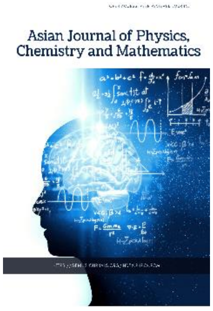


Study of the structural and electrical properties of pure ZNS membranes before and after Annealing

Anas Asaad Hamdi
anasasaad785@gmail.com
Directorate General of Education in Salah al-Din Province

ABSTRACT

In this research, the structural and electrical properties of the ZNS membrane were studied at a pure 5nm (100,200,300) range prepared by a thermochemical spray method at room temperature on hot glass (450°C) and at a spray rate (2.5 mL/min), and the effect of the fish and metallicity at 500°C) on these properties for one hour. X-ray diffraction results have shown that all prepared diaphragms have a multiple crystallization (quadripartite) and predominant orientation (002, 211, 200, 101, 110) structure for all models before and after metamorphism, and that metamorphism increased the grain size

As for electrical properties, the study included the calculation of electrical conducation as a function of temperature within the range (ºc 25-150). The results showed two wake-up energies (EA1,EA2), which indicate two delivery mechanisms.

One is in low (25–85°C) and the other in temperature It is also known that the number of people who have been in the United States has increased from the number of people who have been in the United States since the end of the year to the end of the year is higher than the number of people who have been in the United States.

Keywords:

Introduction.

Thin Films is an important branch of solid-state physics that has crystallized into a stand-alone branch, dealing with micro-devices that all have very small thickness below (1).

The study of the properties of matter, which are in the form of thin membranes, has attracted the attention of physicists since the second half of the 17th century, as many theoretical research has been carried out in this field. The study of practicality evolved in the early 19th century when semiconductors came into practice [2]. This is because the membrane is so thickened that it is easily broken, it is placed on substrates of different materials depending on the nature of use and study, such as glass, quartz, silicon and aluminum And others [3].

The film is used in a wide range of fields and is used in the manufacture of various components of thin electronic devices, detectors, and interference filters and is used in a wide range of optical fields such as mirrors and glass panels sensitive to electromagnetic waves.it is also used in integrated circuits, and thin films have properties and features that may not be found in Other types of substance whose very small thickness is given a rare crystalline structure that is close to and may sometimes surmount the characteristics of the monocrystalline structure, because thin membranes of the substance differ in crystalline composition from the regular composition of the substance by a sentence of all [4]:

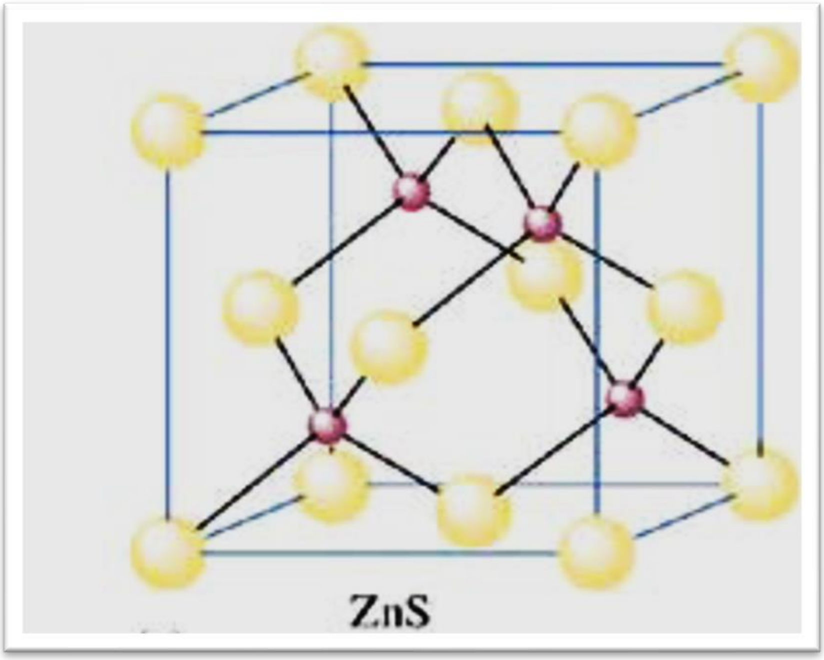
1. The size of the crystals in the thin membranes is smaller than their normal size in matter.
2. Thin film may contain significantly higher impurities than the material in its normal form due to the preparation method.
3. The point defects in thin membranes are greater than in natural matter crystals, especially at temperatures above KO 0= T due to the rocking motion, so that the atoms of matter vibrate in their locations up to date

Zinc sulfide (ZNS):

The outer sulfide returns to the two semiconductor groups (II-VI). It is a mineral sulphide compound, a transparent white powder made up of two crystal compounds (**αwurtzite), (βzincblend)** . It changes to the **α phase** at a temperature (1294 K°) at normal atmospheric pressure and dissolves in aciers and does not dissolve in water. Because ZNSSs and CDS show sensitivity to magnetism and electromagnetism, they are widely used in electronics, and are defacing with other elements that become luminescent [5].

Crystal structure of zinc sulfide (ZnS):-
Crystalline composition (ZNS):

The crystal structure of ZNS is the F.C.C concentric cube type and the ZNS structure cell unit shown in Figure 3-2 is the result of the overlap of two concentric-face arrays, one composed of ZN ions and the other of sulfur ions (S). The two beacles are shifted toward the line that connects two opposite corner of the cube by 1/4. In addition, the structure of the outer sulfide is tightly-knit, where each ion of the outer is surrounded by four-surface sulfide ions, which are centered and at the same time are surrounded by each ion of sulfide b) 4). It is also used to make the same use of the ZNS cell unit, which contains four ZN ions and four S ions. The radius of the ZN ion in this structure is 0.74A° and the radius of S is 1.84A° **[6]**



Figure(1) shows the crystal structure of ZNS

Compound applications ZNS:- [7] [6]

ZNS is an important semiconductor because it has a wide power gap (EV 3.84-3.2) and has many applications including:-

1- lymers.

2- He is a man who is a man who is a man who is a man who is a man who is a man.
3- High-glare devices.
4- producing UV-responsive pigments.
5- TV screens.
6- Cathode ray tubes.
7- Radar screen.
8- Anti-reflective coating.
9- Anti-corrosion coating.
10- flashing meters.
11- Electro-microscope and X-ray System Display.

Preparing solution ZNS:-

For the preparation of the ZNS solution, ZNCL2, which is made up of b.d.h the British Drug houses, was used to the following specifications:-

Molecular Weight = 136.28g/mol.

Color = White crystals that are rapidly dissolved with distiled water.

Purity = 99%.

The two outer chloride solution is prepared with molybdenum (m) 0.1 and volume (100 mL) using the following relationship[8]:

$$M = \frac{w / M_w}{v(\text{Litre})}$$

Where w : Weight of matter, M_W : Molecular Weight, V : Volume of solution.

The ZNCL2 is dissolved (1.3628 GM) in (100ml) distiled water and then placed on a 15 min magnetic mixer to ensure that it is completely dissolved so that a colorless solution is produced that is a source of the external ions (ZN+2).

For the solution containing sulfur ions (S-2), $CS(NH2)_2$, which is equipped by Riedel-Dehaen AG, has been used with the following specifications: Molecular weight = 76.12 g/mol

Color = White crystals that are rapidly dissolved with distiled water. Purity = 99%.

0.7612 GM was dissolved ($CS(NH2)_2$) in (100ml) distiled water and then placed on a magnetic mixer (15min) to ensure that it is completely dissolved to obtain a colorless solution which is a source of sulfur ions (S^{-2}). The two solutions allow for (24) hours to make sure that there is no deposit and then mix with a magnetic mixture to ensure good mixing, and the equation for this reaction is as follows: [8]

$$ZnCl_2+CS(NH_2)_2+3H_2O \rightarrow 2NH_4Cl+ZnS+CO_2\uparrow+H_2O$$

At deposition ammonium chloride at cº350 disintegra into NH3 and HCL, thereby getting a membrane of ZNS the surface of the base according to the follow reactions:

$$2NH_4Cl+ZnS+H_2O \xrightarrow{350C^{\circ}} ZnS+2NH_3\uparrow+2HCl\uparrow+H_2O$$

Thin film thickness measurement:

The thickness of tin dioxide membranes has been calculated using the following methods:

<u>Weight method</u>.

In the early years of the early years of the early years of the early years of the early years, the Δm period of the early years of the early years of the early years of the early years of the early years of the early years of the early years of the early years of the early years of the period of the period of the period of the period of the period of (10^{-4GM}) the thickness of the sediment is calculated from the following equation:-

$$t = \frac{\Delta m}{D.a}$$

Where:

T :- membrane thickness.

Δm :- the mass of the diaphragm.

D :- the density of the material of the membrane.

A :- the area of the diaphragm

Results and discussion

In this research, some of the structural and electrical properties of the pure ZNS membrane have been studied as follows:

First: structural properties:

1- X-ray inspection results.

The structure of the prepared membranes before and after the tilde was recognized as having polycrystalline and tetragonal polycrystalline structure and predominant orientation (110,200,211) with the onset of a directional cube-type phase (100) and the crystalline distance (110) from Brak's Law was calculated (D = 3.350 å) and the network constant (a = 4.736 å) where the distance is (D

= 3.347 å) and the network constant (a = 3.355 å), with the difference between the calculated values and the standard values [9,10]. As shown in figures (2), (3), (4) and 5nm(100.200,300) thickness.

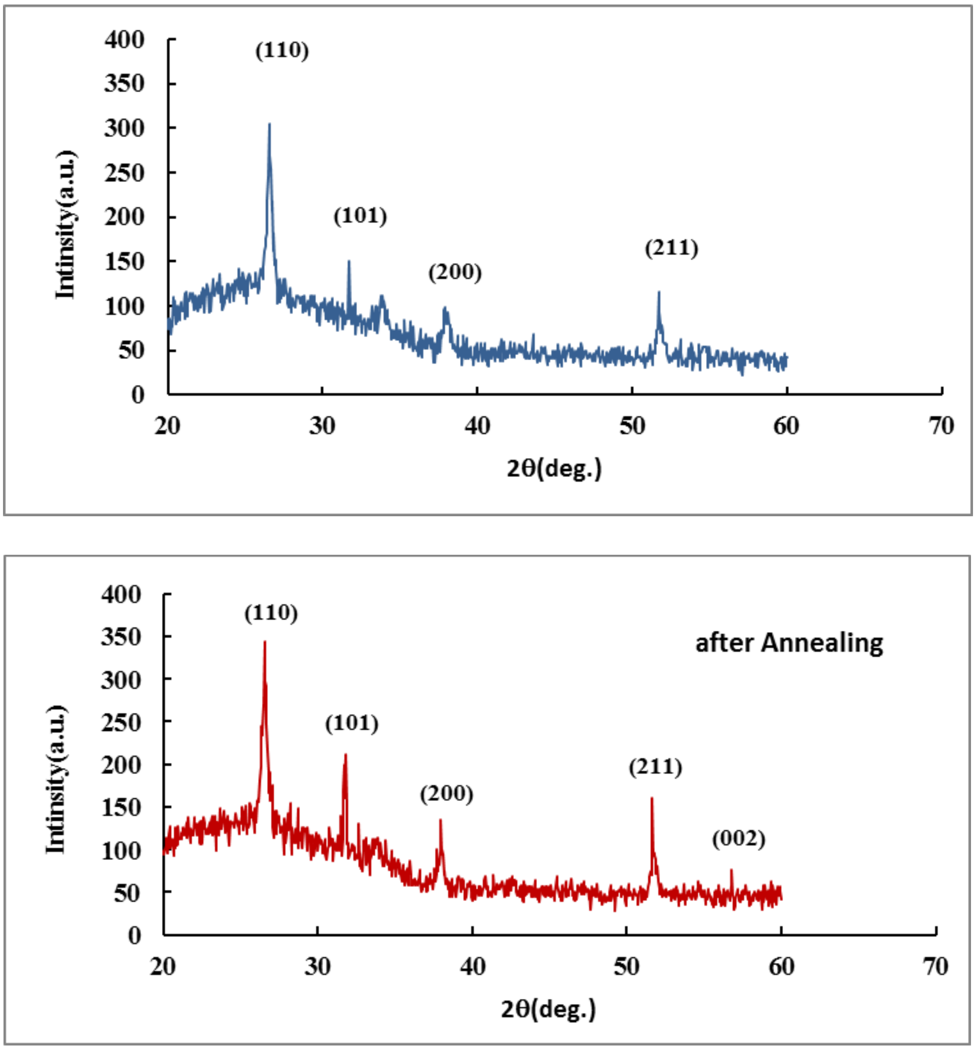
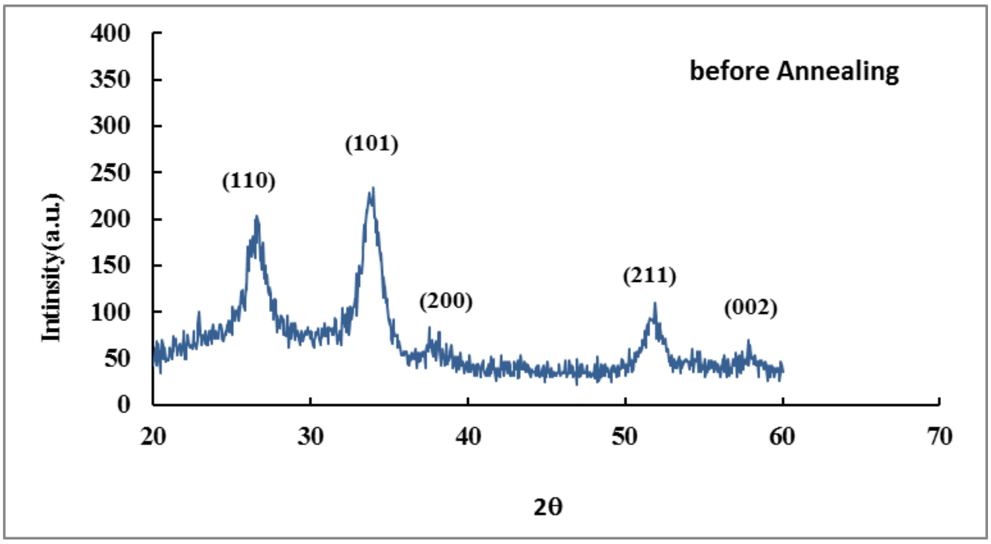


Figure 2 XRD of ZNS membrane before and after Annealing at 100 nm thickness.



ISSN: 2795-7667

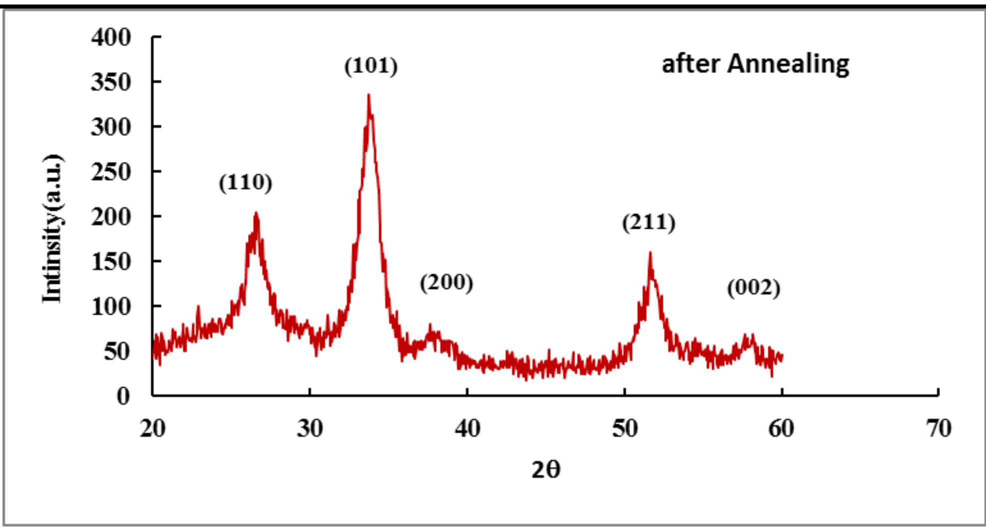


Figure (3) XRD of ZNS membrane **before and after Annealing at 200 nm thickness.**

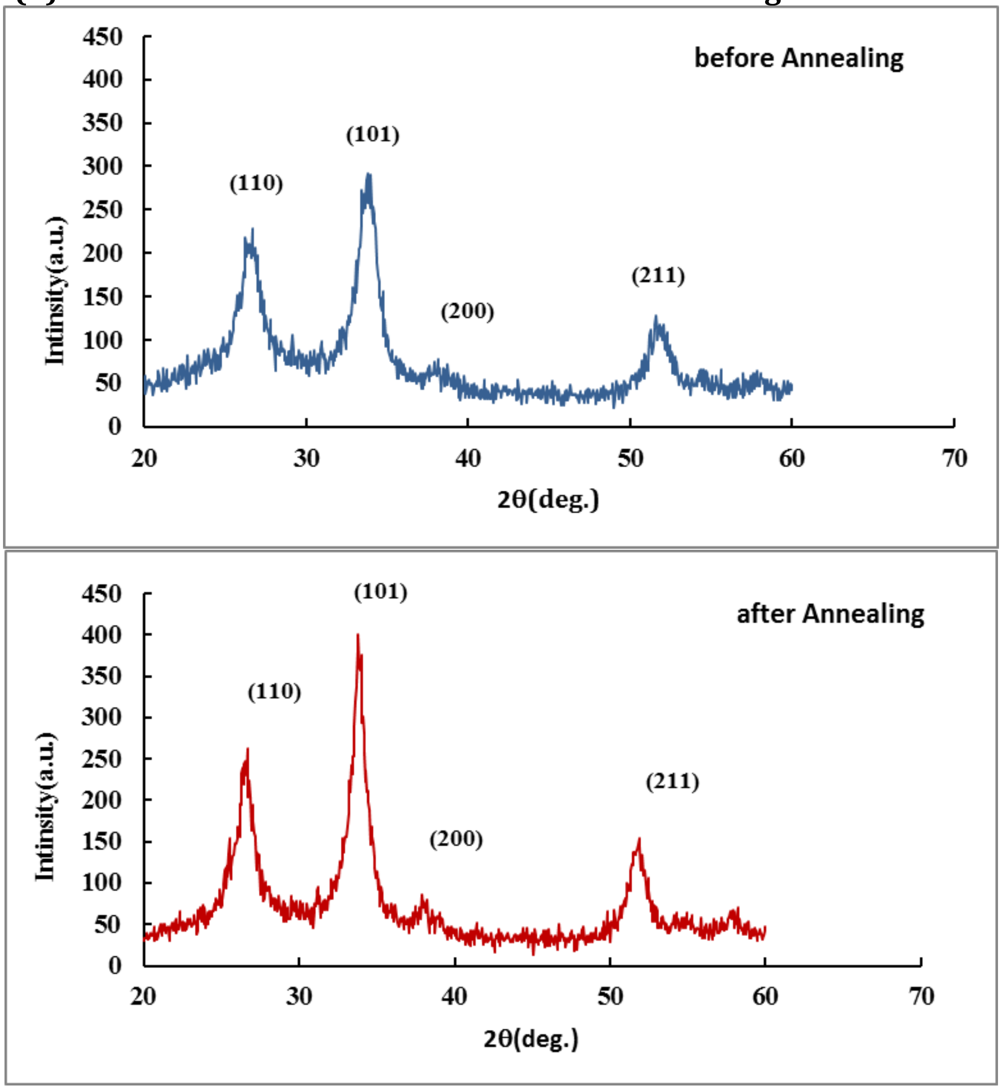


Figure (4) XRD of ZNS membrane **before and after Annealing at 300 nm thickness.**

The rise of peaks after the tilde is observed in forms, due to improved crystallization and decreased crystal defects.

Table 1 shows the comparison of distance values calculated from X-ray diffraction pattern with crystalline distance values taken from 300nm ICDD.

Table (1) shows the X-ray results of ZNS membranes at thickness (300nm).

thickness t = 300(nm)	hkl	$2\theta_S$ (deg)	$2\theta_{cal}$ (deg)	d_s (Å)	d_{cal} (Å)
before Annealing	110	26.611	26.584	3.347	3.350
	101	33.893	33.818	2.642	2.645
	200	37.949	37.963	2.369	2.367
	211	51.780	51.777	1.764	1.764
after Annealing	110	26.611	26.576	3.347	3.351
	101	33.893	33.837	2.642	2.646
	200	37.949	37.958	2.369	2.366
	211	51.780	51.746	1.764	1.765

Second: Electrical Properties Measurement

1- continuous electrical connection results.

Continuous electrolytic conductivity($\sigma_{d.c}$)of ZnS membranes was calculated with fish (100,200,300) ± 5nm after measuring the resistance of ρ membranes per temperature, after knowing the dimensions of the pole and by applying the equation ($\rho = \frac{R.b.t}{l}$) whereas:

ρ : Resistance
R : membrane resistance
b : Pole width.
t : membrane thickness
l: The distance between the aluminum poles.

Then calculate the continuous connection from the following equation$\sigma = \frac{1}{\rho}$)) by drawing the graph relationship between (IND$\sigma_{.C}$) and the reciprocal temperature (1000/T) the slope is calculated and multiplied by the constant of Boltzman (KB) in electron-volts (0.08625 EV) and by applying the equation

$$\sigma = \sigma_\circ \exp\left(-\frac{E_a}{K_B T}\right)$$ Where:

σ : constant representing the minor metal connection, E_a : Activation Energy.
K_b: Boltzman constant. T: Temperature.

We get energizing energy as there are two energizing energies within the temperature range 25–150°C, which indicates two conductivity mechanics, one at low temperature (25–85)°C, the other at high temperature (85–150°C) and figures (5), (6), and (7) illustrate this relationship and from The results of the electrical conductive measurement are that the ZNS membrane has a high conductive capacity, which increases with the increase in temperature, and this is a general characteristic of semiconductors. This is because the Annealing reduces crystal defects and thus reduces the local levels that increase the energy gap, i.e. increase the energizing energy and the table,2 shows the activation energy values of the ZNS membrane for a different thickness [11.12].

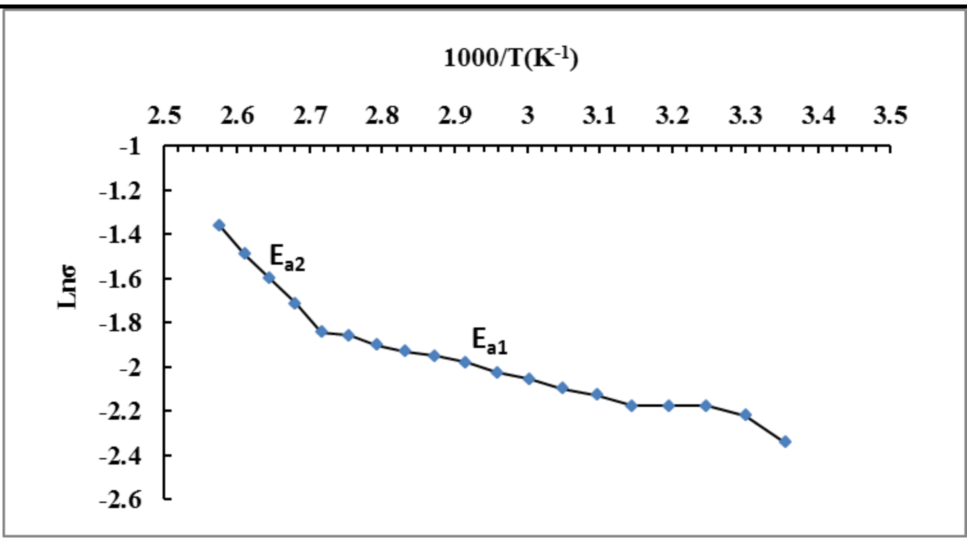


Figure 5 The relationship between lnσ and the inverted temperature of ZNS at **100 nm thickness**

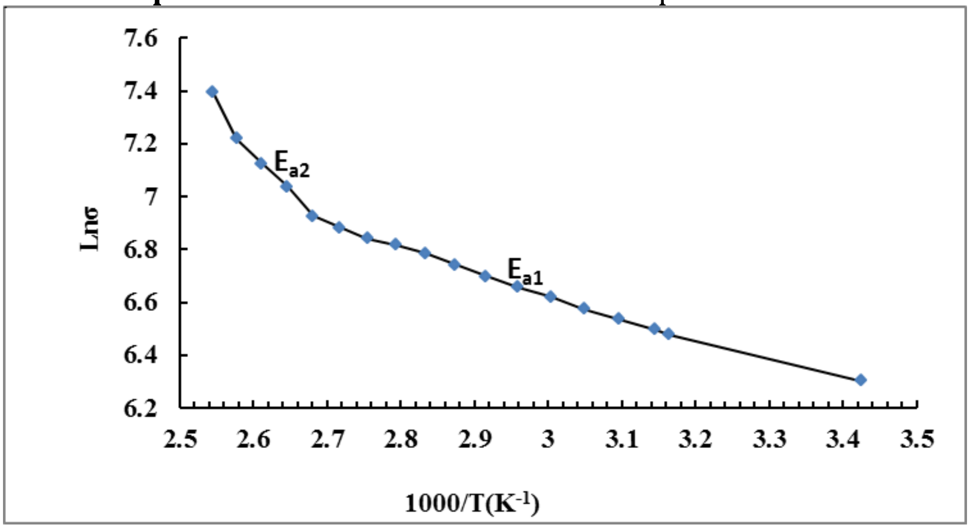


Figure 6 the relationship between the N andσ the inverted temperature of the ZNS membrane **at 200 nm thickness.**

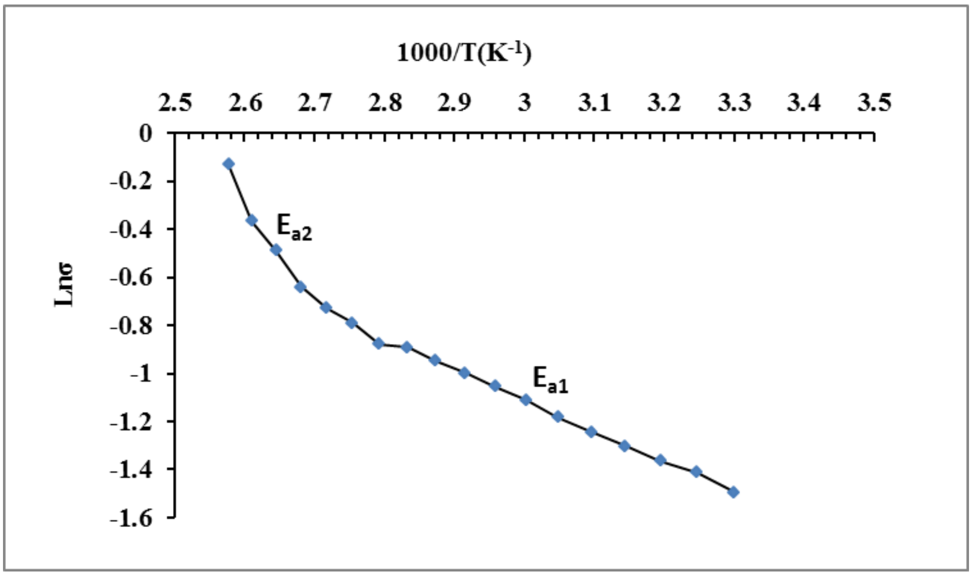


Figure 7)) relationship between the LN andσ the inverted temperature of the ZNS membrane **at 300 nm before the tilde.**

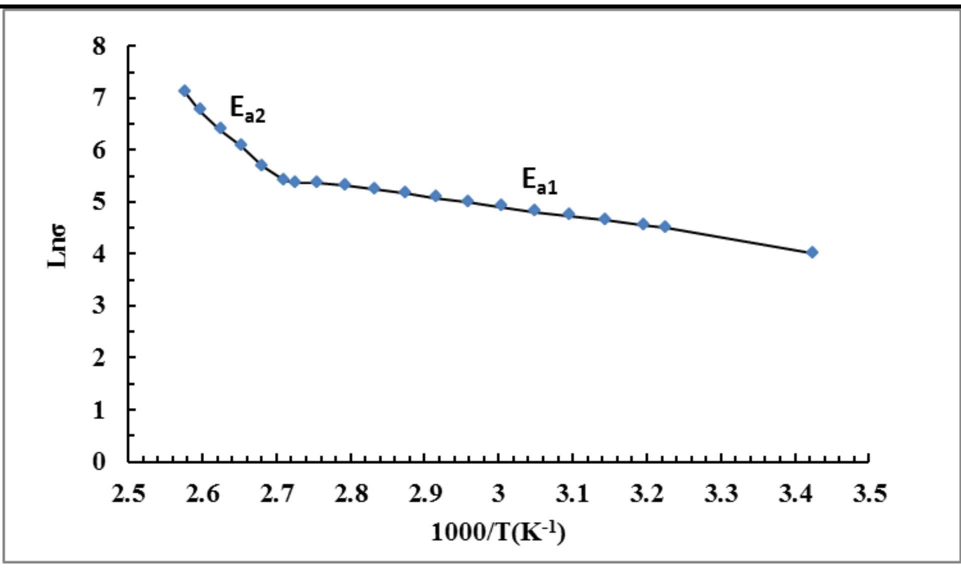


Figure (8) relationship between lnσ and the inverted temperature of ZNS at 300 nm after the tilde.

Table (2) shows the values of the activation energies of the ZNS membrane for the thickness of 100,200,300 (+5 nm).

t(nm)thickness	E_{a1}(eV)	E_{a2}(eV)
100	**0.0604**	**0.235**
200	**0.0723**	**0.250**
before Annealing 300	**0.112**	**0.283**
after Annealing 300	**0.164**	**0.370**

For the purpose of understanding the mechanism of electrical conduction in polycrystallium materials, which consist of crystals separated from each other by barriers called granular boundaries, This is the main reason for the resistance of polycrystallized materials due to the neglect of the resistance of the bulk grain, the current that passes within the granules is formed either by thermal stimulation or by agreement. In contrast, the flow of consents is caused by carriers that have a capacity below the voltage barrier, so they will pass through the voltage barrier through the mediation of the consents [11.12].

Sources

1. K. L. Chopra, "Thin Films Phenomena " ,McGraw-Hill, New York, 1969.
2. L. Eckcrtova, "Physics of Thin Film ",Plenum press, New York and London, 1977.
3. R.W. Berry, P.M. Hall & T. Harris Thin Film Technology " New York, 1979
4. H. G. Rashid, "Rashid" Design and optimization of thin Films optical filters With applications in the Visible and in Frared region", Ph. D. thesis, AL-Mustansiriyah University, 1996.
5. H.H. Afifi, S.A. Mahmoud, A. Ashour " Structural study of ZnS thin films prepared by spray pyrolysis"Thin Solid Films,Vol (263),pp. 248-251.(1995).
6. Adnan Mur'dUN Mansour Al-Saadi "Study of the effect of young women on the physical properties of the ZNS membrane prepared by the Thermochemical decomposition method"MBA thesis submitted to the Department of applied Science, University of Technology (2005).
7. M.Y. NADEEM & Waqas AHMED "Optical Properties of ZNS Thin Films " Turq. J.Phy" Vol.(24) pp.(651-659),(2000).
8. Wen Chen , Jing Wang , Min – rui Wwang , " Influence of doping

Concentration on the properties of ZnO : Mn thin films by sol – gel method " Vol . 81 , P . 8994 – 898 , (2007).

9. Liqa Ghaleb Sobhi "Studying the effect of annealing on the structural and optical properties of ZnS films prepared by thermochemical decomposition method" Master's thesis, Al-Mustansiriya University (2009).
10. B. Thangoroju and P. Kaliannon,"Polycrystalline Lead Tin Chal-Cogenide Thin Film Grown by Spray Pyrolysis "Cryst. Res. Technol. Vol. 35 pp (71-75). (2000)
11. A.Y. Necmeddin ,Ö.Mustafa, B. Metin and K.Refik ,"Determination of the Trapping Parameters of ZnS Thin Films Developed by Chemical Spraying Technique "Turk.J. Phy̏s ,v.26,pp.277-282. ,(2002) .
12. Muntha Jasim Al-Husseini, " Study of the Electrical and Visual characteristics of ZNS and PBS Phrase prepared by Thermal Chemical spraying", M.A. thesis presented to the Faculty of Science, Department of Physics, Mustansiriya University (1998).