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In the Name of Allah
Most Compassionate, Mort Merciful

Edition Word

O Allah, my Lord

Cast felicity in me , facilitate my cause and unknot my tongue to perceive my speech , thanks be upon Him the Evolver of the universe and peace be upon Mohammad and his immaculate and benevolent progeny .

A fledged edition of Al-Bahr , peer reviewed scientific journal, embraces a constellation of research studies pertinent to engineering and natural sciences we do hope to overlap a scientific gap the specialists observe as an academic phenomenon worth being under the lenses of the researchers, that is why there is diversity in the studies to meet the requirements of the journal readership . For the journal, now, comes to the fore , at the efforts of the editorial and advisory boards and the researchers who strain every sinew to publish in Al-Bahr, to be global as to be published in an international publishing house in line with the global scientific journals.

On such an occasion we do pledge the promise of fealty and loyalty to those who observe our issues with love and heed in the International Al-`Ameed for Research and Studies , Department of Cultural and Intellectual Affairs in the Holy Al-`Abbas Shrine and the strenuous endeavour to cull whatever invigorates the scientific interaction and academic research in Iraq and worldwide to create a new generation keeping pace with the development of the current scientific phase and to lay the hands of the researchers, nationwide and worldwide, upon the desired missions.

Thanks be upon Him ,the Evolver ad infinitum .

Consultation and Editaril

Studying some sensing properties of ZnO ethanol sensor prepared by two methods

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الخلاصة

حُضِّر غشاءان لإوكسيد الزنك بطريقة الترسيب بالهجرة الكهربائية (ZnOEPD) والرش الكيميائي(ZnOSpray) على قواعِد من الفولاذ المقاوم للصدأ والزجاج على التوالي. أُستقصيَت الخواص التحسسية لهذه الأغشية للايثانول كدالة لدرجة الحرارة. أزدادت حساسية النماذج مع درجة الحرارة. كانت طريقة ترسيب الأغشية العامل المؤثر على خواصِها التحسسية. أستخدمت تقنيات حيود الاشعه السينية ومجهر القوة الذرية لدراسة الخواص التركيبية وتضاريس السطح للمتحسسات. نتائج هذه التقنيات بينت الفروق بين الأغشية التي أثرت على أدائها التحسسي.

الكلمات المفتاحية

ايثانول، غشاء ZnO، الترسيب بالهجرة الكهربائية، التحسسية.

Abstract

Two (ZnO) films were prepared by electrophoretic deposition (EPD) (ZnOEPD) and chemical spray pyrolysis (ZnOSpray) on stainless steel (St. st.) and glass substrates respectively. The sensing properties of these films to ethanol were investigated as a function to temperature. The sensitivity to ethanol increases with sample's temperature. The method of film's deposition is active factor on sensing properties of the films. X ray diffraction (XRD) and atomic force microscopy (AFM) techniques were utilized to study structural properties and surface topography of sensors. The results of these techniques show the differences between these films that effect on their sensing performances.

Keywords

Ethanol, ZnO films, electrophoretic deposition, sensitivity.

1.Introduction:

For long time, Ethanol is one of the more ancient enjoy spirituous drugs and accurate sensing of alcohol vapor has special importance. So, it is necessary to promote sensors for its detecting. A breath analyst is the most famous application of ethanol sensors because its quantity in the blood is related with its vapor in human breath[1]. Blood alcohol content (BAC) can be defined as ethanol weight per unit blood volume. At large ethanol levels (BAC > 1 g/L), it produces unconsciousness,cognition, stupefaction, and may bedeath [2]. When alcohol levels of blood reach (0.4%); ethanol concentration may causes death. The death is absolute when this quantityreaches(0.5%) or higher. When alcohol levels around (0.1%) intoxication occurs and at (0.3–0.4%)unconsciousness often occurring [3].

Metal oxide semiconductor have been found to be high activity for sensing ethanol vapor [4].

Different methods were used to deposit ZnO sensors, in this work EPD is chosen as first deposition method. EPD method is rapid, low cost and can be achieved by two steps. In the first one;particles which are suspended inside liquid acquire electric charges. In second step homogeneous deposition on one of electrodes is achieved by collection of particles on it as the effect of applied electric field. This coatingtakes electrode's shape [5]. This method has many advantages [6]:comparing with other methods its deposition rate is controllable and has low energy consumption. Also, it is low costs method. In general Deposition by this methodhas very uniform thickness.Objects with ununiformed shapes can be coated fluency by EPD. Depending on its geometry;the deposition can outside object's surface or inside cavities.

The second used method to deposit ZnO is chemical spray pyrolysis. This methodincludes; spraying of an aqueous solution (has soluble salts of the constituent atoms of the desired compounds) on preheated substrates .After splashing and before reaching the substrate or react on it the liquid droplets vaporize. Well adhesion on substrate can be obtained bysolution's pyrolytic decomposition of spray solution droplets [7]. This deposition method is minimal waste production, simple, and also low cost. Large surfaces coating can be produced by this method and the rate of film deposition is controllable. To deposit large numbers of high melting temperature materials; chemical spray pyrolysis is appropriate choice. When this method is used there is no need for complicated vacuum equipment [8].

In this contribution, two ethanol sensors are fabricated by two methods to get best sensing performance.

2. Experimental part

2.1. Deposition ZnO film by EPD method.

To deposit ZnO film, uncomplicated Teflon container is used as shown by Fig.(1).

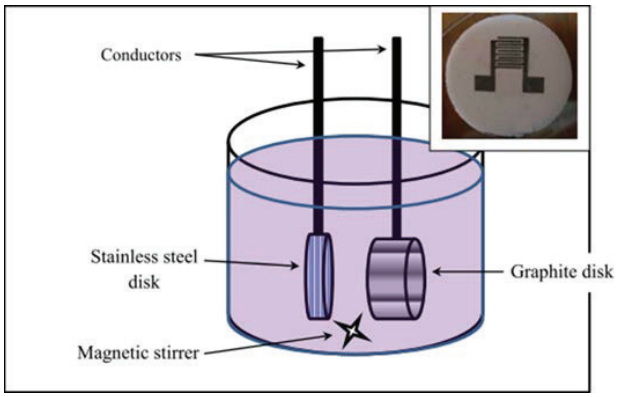


Fig. (1): Diagram of EPD Cell, The inset shows ZnO_{EPD} film covered by mask pattern.

(0.5) cm is the distance between cathode and anode. On (50) ml methanol, one gram ZnO powder is put. By magnetic stirrer the solution is mixed for (10) minute. Graphite disc is used as anode and the cathode (substrate) is made from circular shape St.st. with radius (1.5) cm. (30) volt is applied between both electrodes during deposition process. To prevent formation of cracks which may appear on coated layer; the produced sample is immersed in a viscous solution. This chemical solution consists from 1gm of Poly vinyl alcohol (PVA) which is dissolved in hot water. Removing PVA is done by heating the coated samples to $(500)^0$C in air atmosphere. Weight method is used to calculate the thickness of two films. The thickness of the film prepared by EFD method is (2) μm (ZnO_{EPD}).

Semiconductor behavior of coated samples are tested by measuring their resistance as a function to temperature by utilizing simple heater and DC circuit. Characterizations of samples are achieved usingAFMand XRD techniques. To specify XRD peaks for ZnO and St.st;standard PDF files (050664 and 330397) are used respectively.

2.2. Deposition of ZnO by chemical spray pyrolysis method.

On glass slidespray pyrolysis deposition method a homogeneous ZnO thin film is coated.The chemical solution is prepared as following; dissolving (0.1) M $Zn(CH_3COO)_2$(with 99.99% purity) in hot distilled water (100) ml [9].

$Zn(CH_3COO)_2 + 2H_2O \rightarrow ZnO + CO + CH_4$ + steam - - - - - - - - - - - (1)

To get homogeneous solution the chemical solution is moved by stirrer. During spray process,glass substrate is maintained at $(400)^o$C using hot plate under it. (28) cm is the distance between substrate and glass nozzle. Chemical solutiontransport is achieved by using air as a carrier gas. The thickness of the film prepared by spray method (ZnO_{Spray}) is (0.39)μm.

3. Gas sensor system

The system of tested gases has the following parts: stainless steel sealed chamber (six liter), to heat the sample up to $(400)^0$Ccontrolled heater is used, to evacuate the chamber from gases after testvacuum system is achieved, ohmmeter is used to measure sample's resistance d to read sample's temperaturethermo couple is utilized. There are two techniques to enter tested gas inside the chamberdepending on the amount of it. First

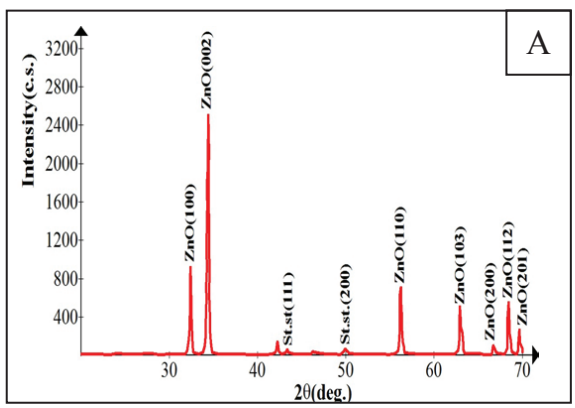
technique (for small gas amount) is done by evaporatinginside output unit appropriate chemical solution. After that produced gas is transferred to the evacuated chamber through plastic pipes. Second technique (for large gas amount) is done by direct injection of chemical solution inside the chamber. Injected solution is evaporated to gas when it touches a hot plate inside chamber. Small amount of chemical solution is evaluated using micropipette type (DRAGONMED-made in china) volume:(5-50)µl. Ammonia was produced by evaporate ammonia solution (32% concentration, Scharlau-Spain).

4. Results and discussions

Fig.(2).shows XRD pattern of (ZnO_{EPD}) and its AFM image.ZnO dominant peak for this pattern is (002) peak. Inside this pattern, two peaks refer to St.st which used as substrate. Crystallite size is calculated from this pattern by using Scherrer equation

Crystallite size = $0.94\lambda / B\cos\theta$ - - - - - (2)

λ is thewavelength of X-ray beam , B is full width of half maximum for a dominant peak (002) . For (ZnO_{EPD}) crystallite size is (606.7) Å. From AFM image in Fig.(2).



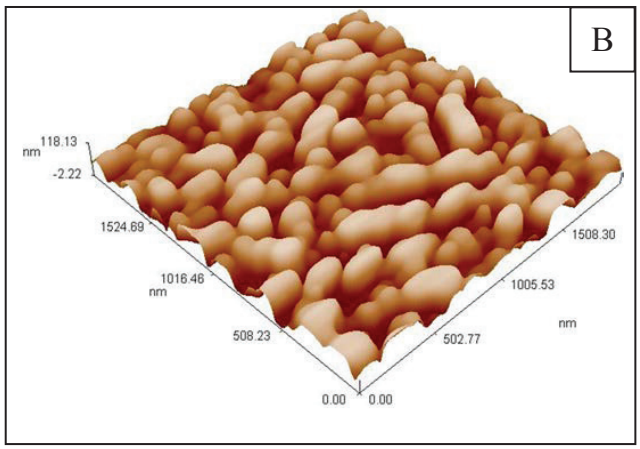


Fig. (2): A-XRD of ZnO_{EPD}, B-AFM image of ZnO_{EPD}.

The following parameters are extracted: average roughness (22)nm and grain size (100.72)nm.

For different injected ethanol concentrations; Fig.(3). illustrates (ZnO_{EPD}) resistance variations as a function to time. After exposing ZnO sensor to ethanol; electrons release back into it as a result to substitution of surface-bound oxygen by gas [10].The increasing of injected amount of ethanol increases the reaction with oxygen and then decreasing ZnO resistance.The reaction of ZnO with oxygen is increased withthe increasing of injected the amount of ethanol. As a result ZnO resistance decreases.

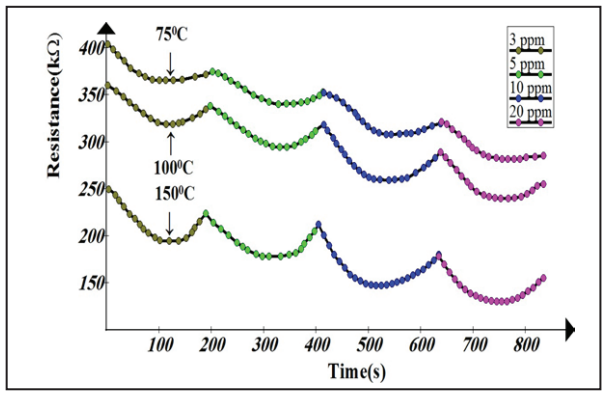


Fig. (3): ZnO_{EPD} response to ethanol gas for different ethanol concentrations at three sample's temperature.

The manners of Fig.(3).curveslook like that happened withHongsith et al. who noticed the decreasing of ZnO resistance sensor as a response to ethanol atmosphere [11]. Refilling the chamber with air restores non-conducting state of the sensor.

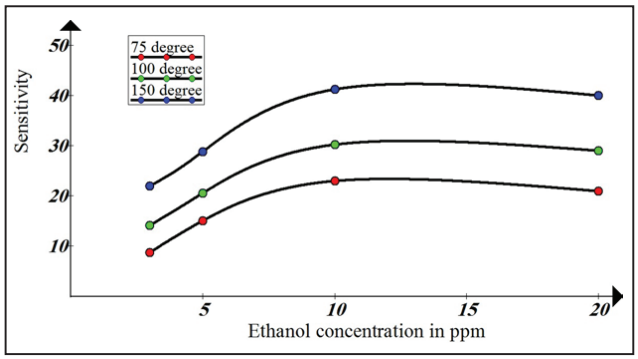
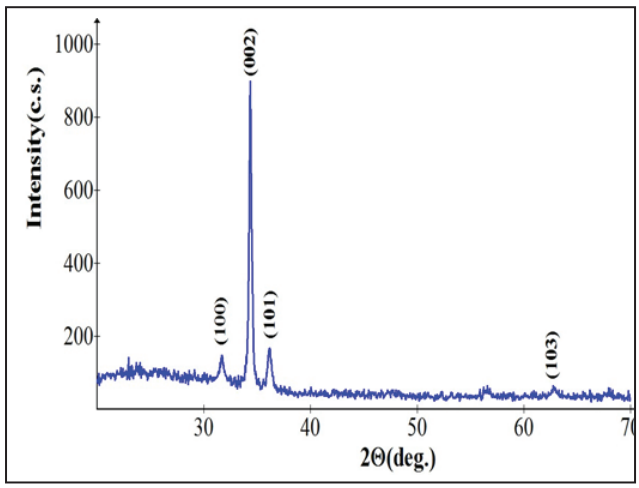


Fig. (4): The sensitivity of ZnO_{EPD} to ethanol gas.

Fig.(4).shows (ZnO_{EPD}) sensitivity to ethanol. These are an increasing of sensitivityto ethanolby (ZnO_{EPD}) sensor when the temperature increases in harmony with that obtained by [12]. This result can be attributed to the interaction increasing of ethanol molecule with oxygen ions as a result to the increasing of adsorption of these ions with temperature. Better response can be obtained by pumping larger amount of test gas; because this process activate the reaction between oxygen and adsorbed reducing gas [13].

On the other hand injection of relatively high amount of ethanol inside chamber results in decreasing sensor sensitivity. In this case the interaction on sensor surface would proceed to left; causesreduction of oxygen ions and the ZnO response would be decreased [14].

Fig.(5). illustrates XRD pattern of (ZnO_{Spray}) and its AFM image. Dominant peak of XRD curve is (002). Compared with standard position of (002) peak (2θ standard = 34.422), this peak is shifted to the left. Thisshift is a direct result to residual stress in the film. In current work, compressive stresses are created in ZnO filmas a result toc-axis value increasing compared to that of $C_{(ASTM)}$ Å [15] . Crystallite size for (ZnO_{Spray}) is calculated using equation (2), this value is (410.7) Å. From AFM image in Fig.(5); (ZnO_{Spray}) average roughness and grain size are (0.581)nm (62) nm respectively.



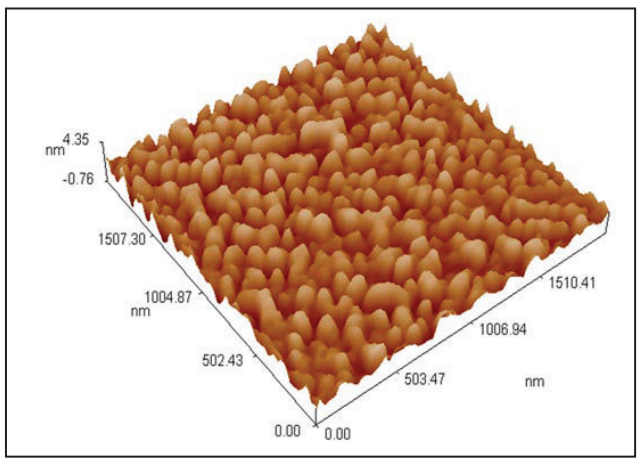


Fig. (5): A-XRD of ZnO_{Spray}, B-AFM image of ZnO_{Spray}.

The variation of (ZnO_{Spray}) resistance with ethanol solution is shown in Fig.(6).

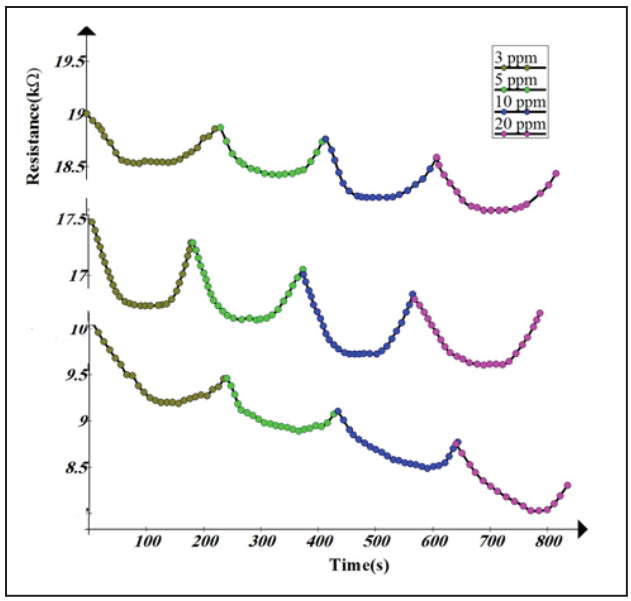


Fig. (6): Resistance of ZnO_{Spray} as function of time for different ethanol concentrations at three Sample's temperature.

Ethanolentrance into the chamber results interaction of it with chemisorbed oxygen.The trapped electrons after this interaction become free and then they contribute to the conduction process of ZnO sensor. As a result, the resistance of this semiconductor sensor`

As gases sensors; the differences between (ZnO_{EPD}) and (ZnO_{Spray}) are a direct results to the different properties of them.XRD patterns in Fig.(2).and(5) are different. The method of deposition and the type of substrate give each film specific surface topography and then different response.

5. Conclusion:

- Deposition method has a direct effect on morphology of each film and then on its operation as ethanol sensor.
- (ZnO_{EPD}) sensor sensitivity to this gas is higher than that of (ZnO_{Spray}) sensor.
- The highest sensitivity values are recorded when the sensors had highest temperature.

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