdO film on glass and PSi samples . CuO show a good transparency in the spectral range (300-900) nm and the porosity of Si improves the performance the solar cell p-CuO/n-Si heterojunction . To increase power conversion efficiency structures of the solar cells should be optimized.

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