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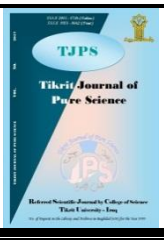

Study of optical, structural and electrical properties of copper oxide films prepared by chemical bath deposition with laser at different concentrations

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ABSTRACT

In this study, a copper oxide (CuO) thin film was prepared by the (Continuous-Wave) CW laser assisted-chemical bath deposition (LACBD) technique. The effect of laser wavelength on the structural, optical, and electrical properties of CuO film was investigated. The X-ray diffraction (XRD) study shows that the deposited CuO films are crystalline with a monoclinic structure. The optical energy gap increases with the use of a laser during film preparation and it varies from 2.3 to 1.8 eV. The scanning electron microscope (SEM) images confirm that the morphology of the film was dependent on the laser wavelength. Increasing the laser wavelength results in decreasing the grain size of the film which enhancing the crystallization. Energy dispersive X-ray (EDX) analysis confirms the presence of copper and oxygen elements. Hall measurement revealed that the deposited films are p-type and the electrical conductivity and mobility increased with the use of a laser. The current-voltage characteristics of the p-CuO/p-Si heterojunction were studied in the dark and under illumination. The maximum optical current of the prepared photodetector at a laser wavelength of 550 nm was found to be in the order of 1.59×10^{12} $cm.Hz^{1/2}.W^{-1}$. The spectral responsivity revealed that the photodetectors exhibit two peaks of response at 450 nm and 800 nm. The maximum responsivity reached was 0.48 A/W at 450 nm and 0.53 A/W at 800 nm for a photodetector prepared at the laser wavelength of 550 nm.

1. Introduction

Copper oxide (CuO) is one of the most important semiconducting materials, which is echo-friendly and has attracted considerable attention due to its superior optical and electrical properties. At room temperature, bulk CuO has an energy gap in the range of 1.5-1.9 eV [1], whereas CuO films have an energy gap in the range of 1.7-2.3eV depending on the preparation method [2]. It has been used for a variety of applications, such as solar absorber materials, photodetectors, gas sensors, photoelectrical and photochemical applications [3-5]. Many routes were used to prepare CuO film, for example, thermal oxidation of Cu, chemical spray pyrolysis, pulsed laser deposition, chemical vapor deposition, plasma evaporation, thermal evaporation, electro-deposition, and chemical bath deposition. CuO thin film was used as a window layer for the broadband and cost effective CuO/Si heterojunction photodetector. Many studies have been reported on the fabrication and characterization of CuO/Si photodetectors. Ismail prepared and studied the main parameters of the CuO/Si photodetector by thermal oxidation of Cu [6]. Kim et al. reported on the fabrication of a fast ITO/CuO/Si photodetector [1, 7]. Zhang et al. prepared a conformal CuO/Si microholes array heterojunction through DC reactive magnetron sputtering with a maximum responsivity of 0.3 A/W at 530 nm [2, 8]. Salih et al. prepared a porous silicon/CuO silicon photodetector by electrochemical etching and pulsed laser deposition, and they studied

its main parameters [3, 9]. The chemical bath deposition (CBD) technique is one promising method among various deposition techniques. CBD has many advantages, such as simplicity, low-cost, no vacuum needed, large-area film, good film stability, film area, fast, uniform film, low-temperature processing, and good film adhesion to substrate. To improve the film properties, a visible laser was used during the deposition process. There have been few reports on laser-assisted chemical bath deposition (LACBD). Garcia et al. prepared nanocrystalline CdS film with good optoelectronic properties by the LACBD technique using a laser wavelength of 532 nm [4, 10] Palma et al. investigate the effect of laser wavelength on the structural and optoelectronic properties of CdS film prepared by the LACBD route [5,11]. This study confirmed the improvement in the CdS film properties after using the laser. In this work, the preparation of CuO film by the LACBD method. The effect of laser wavelength on the structural, optical, and electrical properties of CuO film was investigated. Fabrication and characterization of CuO/Si photodetector prepared without and with a laser at various wavelengths was demonstrated.

2. Experimental

All the reagents are analytical grade and are used without further purification. The CuO film was deposited on the cleaned glass and silicon substrate using the LACBD technique. To begin, 8 g of copper (II) nitrate trihydrate [Cu(NO3)2.3H2O] with a purity of 99.5% provided by CDH company was dissolved in 100 ml of distilled water and the dissolution was carried out using a magnetic stirrer with hot plate (MS-300HS, Musing Scientific Co.) for 10 minutes at 90 °C to ensure complete dissolution of the material and confirm the absence of sediments. Secondly, after complete dissolution of the aqueous copper nitrate in the solution, 1.6 g of high purity sodium hydroxide (NaOH) was dissolved in 100 ml of water for 10 min with the aid of a magnetic stirrer located on the hot plate. The addition of sodium hydroxide (NaOH) to aqueous solutions is to control the PH of the solution, and in this study it was adjusted to be 10. The substrates used in this work were glass and silicon substrates, and these substrates are immersed vertically in solution. They are arranged in a simple way in order to be illuminated with a laser beam. Three diode lasers with wavelengths of 450, 550, and 650 nm are used to illuminate the substrate during the film deposition (front illumination). A beam expander was used to expand the laser beam to cover the entire substrate. A facility for rotating the substrate during deposition was used to obtain a uniform film. Fig.1 shows the schematic diagram of the LACBD set-up. In the beginning, the substrates were cleaned with an ultrasonic bath and then with alcohol and distilled water. Single crystal p-type silicon substrates of 1 cm^2 area with (111) orientation and electrical resistivity of 5-10 Ω.cm were used. A digital pen type PH meter (PH-009, RoHS0) is used to measure the PH of a solution. The optical transmission of the films was measured using a spectrophotometer (Shimadzu 1800). The film morphology was studied using a field emission scanning electron microscope (FESEM) (TSCAN). Energy dispersive X-ray (EDX) was employed so as to estimate the chemical composition of the deposited films. The structural properties of the film were studied using an X-ray diffractometer (XRD-6000, Shimadzu). The electrical conductivity and mobility of the CuO film were measured using the Hall effect. Fabrication of CuO/Si was performed by depositing CuO film with 0.8 , 1.2 and 1.6M on the silicon substrate on the mirror-like side through a metal mask, and then ohmic contacts were made by depositing In and Al films on CuO and the back side of the silicon substrate, respectively, as shown in Fig.2.

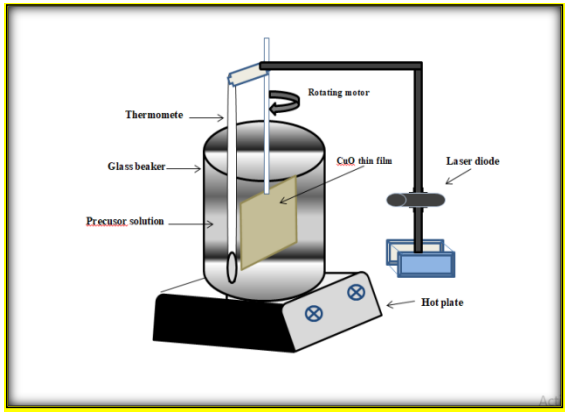

Fig. 1: Schematic illustration of LACBD system used for deposition of CuO film

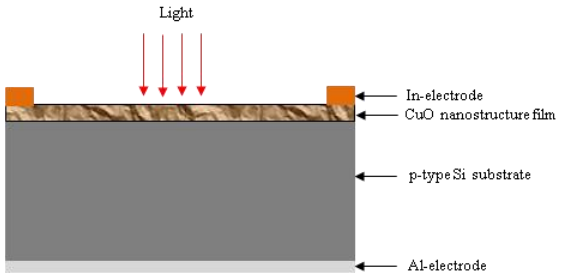

Fig. 2: Cross-section diagram view of nanostructured CuO/p-Si photodetector

3 - Results and discussion

Fig. 3 shows the results obtained in calculating the X-ray diffraction of CuO films prepared with concentrations 0.8, 1.2 and 1.6 M under the influence of illumination by a blue laser with a wavelength 550 nm when focusing 1.2M two peaks appears, the first at 31.847° , which corresponds to the dominant level (110), and the second peak, which is less severe than the first peak at 66.566°, which corresponds to the level (311) as for focus 1.6M, the first two peaks appear at 31.843°, which corresponds to the prevailing level (110), while the second peak appears at 66.581°, as the use of the laser helps to increase the intensity of diffraction and contributes to obtaining crystallized films the results showed that the films

have a crystalline structure. Likewise, at concentration 0.8M, two peaks also appeared, one of these peaks was at 31.841° which corresponds to the prevailing level (110) as well, and the second peak was at 62.536°, which corresponds to the level (202). This shows that the use of the laser works to reorganize the crystalline shape of the prepared films in addition to reducing crystal defects. The grain size, density of dislocations and number of crystals were calculated for the prepared films. Table1 represents the values and results that were reached.

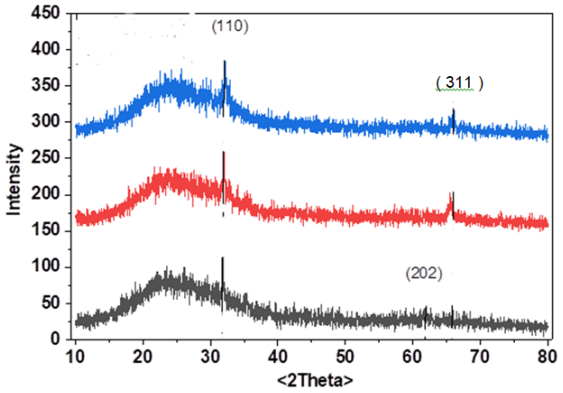

Fig. 3: represents the X-ray diffraction of the (CuO) films prepared with concentrations 0.8, 1.2 and 1.6 M Under the influence of blue laser

Table 1: represents the values of grain size, density of dislocations, and number of crystals formed for the films prepared under the influence of the blue laser.

Focusing under the effect of blue laser	2θ (deg)		FWHM		Granule size (D nm)		Intensity of dislocations δ		The number of crystals formed (N)	
	1	2	1	2	1	2	1	2	1	2
0.8M	31.841°	62.536°	0.14	0.215	116.6	139.8	1.30×10^{4}	1.96×10^{4}	1.58×10^{6}	2.73×10^{6}
1.2M	31.847°	66.566°	0.132	0.218	123. 9	159.7	1.54×10^{4}	2.55×10^{4}	1.90×10^{6}	4.07×10^{6}
1.6M	31.843°	66.581°	0.204	0.172	80.01	203.2	6.40×10^{3}	4.13×10^{4}	5.12×10^{5}	8.39×10^{6}

Through the results that were reached by using the scanning electron microscope technique for CuO thin films prepared with concentrations 0.8, 1.2 and 1.6 M in the presence of a blue laser, and with a magnification power of 200 nm, and during a period of time 10 min, no cracks or holes were observed, compact and relatively heterogeneous grains, as each large particle consists of many nanoparticles of spherical shape, where the average size of the particles for the prepared film with a concentration of 0.8M was about 19.54nm, while the size of these particles for the prepared film was at a concentration of 1.2M was within 16.19nm and at concentration 1.6M was within 23.73 nm. The reason for this is a clustering of the cores of newly formed crystals. Fig. 4 represents ~~a~~ (SEM) image of the thin films CuO prepared with concentrations 0.8, 1.2 and 1.6 M over a period of 10 min using a blue laser.

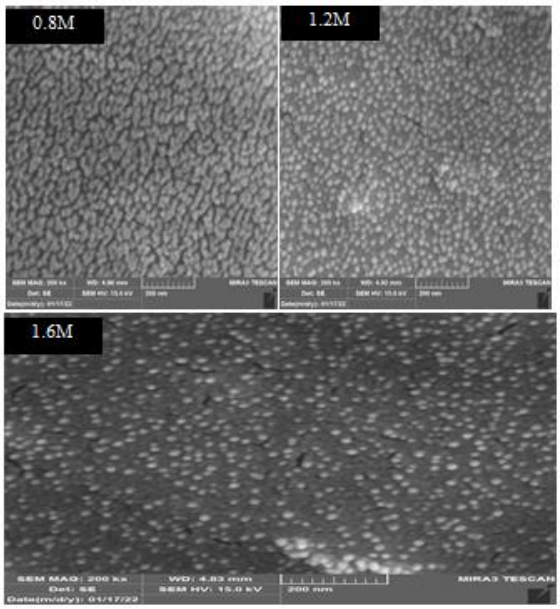

Fig. 4: represents SEM image of the thin films CuO prepared with concentrations 0.8, 1.2 and 1.6 M over a period of 10 min using a blue laser

As for the results that were reached regarding the optical properties, which depend on the spectroscopic analysis of ultraviolet-visible rays, it was shown that the transmittance values for all samples that were prepared at concentrations 0.8, 1.2 and 1.6M, with the use of blue laser increases with increasing wavelength. The transmittance is low in the regions with ultraviolet wavelengths within the range 300-350 nm and it increases rapidly in the visible region within the range 400-700 nm up to the highest values within the range 700-900 nm. The results also showed that the treatment the thermal permeability of

the prepared samples increases, as this treatment leads to an improvement in the crystal structure of the films, an increase in the particle size, and a reduction in crystal defects. It also showed that the use of the blue laser leads to a non-sharp increase with high optical transparency and gradually within the region that lies between 400-700 nm up to the saturation state in the infrared region. Also note a relative change of the absorption edge, which represents the boundary in the region in which the absorption is large and the region in which the absorption is little, and this region is transparent to light. Fig .5 represents the transmittance spectrum for concentrations 0.8, 1.2 and 1.6M using a blue laser.

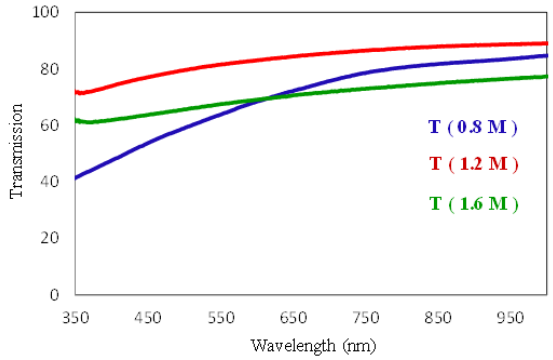

Fig. 5: represents the transmittance spectrum for concentrations 0.8, 1.2 and 1.6 M using a blue laser.

Fig .6 it shows the results that were reached for the values of the energy gaps, where it was noted from the figure that there is a decrease in the values from what they were before the use of the laser. The width of β and Table.2 show the values of the decrease in the energy gaps before and after using the blue laser for CuO films prepared at concentrations 0.8 , 1.2 and 1.6 M.

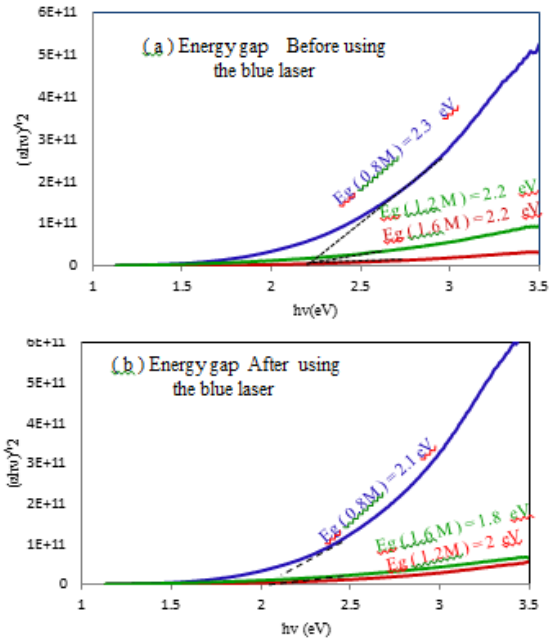

Fig. 6: shows the values of the energy gaps (a) before using the laser and (b) after using the blue laser

Table 2: shows the values of the energy gaps before and after using the blue laser

concentration	Energy gap Before using the blue laser (eV)	Energy gap After using the blue laser (eV)
0.8 M	2.3	2.1
1.2 M	2.2	2
1.6 M	2.3	1.8

Fig .7 shows the results obtained for the EDX spectra of the CuO films during a period of 10 min and at concentrations 0.8, 1.2 and 1.6 M using the blue laser, where it was observed that there are peaks related to the elements O, Cu in addition to the emergence of peaks associated with other elements Si, Na, Ca, Mg, Al, Cl, k, S, where the weight ratio [Cu] / [O] of the CuO film prepared with a concentration of 0.8M was 0.057 , while that of the film prepared at a concentration of 1.2M was 0.11 , while at the concentration 1.6M it was 0.28. Due to the presence of oxygen vacancies in the prepared membranes, what we obtained shows that all the different concentration ratios and the effect of the blue laser were less than one.

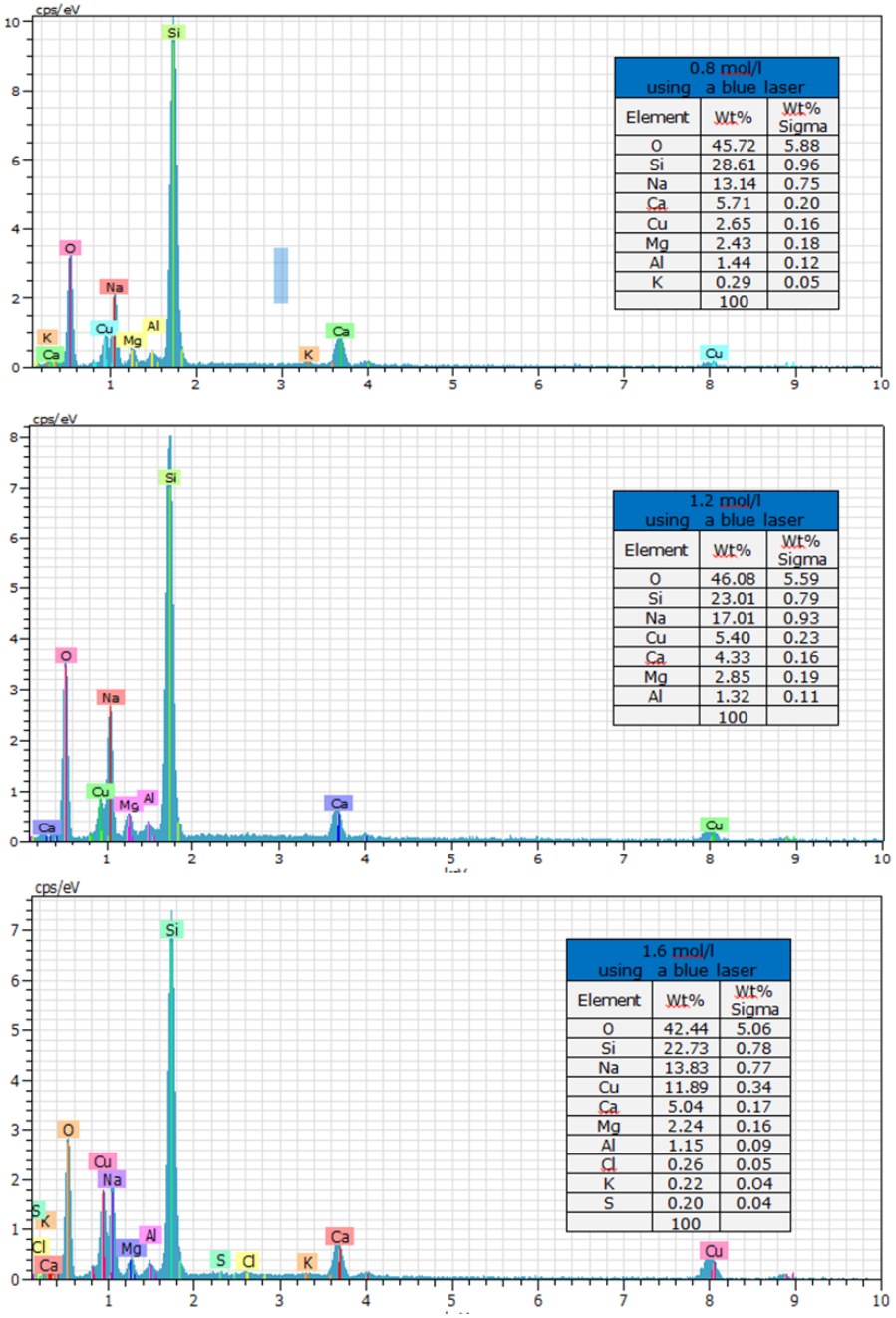

Fig. 7: represents the EDX spectra of (CuO) films over a period of 10 min at concentrations 0.8, 1.2 and 1.6 M using a blue laser.

The results obtained from the Hall effect measurement showed that all the films that were prepared with different concentrations and using the chemical bath technique were of the positive type (P-type), where the conductivity (s) was within the limits of $2.28 \times 10^{+1}\ (O.cm)^{-1}$ .The decrease in conductivity is caused by oxidation on the surface of the prepared films, as well as an increase in the rate of particle size and atom growth, and this is consistent with the results we obtained for (EDX).), while the mobility (m) was about $1.48 \times 10^{+2}\ (cm^2\ v^{-1}\ s^{-1})$ and this increase is due to the increase in the granular size. It also increases with the increase in the laser wavelength .

As for Fig. 8, it shows the results that obtained by changing the current-voltage of the detector CuO prepared in concentrations 0.8 , 1,2 and 1.6 M with the effect of the blue laser on these concentrations and during a period of time 10 min in The dark case, where notice from the figure that the largest value recorded for the forward bias current was the sample with focus 1.2M that was highlighted by the blue laser, as the increase in the applied potential difference led to an increase in the current that passes through the detector as the behavior of the forward bias current is coming soon to the exponential function and the control of the propagation current over the re-union current.

The decrease in the value of the internal voltage and a decrease in the width of the depletion region is caused by the increase in the voltage difference that works to inject the majority carriers. As for the two samples 0.8M and 1.6M, their value recorded for the forward bias current was less than the value recorded for the sample focued 1.2M.

Fig. 8 also shows that the reverse bias current appears in two regions, the first in which the values of the reverse bias current are few, and this is due to an increase in the display of the depletion region and a decrease in the concentration of carriers. Asymmetric type.

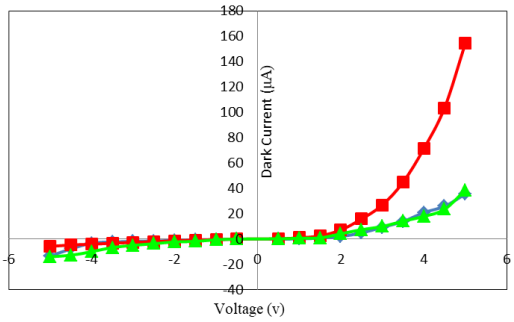

Fig. 8: represents the current-voltage change of the detector (CuO) in the dark state with concentrations 0.8, 1.2 and 1.6 M using a blue laser.

While Fig .9 represents the (I-V) characteristics of the CuO detector prepared at concentrations 0.8, 1.2 and 1.6 M with the use of a blue laser and during a time period of 10 min and the use of reverse bias in the case of light.

When the detector is exposed to different intensities of white light and an increase in the potential difference, the current will increase and the reason for the increase is that the detector will work to absorb the incident photons that increase when the intensity of the light increases so that this leads to the generation and spread of light carriers within the depletion region, which results in the formation of pairs Electron - hole.

As for the photons absorbed outside the depletion region, it does not lead to the generation of any light current, and this is due to the return of the union of electrons with the holes, while the internal electric field prevents the occurrence of a union between the electrons and the holes.

When the applied potential difference increases, this leads to an increase in the width of the depletion region, so will get light absorption at this region. This leads to the possibility that the generated carriers contribute to an increase in the light current and a decrease in the processes of occurrence of volumetric and surface unions, and the reason for this decrease is the result of an increase in the value of the electric field.

The light current depends on the rate of generation of charge carriers and the depth of propagation, while the depth of absorption depends on the rate of absorption and on the photon energy of the detector material.

The carriers that were generated far from the junction do not contribute to the generation of the light current, that is, it does not reach the depletion area. The photodetector and precipitator after using the laser has an on/off, where the ratio at focus 8M is 25.67 and

at focus 1.2M is 264.28 . As for the concentration 1.6M it was 99.56, and the reason for that is that it is displayed in the depletion region, and the surface of the deposited membrane is rough, which leads to an increase in the interaction of photons at different angles, which leads to an increase in the light sensitivity of the detector. The values of the highest currents that were obtained using the blue laser with a wavelength 550nm were as follows when focusing 0.8M, it was at bias voltage -5V and light intensity 180.1 mW/cm^2 (-344.1), while it was at The focus is 1.2M (-1480), while at the focus 1.6M it was (-1384).

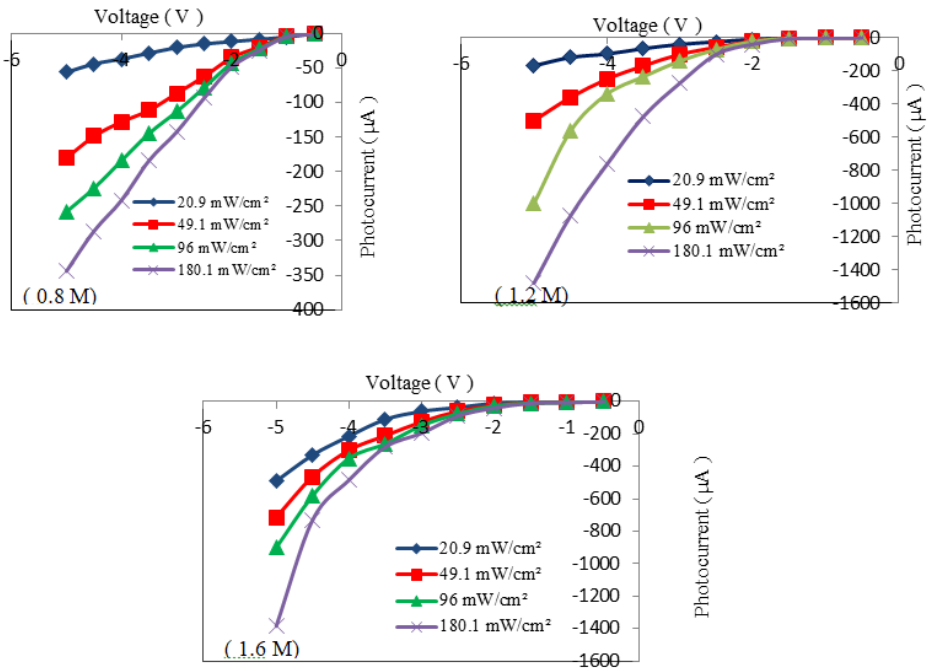

Fig. 9: represents the current-voltage change of the detector (CuO) in the case of light prepared with concentrations 0.8, 1.2 and 1.6 M with the use of a blue laser

In order to determine the spectral range through which the detector operates, especially when the energy gap is large, it is necessary to study the spectral response of the detector, Fig. 10 shows the response is high at voltage 5V in the presence of bias if the applied voltage works to separate the pairs (electron-gap) which leads to a decrease in the generation of these pairs, and an increase in the width of the depletion region and the collection of generated electrons leads to an increase in the spectral response. Fig. 10 shows the appearance of two peaks for all the concentrations used 0.8, 1.2 and 1.6 M and the effect of the blue laser. The first peak is at wavelength 450 nm, which is the absorption edge of the CuO film where the film absorbs light. The wavelength 750 nm for each of the concentrations was 0.8 and 1.6M, while the second peak of the concentration was 1.2M at the wavelength 800 nm , which represents the absorption edge for silicon. It was found from Fig .10 that the highest value of the spectral response at the wavelength 450 nm was 0.48 A/W and at the wavelength 800 nm it was 0.53 A/W. As for the visible region, the response was similar for some High energy gaps of silicon. And Table 3 represents the spectral response values for the concentrations used 0.8, 1.2 and 1.6M and the effect of the blue laser on them.

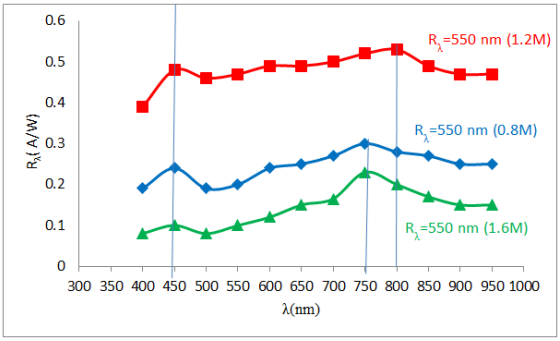

Fig .10: represents the change of the spectral response as a function of the wavelength change of the photodetector (CuO), which was prepared at concentrations 0.8, 1.2 and 1.6 M using the blue laser

Table 3: represents the spectral response values for the concentrations used 0.8, 1.2 and 1.6 M and the effect of the blue laser on them

Concentrations	The wavelength of the first region	Spectral Response	The wavelength of the second region	Spectral Response
0.8	450	0.24	750	0.3
1.2	450	0.48	800	0.53
1.6	450	0.1	750	0.23

For Fig. 11, the detector efficiency represents the concentrations of 0.8, 1.2 and 1.6 M of CuO prepared by the effect of a blue laser, and it was at the wavelength region of 450 nm (0.66, 1.32 and 0.27), respectively, and this discrepancy in the work of the detector is the product of the preparation method, when The working efficiency value of the detector at a concentration of 1.2m is more than 100% and as a result leads to the generation of a group of carriers that absorb the incident photons, the natural film

synthesis rate decreases and the amount of light doubles.

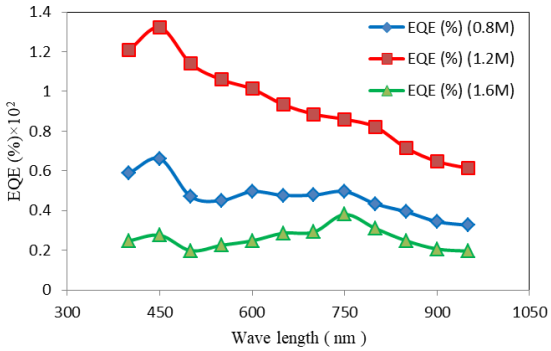

Fig.11: represents the relationship of wavelength and efficiency of work of the detector for the prepared concentrations

(EQE) represents the external quantitative efficiency of the photodetector at concentrations of 0.8, 1.2 and 1.6 M.

As for Fig . 12 it shows the results obtained by calculating the scout (D*) as a function of a change in wavelength at voltage 5V for concentrations 0.8, 1.2 and 1.6 M under the influence of blue laser illumination, where it was found that the best value of the scout was At the wavelength 450 nm of the focus 1.2M it was 1.59×10^{12} cm.Hz$^{1/2}$.W^{-1} and the equivalent noise power value was (NEP) 6.30×10^{-13}W , while it was at the wavelength 800 nm for the same concentration 1.75×10^{12} cm.Hz$^{1/2}$.W^{-1} and the corresponding noise equivalent power value (NEP) 5.71×10^{-13}W , as the increase in scouting is due to an increase in the spectral response. Table 4 shows the detection values of the prepared concentrations and the equivalent noise power value.

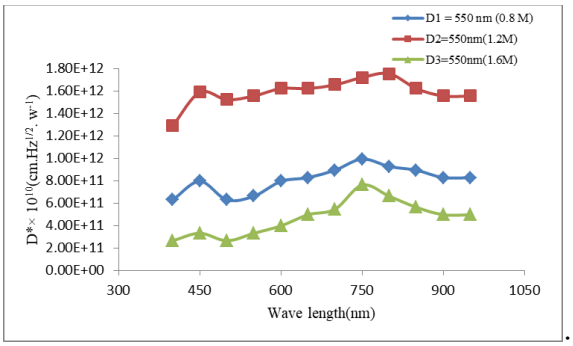

Fig. 12: represents the qualitative scout as a function of the wavelength change of the detector CuO prepared with concentrations 0.8, 1.2 and 1.6 M under the influence of the blue laser.

Table 4: It shows the prepared detection concentration values and the equivalent noise power value

Concentration	wave length	(D^*)	(NEP)	wave length	(D^*)	(NEP)
0.8M	450nm	7.94×10^{11}	1.26×10^{-12}	800nm	9.26×10^{11}	1.08×10^{-12}
1.2M	450nm	1.59×10^{12}	6.30×10^{-13}	800nm	1.75×10^{12}	5.71×10^{-13}
1.6M	450nm	3.31×10^{11}	3.02×10^{-12}	800nm	6.61×10^{11}	1.51×10^{-12}

4. Conclusion

We have demonstrated the fabrication and characteristics study of CuO/Si heterojunction with a maximum responsivity of 0.48 A/W and a detectivity of 1.59 $\times10^{12}$ cm.Hz$^{1/2}$.W^{-1} at 450 nm by laser-assisted chemical bath deposition. The effect of laser wavelength on the structural, optical, and electrical properties of CuO film was investigated. XRD revealed that all grown CuO films are crystalline with a monoclinic structure, and the film crystallinity improved with the use of a laser. The energy gap of the CuO film decreased from 2.3 to 1.8 eV with the use of a laser. SEM studies showed that the grain size increased with the use of a laser, and films prepared with a laser exhibited more uniformity. The best CuO/Si junction properties were obtained for a photodetector fabricated with a laser at 550 nm. The maximum values of, EQE, and D* were 0.48 A/W, and 1.59×10^{12} cm.Hz$^{1/2}$.W^{-1}, respectively. Based on the obtained results, we think that the route used in this study opens the door for the fabrication of low-cost and high-performance silicon-based photodetectors.

References

[1] Kazuo morigaki "Physics of Amorphous semiconductors" Hiroshima institute of technology, 2011.

[2] A.A .ogwa, T.H.Darma "Electrical resistivity of Copper Oxide thin films" Journal of achievements in materials & manufacturing engineering, V-24, issue-1, 2007.

[3] M.Bakanski & R.F.Wallis "semiconductor physics and application "Published in united state by oxford university press Inc, New York, 2000.

[4] B.Balamurugan, B.R. Mehta, "Optical & strachural properties of nano crystalline Copper oxide thin films prepared by activated rcactive evaporation "Institute of technology Delhi, dept of physics, Indian, 2001.

[5] A. iping chen, Gung yang, Hualong , Fang li, yuhua li , & peixiang lu, : Thin solid films " V-517, issue- 15 , P-4277-4280, 2009.

[6] M.I. Ali, S.M. Jasim, Q.A.Sbbar, Iraqi journal of Applied Physics letters vol.1, No.2 2008.

[7] Yatendra S. Chandhary, International journal of Hydrogen Energy vol.29 p.131-134, 2004.

[8] J.R. Areland, J.G.Zhang, Solid State Electronic vol. 29, p.84-89, 2004.

[9] N. Serin. T. Serin, S. Horzum j. Semiconductors Science and Technology, vol.20. p. 398-410, 2005.

[10] H. BENZAROUK, "Synthése d'un oxide transparent conducteur par pulverization chimique (ZnO, NiO) mémoire de magistére, Université D'Annaba , 2008 .

[11] K. Murali, T.Sarvanan, T.Poovarasan, R. Karthikeyan "Li-SnO_2 anodes for lithium rechargeable batteries" procceding of the 197th meeting of Electrochemical society, Toronto, 2000.

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دراسة الخواص البصرية والتركيبية والكهربائية لأغشية أوكسيد النحاس المحضرة بواسطة ترسيب الحمام الكيميائي بالليزر بتراكيز مختلفة

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الملخص

في هذه الدراسة ، تم تحضير غشاء رقيق من أوكسيد النحاس (CuO) باستخدام تقنية ترسيب الحمام الكيميائي بمساعدة الليزر (الموجة المستمرة CW (LACBD). تم دراسة تأثير الطول الموجي بالليزر على الخصائص التركيبية والبصرية والكهربائية للغشاء CuO. أظهر دراسة حيود الأشعة السينية (XRD) أن أغشية CuO المحضرة بلورية ذات تركيب أحادي الميل. حيث ان فجوة الطاقة الضوئية تزداد اثناء تحضير الغشاء عند استخدام الليزر وتتراوح من 2.3 إلى 1.8 فولت. تؤكد صور المجهر الإلكتروني الماسح (SEM) أن شكل الغشاء يعتمد على الطول الموجي لليزر. حيث تؤدي زيادة الطول الموجي لليزر إلى تقليل حجم حبيبات الغشاء مما يعزز التبلور. يؤكد تحليل الأشعة السينية المشتتة للطاقة (EDX) وجود عناصر النحاس والأكسجين. وأظهر قياس تأثير هول أن الأغشية المترسبة هي من النوع p وأن التوصيلية الكهربائية والحركية تزداد باستخدام الليزر.كذلك تمت دراسة خصائص التيار–الجهد للكشف الحالي p-CuO / p-Si في الظلام وتحت الإضاءة. حيث وجد ان الحد الأقصى للتيار البصري للكاشف الضوئي المحضر بطول موجي ليزر يبلغ 550 نانومتر كان في حدود (1.59×10^{12} cm.Hz ^{½} W $^{-1}$). كما ان اجهزة الكشف الضوئي بينت ان الاستجابية الطيفية تظهر ذروتين من الاستجابة عند 450nm و 800nm. حيث ان اعلى قيمة للاستجابية الطيفية عند الطول الموجي (450nm) كانت (0.48A/W) وعند الطول الموجي (800 nm) كانت (0.53 A/W) الكشاف الضوئي الذي تم تحضيره عند طول موجة الليزر (550 nm)