تأثير زاوية الترسيب و عرض الغشاء على بعض الخصائص الكهربائية لأغشية (SnTe) المحضرة بطريقة التبخير الحراري الفراغي

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الخلاصة:

في هذا البحث درست الخصائص الكهربائية لأغشية (SnTe) المحضرة بطريقة التبخير الحراري الفراغي تحت ضغط (10^{-6} Torr) على قواعد زجاجية عند درجة حرارة الغرفة وبزوايا ترسيب مختلفة (θ=(0°,45°,70°) وبسمك (350 nm ± 10 nm) وبعرض غشاء (3 mm , 4 mm , 5 mm). وتبين ان زيادة زاوية الترسيب له تأثير واضح في تقليل التوصيلية الكهربائية وزيادة معامل سيبك. وتسببت زيادة عرض الغشاء تأثيرا في التوصيلية وزيادة معامل سيبك بشكل ملحوظ .

The Effect of Deposition Angle and film width on some Electrical Properties of (SnTe) Films Prepared by Thermal Evaporation

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ABSTRACT

In this research had been studied the Tin Telluride films deposited at angels $\theta = (0^\circ, 45^\circ, 70^\circ)$ by thermal evaporation method at a pressure of 10^{-6} torr on glass substrates at room temperature. Films thickness t =(350 ± 10) nm and films width (3 mm , 4 mm , 5 mm) . The conductivity decreases with increasing deposition angles and films width. The Seebeck Coefficient increases with increasing deposition angles and films width.

Keywords: Thin films , Films width , SnTe thin films , Obliquely Deposited, D.C conductivity, Seebeck Coefficient .

1. Introduction:-

Tin Telluride (SnTe) semiconductor have a cubic and rhombohedral structure [1]. Thermal evaporation technique is useful to obtain SnTe films [2]. Obliquely deposition technique give a unique nanostructures[3] .
As well as the complex morphologies, specific crystallographic phases can be selectively grown using obliquely deposition [4, 5].Also the change in structural properties affected the electrical properties[6].

The purpose of the search study the effect of deposition angle (θ) and width film on the conductivity and Seebeck Coefficient of (SnTe) films.

2. The experimental work:-

SnTe compound was synthesized as an alloy by using Tin , and Tellurium produce (May and Baker LTD, Dagenham England), their purity is (99.99%) and then weighting each element according to the atomic weight (Sn=118.710 g. mol^{-1}) , (Te=127.60 g. mol^{-1}) by using sensitive electrical balance type (AE 166 Metter), then mixing these elements[7].

Done clean quartz tube was cleaned well to remove dust and other pollutants. Then the mixture was placed, then putting this combination in it (the tube is 10 cm length and 1.5 cm diameter) . It was vacuumed by using a rotary pump. When the pressure reached ≈ (10^{-2} Torr), the tube is sealed and put in electric furnace of type SRJX-5-13 Model Box-Resistance Furnace supplied by (Tianjin Taisite instrument co. LTD), the material inside ampoule was heated to 200 °C for 3 h .Then the furnace temperature increases slowly at a rate of 3°C/min, up to 450°C then to 830˚C for 15 min [8].

The quartz ampoules rocked constantly to obtain homogeneous glassy alloys, then cooled rapidly in a cold water to reduce segregation and to obtain more homogenous alloy. The alloys were taken out by breaking the quartz ampoules.

Molybdenum boat is uses to evaporate SnTe. Prior to deposition, the glass substrates were cleaned with alcohol (C_2H_2OH) with purity (99.9%) and deionised water and dried. The D.C conductivity measurements for SnTe films $\theta^{\circ} = (0^{o}, 45^{o}, 70^{o})$ and film thickness t =(350) nm measured by using (Minitest 3000 supplied by Erichsen Germany company).

The thermoelectric motive force was measured by digital voltmeter, as a function of temperature difference. The Copper wires formed junctions between voltmeter with Aluminum electrodes on the film surface. Because

the Seebeck coefficient of Copper was much smaller than oblique film, we can ignore its effect in the results.
The thermoelectric power of films prepared at different conditions was measured. The difference in temperatures in range [300-398] K, for all samples deposited at different angles.

3-Results and discussion:-

1- D.C. Conductivity:

The conductivity of the film depends upon several factors such as the preparation technique, and parameters, doping agent, the temperature and even the measurement conditions. Therefore, the equation of change in conductivity with the temperature can be written as in equation (Arhinus)[9]:

$$\sigma = \sigma_{\circ} \exp(-E_a/k_B T) \quad \text{.....(1)}$$

σ_0 = relation constant
E_a = Activation energy
T = Absolute temperature
k_B = Boltzmannn's constant

According to the equation (1) when drawing (ln σ) vs (1/T) the slope equal $(-E_a/k_B)$, The activation energy value will be in units (eV) As follows [10]:

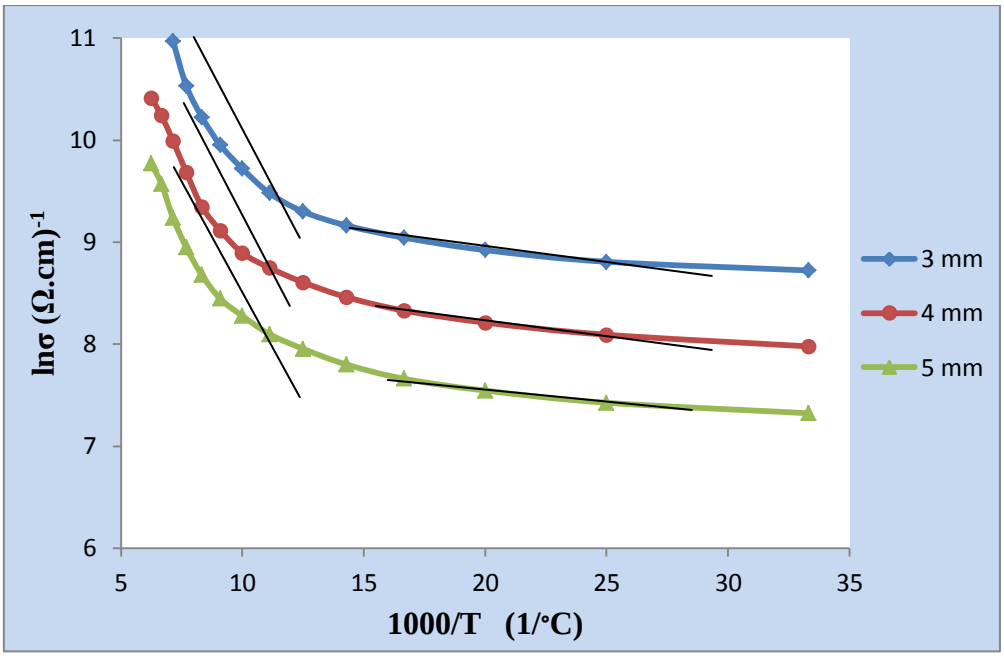
$$E_a = \text{slope} \times k_B \quad \text{..... (2)}$$

Figures (1) , (2) and (3) show the relation between (ln σ) and (1000/T) for (SnTe) films deposited at angles Θ= (0º , 45º, 70º) respectively , the thicknesses t = (350) nm and films width (3 mm , 4 mm , 5 mm),and table (1) show the value activation energy values of prepared films at different temperatures. It is noticed clearly from the figures that the conductivity decreases with increasing deposition angles for the user thermal range, also the conductivity increases with increasing temperature. This behavior means that the thin films are made from semiconductor material .

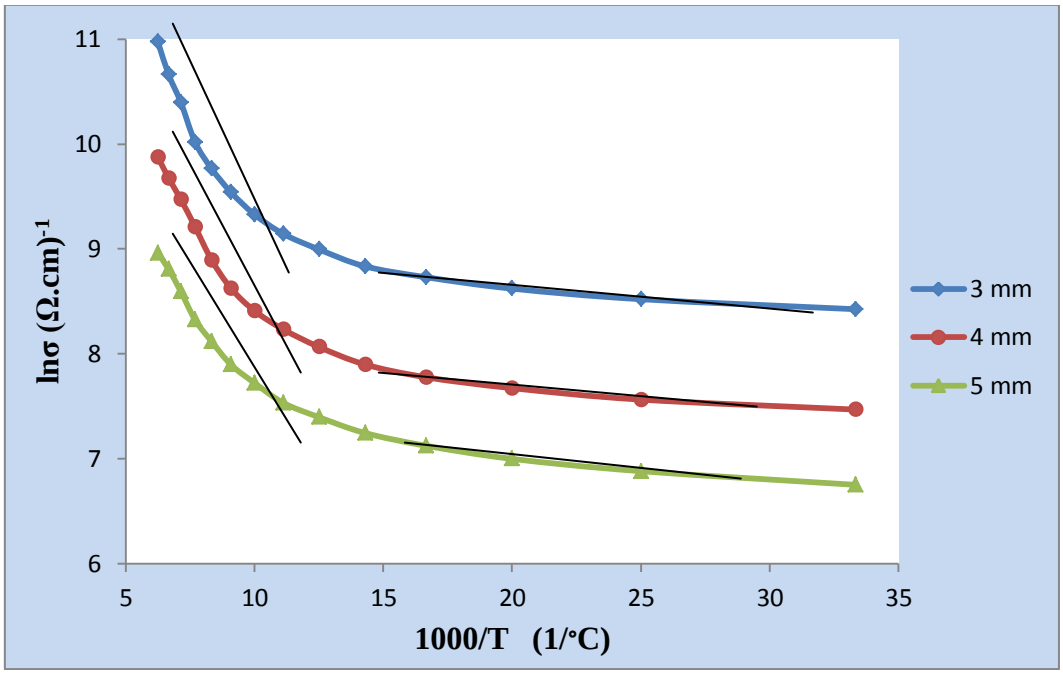
It was noticed that the conductivity decreases with the increasing of films width. influence the crystal structure and the columnar growth . When the angle increases the columnar growth and the voids between columns increase[11].

Table (1) shows the existence of more than one value of the activation energy, that is, the electrical conductivity has occurred by two methods: the first in a way bounced charge carriers raised between the restricted levels at low temperatures, either at high temperatures, the connection was carried out by charge carriers above and under the edge Kinetics .

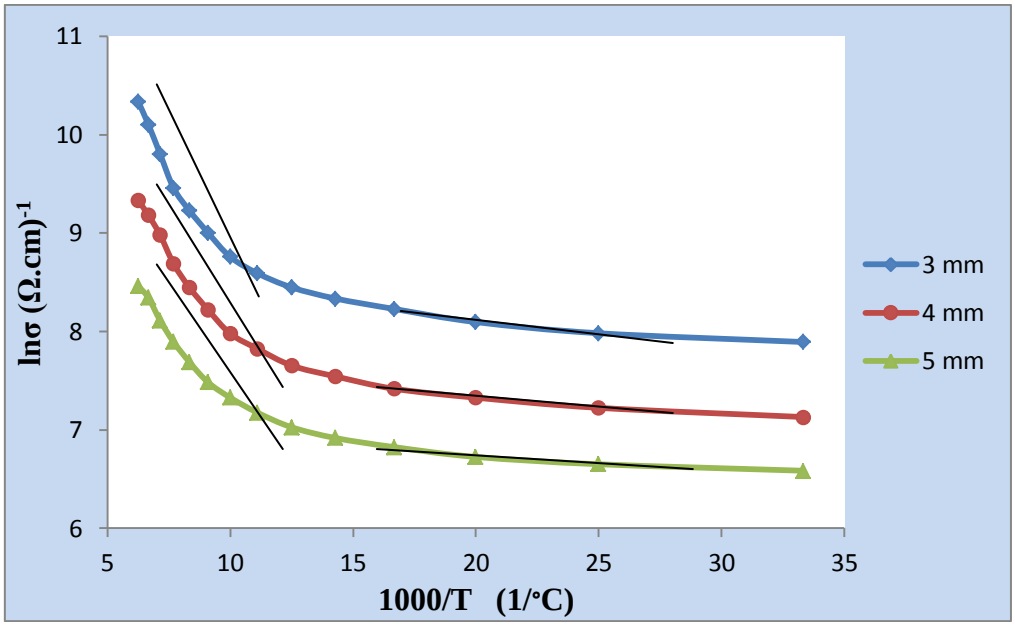
We can say that conductivity occurred by thermally Excitation , the conductivity relationship with temperature showed activation energy and were decreasing with increased deposition angles and films width .



Figure(1): The variation of D.C conductivity with temperature of SnTe films for deposition angle θ = 0°.



Figure(2): The variation of D.C conductivity with temperature of SnTe films for deposition angle θ = 45°.



Figure(3): The variation of D.C conductivity with temperature of SnTe films for deposition angle θ = 70°.

θ	E_{a1} (eV)			E_{a2} (eV)		
	3mm	4mm	5mm	3mm	4mm	5mm
0°	0.026	0.031	0.0347	0.0025	0.0023	0.0024
45°	0.025	0.03	0.0332	0.002	0.0021	0.00225
70°	0.024	0.029	0.0321	0.0016	0.0018	0.002

Tabel (1) : the values Activation energy and different deposition angles and films width

2- Thermoelectric power (Seebeck Coefficient):

Figures (4), (5) and (6), show the relation between Seebeck Coefficient (mV/K) and temperature difference (T) of (SnTe) films deposited at angles Θ= (0º , 45º, 70º) respectively , the thicknesses t = (350) nm and width films (3 mm , 4 mm , 5 mm) . Seebeck Coefficient increase with increasing the temperatures difference for all deposition angles of the user thermal range and that thermoelectric power value is positive and this agree with reference[12].

Also Seebeck Coefficient value increase with increasing deposition angle within the measured range. It was noticed that Seebeck Coefficient increase with the increasing films width because of the increasing resistance with decreasing the conductivity and this phenomenon has been to focus on and take advantage of them in the manufacture of reagents laser infrared high-efficiency [13].

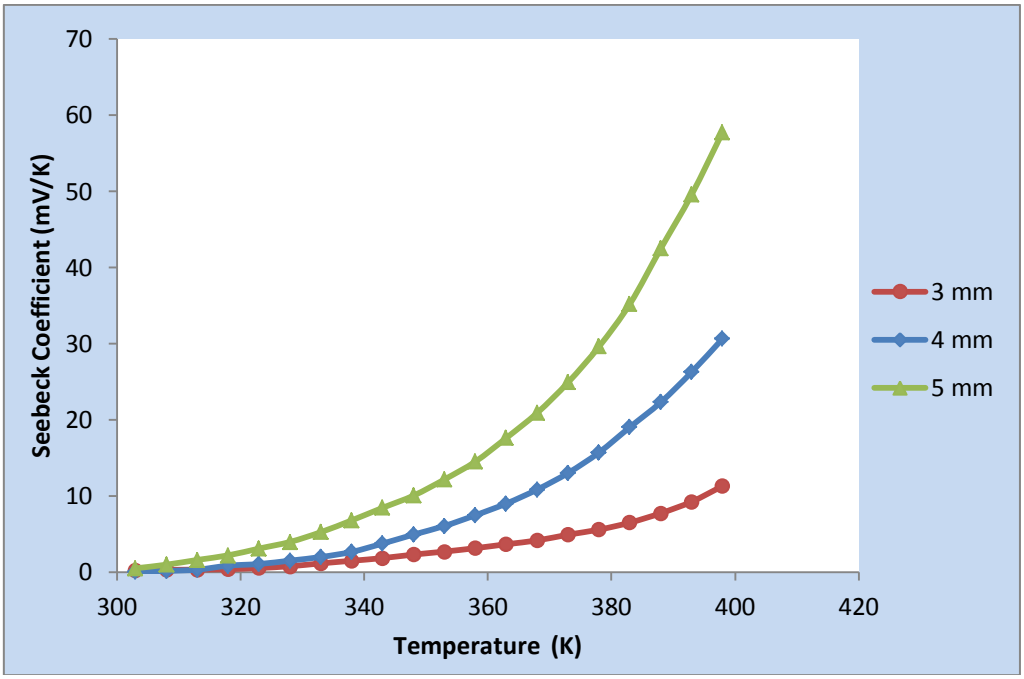


Figure (4): The variation of Seebeck Coefficient with temperature difference for SnTe films for deposition angle θ = 0°.

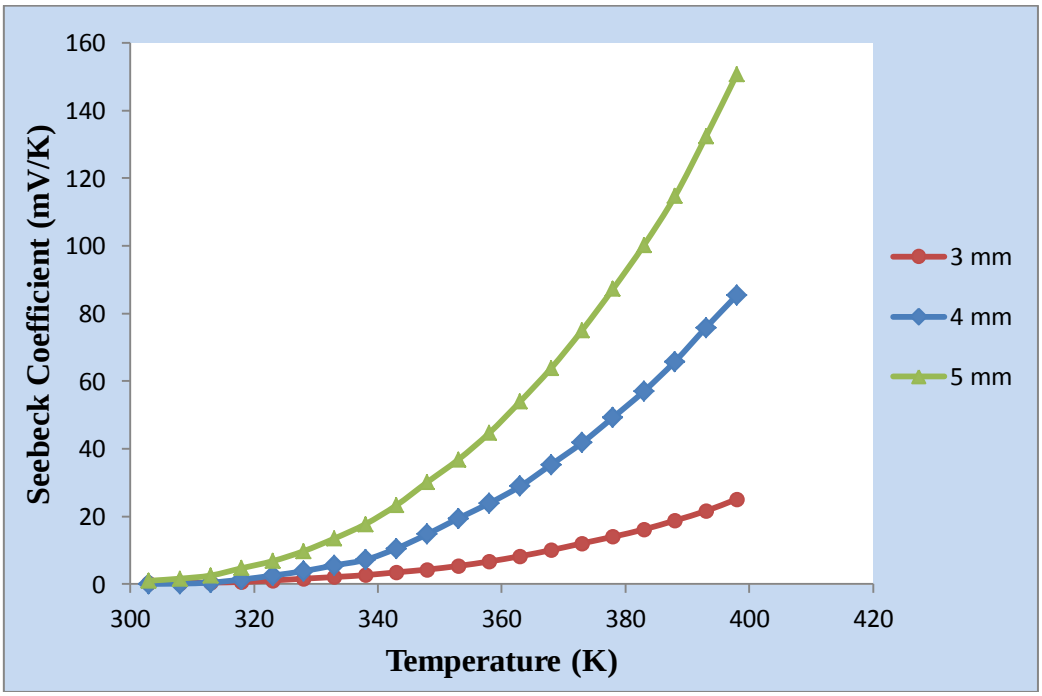


Figure (5): The variation of Seebeck Coefficient with temperature difference for SnTe films for deposition angle θ = 45°.

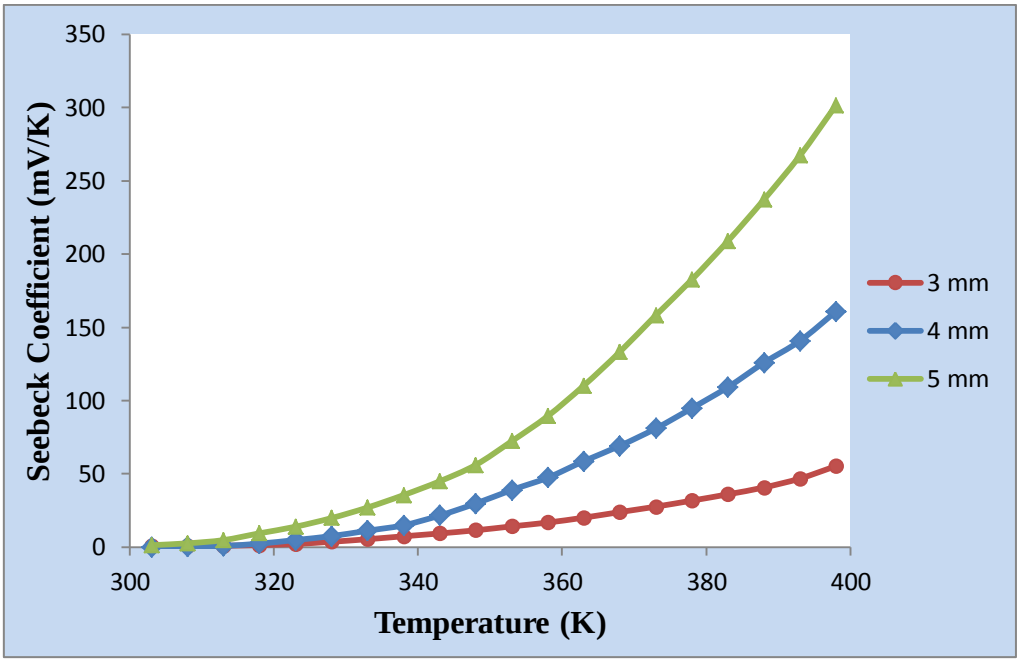


Figure (6): The variation of Seebeck Coefficient with temperature difference for SnTe films for deposition angle θ = 70°.

3 -Conclousions:-

Tin Telluride films were prepared by thermal evaporation method. The increasing of deposition angle has a great effect of increasing the Seebeck Coefficient and decreases the conductivity and the activation energy. Also the increasing films width has a great effect of increasing the Seebeck Coefficient, and decreasing the conductivity and the activation energy .

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