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Effect of molar concentration on the optical and structural properties of ZnO thin films prepared by chemical bath deposition method

* **Qasim Chfat Abdulridha** **Hussein Ali Noor**

Physics Department, College of Education, University of Qadisiyah, Iraq.

*Corresponding Author E-mail: basaqaseemjafat@gmail.com

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ABSTRACT

This research included the preparation of (ZnO) thin films by CBD technique for the deposition of chemical bath thickness (150 ± 20nm). X-ray diffraction was analyzed and showed that the films crystallize in a polycrystalline hexagonal structure, with a preferred direction along the level (100). Increased volume of calculated crystals for deposited films was found by increasing molar concentration. The surface morphology of films was studied by SEM, and the surface morphology of ZnO films is a heterogeneous distribution. The optical properties of all deposited ZnO films contained a spectral permeability and absorption spectrum in the wavelength range (300-1100nm), and the transmittance decreased with increasing molar concentration, it was found that the value of the light energy gap (Eg) increases with increasing molecular concentration band gap between 3.1 and 3.2 eV.

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تأثير التركيز المولي على الخواص البصرية والتركيبية لأغشية ZnO الرقيقة المحضرة بطريقة ترسيب الحمام الكيميائي

قاسم جفات عبد الرضا **حسين علي نور**

قسم الفيزياء كلية التربية ، جامعة القادسية ، العراق

الكلمات المفتاحية:

ZnO
طريقة الترسيب بالحمام الكيميائي
الخصائص التركيبية
الخصائص البصرية

الـــخُـــلاصـــة

في هذا الدراسة، تضمن تحضير الأغشية الرقيقة لـ (ZnO) بتقنية CBD حيث تم ترسيب حمام كيميائي بسمك (١٥٠ ± ٢٠ نانومتر). تم تحليل حيود الأشعة السينية وتبين أن الأغشية تتبلور في بنية سداسية متعددة البلورات ، مع اتجاه مفضل على طول المستوى (١٠٠). تم العثور على زيادة حجم البلورات المحسوبة للأغشية المترسبة عن طريق زيادة التركيز المولي. كذلك تم دراسة التشكل السطحي للأفلام بواسطة SEM ، والتشكل السطحي لأفلام ZnO هو توزيع غير متجانس. حيث أوضحت النتائج أن الخواص البصرية لجميع أغشية ZnO المرسبة تحتوي على نفاذية طيفية وطيف امتصاص في نطاق الطول الموجي

(٣٠٠-١١٠٠ نانومتر) ، وتناقصت النفاذية مع زيادة التركيز المولي ، ووجد أن قيمة فجوة الطاقة الضوئية تزداد مع زيادة فجوة الطاقة ضمن نطاق التركيز الجزيئي بين 3.1 و 3.2 ألكترون فولت.

1. INTRODUCTION

Thin-film is called a layer or several layers of material atoms that do not intersect with a thickness less than "1mm" (Look, 2001; Ratner, 2002) With the development of the economy and industry, environmental defects have become more acute over the past decades (Xu et al., 2003a). ZnO nanostructures as dual-conductor II-IV semiconductors have been interesting to many researchers because they have good optical and electrical applications, their potential use in solar cells, easily manageable morphological properties, solar hydrogen conversion devices, hydrogen photoelectric generators and sensors (Li and Alivisatos, 2003; Ma et al., 2004; Wang and Li, 2003). Organic pollutants. Those who resist environmental degradation, and therefore can stay in the environment for a long time, are more dangerous to living organisms(Ebothé et al., 2003; Munef, 2015; Schropp and Madan, 1989). ZnO thin films have been studied as an active channel material in the development of thin film transistors due to the characteristics of n-type semiconductors and excellent thermal stability and can be well-directed crystals in different substrates(Öztas and Bedir, 2008; Zhang and Ma, 1996). Several thin-film methods have been used for the synthesis of ZnO, such as the deposition of a laser-chemical molecular beam bath and electrochemical deposition(Chung et al., 2008). ZnO thin films are used in a wide range of transparent electrodes, surface acoustic waves, field-effect transistors and projectors(Lin et al., 2007). ZnO is a useful semiconductor material, environmentally friendly and environmentally friendly due to its typical properties, such as the direct direct-inhibited band (3.3 volts) in the present work The effect of molar concentration on the optical and structural properties of thin films of ZnO prepared by the deposition of a chemical bath (Fritzsche and Tauc, 1974).

2. Experimental details

Thin films of zinc oxide nanoparticles were prepared on glass substrates (75 × 25 ×1 mm), cleaned with a sterilizer, degreased from trichlorethylene and ethanol and washed with sediment. ZnO thin films grew on a glass substrate using CBD techniques, and ZnO films were prepared using aqueous solutions of zinc chloride (II), sodium chloride (ZnCl2) and NaOH 3M in deionized water to a volume of 50 ml with magnetic stirring. Next, the solution (NaOH) was added to mixed wisdom by 10 ml, and the pH measured at 10.5. All films were deposited with a solution (1, 2, 3, 4) M of ZnCl2. Before deposition, the beaker containing the deposition solution was placed in a water bath at 80 ° C for about 5 minutes to stabilize the temperature of the solution, then kept the beaker in the water bath. At the end of the deposition time (1 hour), the slices were ejected, rinsed with distilled water and allowed to dry with hot air. The samples were analyzed by a type of X-ray diffraction (SHIMADZU Japan XRD 6000) to determine the crystal structure. Of prepared films (Öztas and Bedir, 2008). X-ray diffraction (XRD) measurements using Cu Kα radiation with a wavelength of $\lambda = 1.5406$Å in the scanning range $2\theta = 20^{o}$-90^{o}. Spectral measurements were performed using the UV-VIS spectrometer (Shimadzu, UV-1800). Surface terrain analysis and surface morphology were studied by scanning electron microscopy type (SEM) (manufacturer: FEI, Quanta 450).

3. Results and discussio

X-ray diffraction patterns (XRD) for Plano nano-ZnO films (0.1,0.2, 0.3) M were obtained by CBD technique. All thin films are compared to the standard ICD card JCPDS No. 13-0311, where all films have peaks linked to a hexagonal crystalline structure with a preferential direction of level (101) (Liu and Zeng, 2003). In Figure 1 X-ray spectra of pure ZnO by (0. 1, 0.2, 0. 3) thin films M show an increase in the severity of peaks with an increase in molar concentration (Lindroos and Leskelä, 2000). The diffraction peaks are slightly converted to samples of two and a half values, and the distance between the crystalline levels of the prepared membranes was calculated using Brack's law under the relationship(Raether, 1977):

$$n_r\lambda=2d_{hkl}\,sin\theta_B \qquad (1)$$

The interstitial distances between the crystalline levels were affected by the crystalline structure being affected by the increase of molar concentrations. As shown in Table 1. The crystallite size (D) was calculated by Scherer formula (Raether, 1977):

$$D=\frac{k\lambda}{Bcos\theta} \qquad (2)$$

Where K is the Scherer constant, and this value is 0.94, λ is the wavelength, and B is the full width at half maximum The interstitial the crystallite size (D) were affected by the crystalline structure being affected by the increase of molar concentrations.

Table 1: XRD result of ZnO thin films for (111) plane

Material	2Θ (deg)	d(Å) Observe	d(Å) FWHM	((hkl)	*crystallin e Size*
ZnO (0.1M)	31.64	2.825192	2.81	0.293	(100)	**29**
ZnO (0.2M)	31.67	2.82256	2.81	0.24	(100)	**36**
ZnO (0.3M)	31.68	2.82167	2.81	0.1233	(100)	**70**

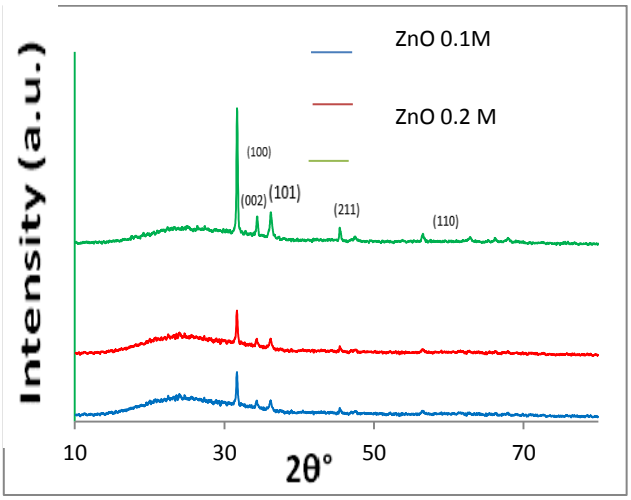

Fig. 1: XRD pattern of deposited ZnO thin films

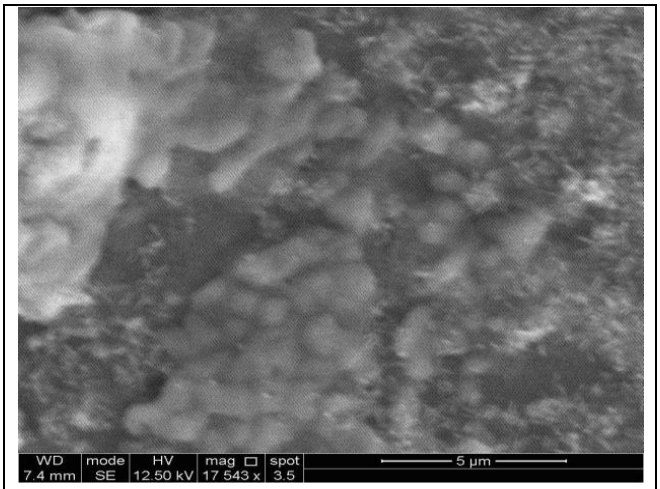

Fig. 2(a): SEM images of ZnO at 0.1 M.

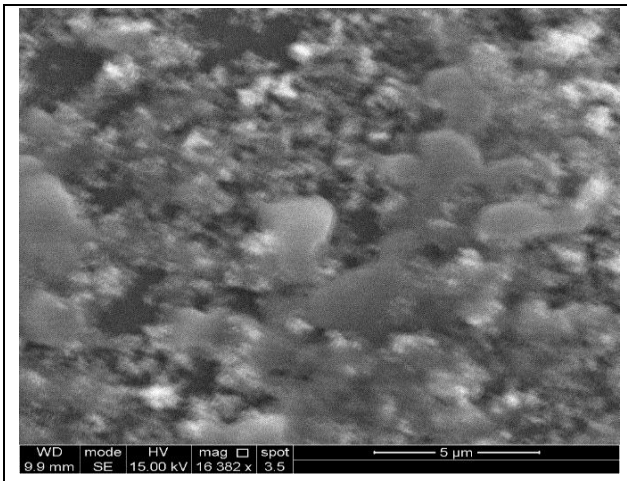

Fig. 2(b): SEM images of ZnO at 0.2 M.

SEM images are shown in a simple form of the ZnO sample (0. 1, 0.2 M) in Figure 2, a, b. As clearly demonstrated, the ZnO sample (0.1,0.2M) consists of dense, continuous and clearly defined. Obviously, the microscopic structure consists of almost many grains. Its shape can be spherical covering the surface of the substrate in one form or another. Figure 3c, d illustrates that the EDAX spectrum of thin films obtained from CBD ZnO (0.1,0.2 M) is the EDAX spectrum consistent with the formation of Zn, O

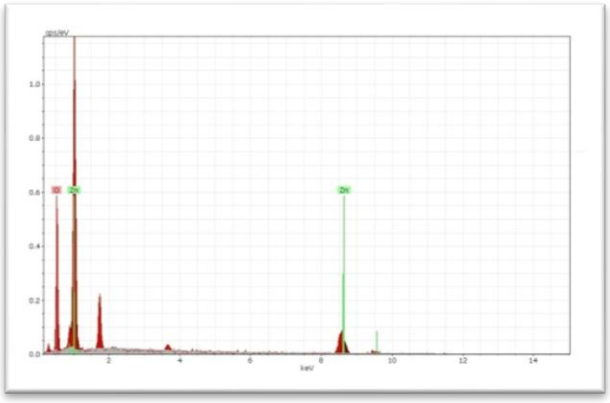

Fig. 3(a): EDX images of ZnO at 0.1M.

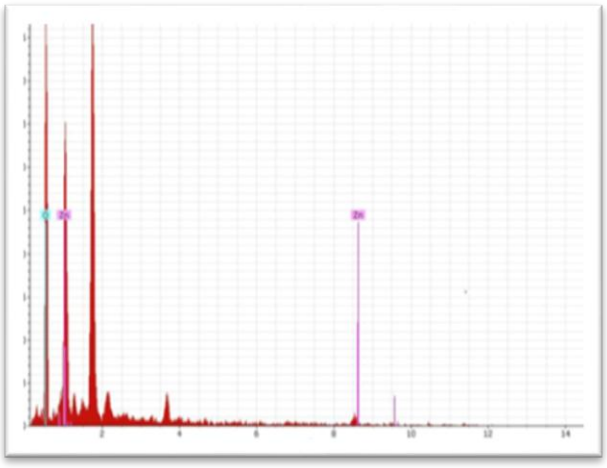

Fig. 3(b): EDX images of ZnO at 0.2M.

Table 3: EDX result of ZnO 0.1 thin films

Spectrum: Acquisition

Element	Series	wt %	wt %	wt %
Oxygen	K-series	91.06	91.06	97.66
Zinc	K-series	8.94	8.94	2.34
Total		100.00	100.00	100.00

Table 4: EDX result of ZnO 0.2M thin films

Spectrum: Acquisition

Element	Series	wt %	wt %	wt %
Oxygen	K-series	36.83	54.23	82.88
Zinc	K-series	31.08	45.77	17.12
Total		100. 00	100.00	100.00

The external morphology of the ZnO heterostructure was first investigated by SEM (Fig. 3- a, b). Large, partially separated granules with an average size of 5 mm can be observed. (Fig. 3, a, b) shows the EDX image and the composition of the elements O and Zn, belonging to the sample. It was calculated that the formation results were almost consistent with the molar ratio of ZnO from Formation Table (3&4).

3.2 Optical Properties

The optical transmittance spectra of pure ZnO (0.1, 0.2, 0. 3) M of films, which were examined using UV visible spectrometer in wavelength ranged from 300 to 1100 nm as shown in Figure 4. The results show that the transmittance shows the films Thin film with

increased molar concentration. It can be said that the permeability of the prepared membranes decreases with increasing molar concentration leading to more atomic arrangement and better cohesion, which reduces the amount of permeability, as this permeability is important in certain applications such as transparent conductor (transparent conductor) and solar cell windows (solar cell windows).

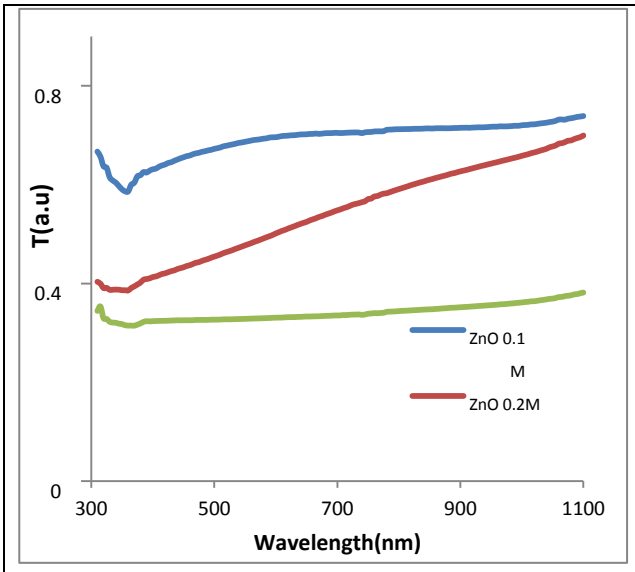

Fig. 4: Optical transmittance of pure ZnO .

Fig.5. Showing the absorption coefficient as a function of the energy photon "hν", it can be observed that the films have a high absorption coefficient (α>104 cm^{-1}) indicating direct electronic transformations. The absorption coefficient increases with increasing photon energy and slightly increases in the range (3.3) volts. It can be seen that the absorption coefficient increases in molar concentration (Uekawa et al., 2001; Xu et al., 2003b). Optical measurements were performed at room temperature. The spectra were recorded using similar glass as a reference, therefore, only the absorption since the film was obtained, the absorption coefficient (α) is determined according to (Das and Chaudhuri, 2007).

$$\alpha = 2.303 \frac{A}{t} \qquad (٣)$$

Where A is the absorption, t is the film thickness.

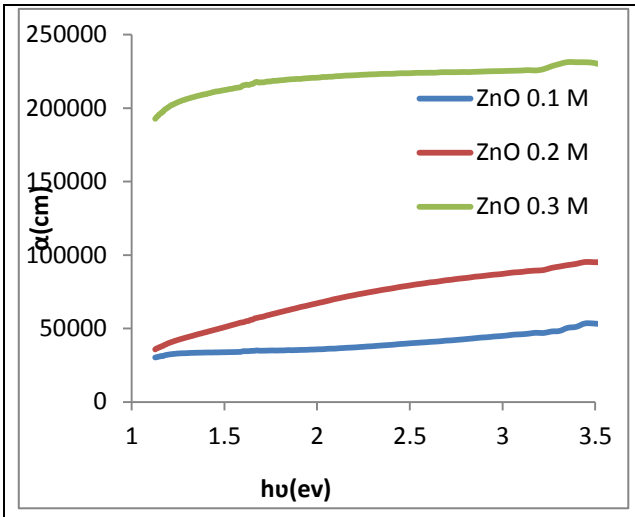

Fig. 5: Absorption coefficient of pure ZnO.

The optical band gap E_g^{opt} was calculated by the following relation [18]:

$$\alpha h\nu = B\,(h\nu - E_g^{opt})^r \qquad (4)$$

Where hν is photon energy, B is a constant value, depends on the nature of the material, and r is a quantity depends on the nature of the transition.

Figure 6, backward illustrates the value of the light energy band gap of pure ZnO by (0.1,0.2,0. 3) M for the allowable direct transition, and is calculated using the relation (3) by choosing the perfect linear portion, which is determined from During extrapolation of the linear portion of the curves until intercepted by the photon energy axis at ($\alpha h\nu$) 2 = 0. Light power outages were calculated according to relationship (3), and were found to increase with increasing molar concentration. The reason is that Burstein-Moss has been altered so that the default energy gap is larger than the original gap due to the bottom of the electron beam.

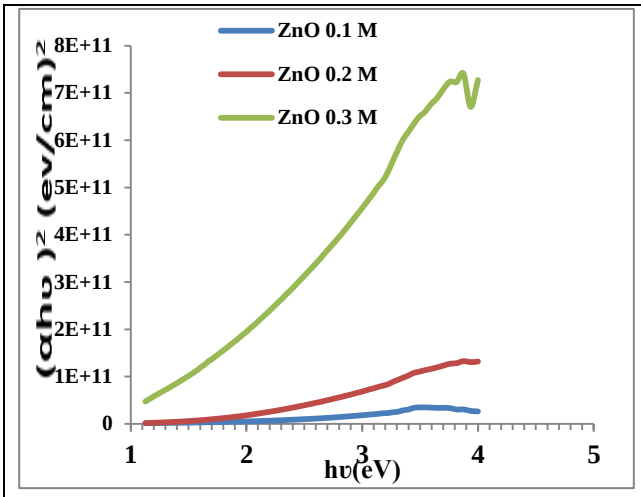

Fig. 6: The optical energy gap of ZnO**.**

4. Conclusions

We have found that zinc oxide reduces particle size, which means that increased molar concentration affects the crystal structure of the zinc oxide membrane. Since structural properties are related to optical properties, we see reduced permeability with increased molar concentration. This means it can be used as good optical windows in electroplating and anti-reflective coatings to improve the efficiency of solar cells. Thin films have a small absorption factor indicating that the electronic transmission is the direct type.

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