Studying the Conduction Mechanism of 5- Methoxy Indole -2 , 3- Dion (5- Methoxy Isatin) Films.

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Abstract

The work described in this article is concentrated on the preparation and analysis to examine the conduction mechanism of 5- methoxy Indole -2,3- dione (5-Methoxy Isatin) films by condensation method .

Electrical measurements including (current- voltage) and (conductivity- temperature) characteristics were studied in the temperature range (291- 343) K for specimens of compact disk form . Aluminum electrodes were used to connect the specimens with electrical circuit. Some related parameters namly electrical conduction of which the values varied between $4.5x10^{-10}$ to $2.7x10^{-9}$ s/ cm , trapping concentration (θ) varied between 23.07 to 8.8 and the activation energy (Ea) was 0.315 eV.

Hopping conduction mechanism seems to be the most probable of interpreting the behavior of charge transport that is supplied by injection of electrodes.

الخلاصة

ركز البحث على تحضير ودراسة اليه التوصيل الكهربائي لاغشية 5 – ميثوكسي استاين المحضر بطريقة التكثيف .

تضمنت الدراسة قياس ميزة (التيار – الفولتية) و التوصيلية كدالة الدرجات الحرارة ضمن المدى (291 – 343) كلفن . حضرت العينات بشكل اقراص لغرض القياسات الكهربائية ورسبت اقطاب الالمنيوم بواسطة تقنية التبخير وكانت التوصيلية تتراوح بين $4.5 \times 10^{-10} - 2.7 \times 10^{-9}$ 5 km وتركيز القانصات تتراوح بين 8.8 – 23.07 وطاقة التنشيط للعينة 0. 315 ev .

من خلال اختبار اليات التوصيل تبين ان الية القفز (الحموي) اكثر احتمالية لتفسير السلوك للتوصيل الكهربائي للعينات من اغشية 5 – ميثوكسي استاني.

Introduction

Organic semiconductors have attracted widespread research efforts in their use as an active materials in semiconductor devices. The unbeatable combination of characteristics such as simple synthesis technology ,easy to fabricate, relatively low cost materials, light weight and its deposition on different substrates , good conduction properties.The organic materials one of the most esirable of electrical and electronic applications such as a photovoltaic devices [1,2] and Schottiky barrier with metal or with inorganic semiconductor as well as the organic materials (isatin derivatives) have a great biological interest and have a wide range of industrial application and promising physical properties.

To our best knowledge, the electrical properties and conduction mechanisms of 5-methoxy isatin have not yet been studied for films over a wide temperature range.

In this article the results of an investigation of temperature dependence of electrical conductivity and concentration traps are described at temperature range (291- 343) K. and possible conduction mechanism in this region was also identified due to the available theories .

The elementary equation describing electrical conductivity σ [3] is

$$\sigma = nq\mu \quad \text{.................. (1)}$$

Where q is the elementary charge, n is the concentration of charge carriers and μ is their mobility.

Experimental

Sample preparation

Samples of 5- methoxy isatin were prepared by mixing three solutions which were prepared separately and then mixed together. These solutions are namely ; solution (1) dissolving 0.005 mol of para methoxy aniline and 23.5 ml of HCl in 6 ml of H_2O , solutions (2) by dissolving 0.02 mol of chloral hydrate and 0.291 mol Na_2SO_4 in 8 ml of H_2O and solution (3) dissolving 4.9 mol of hydroxyl amine hydrochloride in l0 ml of H_2O.The product mixture was heated to boiling temperature for 30 minutes.

Finally, the product was washed with cooled water and extracted by using 50 ml of other. The other solution was evaporated from the final product of 5- methoxy isatin. The preparation method of these compounds were discussed elsewhere [4] .The chemical structure of 5-methoxy isatin shown in fig.(1).

Several chemical analysis which confirmed the expected structure were carried out including spectrophotometer measurements (IR and NMR) the data was in good agreement with the reported value [4-6]

The Electrical Measurements

I-V Measurements have were out on disc shaped samples with an area 0.64cm^2 and the thickness ≈ 0.08 cm. Aluminum electrode was deposited by evaporation method under vacuum environment less than 10^{-4} torr.

Evaporation method was used in order to a void any air gap existing between the specimen and the metallic contact. Before measuring the specimen, heat treatment was performed by inserting the specimens into a augmented vacuum oven. Its temperature regradually from 40̊C to 100˚ C. It held at this temperature for 6 hours then cooled gradually up to the room temperature.

All measurements were carried out under down to 10^{-2} torr at temperature range (291- 343)K. Heating by Nicrome wire heater the temperature was measured by a thermocouple type copper constantan positioned near the specimen as shown in Fig. (2).

Results and discussion

The electrical properties of the samples are represented by measuring the electrical conductivity. The conductivity measurements were carried out on disc shapped bulk specimens of 5- methoxy isatin were measured by two point probes.

The current voltage (I-V) characterization of samples were measured for the sandwich configuration , at temperature range (291- 343)K. Fig. (3) shows the (I-V) characteristic of samples at different temperatures.

From Fig.3 , It can be seen that the current depends on the temperature and applied voltage i.e. the current increased as the applied voltage and the temperature increases.

The conductivity measurements of samples [7]were found according to

$$\sigma = \frac{d}{A}\frac{I}{V} \quad \text{.........} (2)$$

Where I is the current, V is the voltage , d is the thickness of samples and A is the area of samples.

The results indicate that the conductivity doesn't obey ohmic law because the charge carrier generation caused by thermal treatment less than the charge carrier supplied by the injected electrode. Therefore , different conduction mechanisms can be occurred to explain the charge transfer.

The dependence of conductivity on temperature is shown in Fig.(4). All curves can be divided into two regions at high temperature (region one) the conductivity follows the free carrier transition in extended states. When a temperature is lowered (region two) the conductivity may be explained according to the hopping through the defect state [8-9].

The conductivities are tabulated in Table 1

Table(1):The values of conductivity and traping as a function of its temperature

T(k`)	Θ	σ(S.cm⁻¹)
291	23.07	2.21
303	22.75	2.40
313	22.187	2.77
333	20	4
343	8.8	6

The trapping center (θ) can be calculated from the following relation namely Child's Law [3]

$$J = \in_r \in_o U_o \frac{v^2}{d^3} \ldots\ldots\ldots (3$$

Where J is the current density , V^2 is applied voltage ϵ_O and ϵ_r are the space permittivity and relativity permittivity to the material, d is the sample thickness and μ_o is the mobility of charge carriers.

When the trapping centers existed the equation (3) becomes

$$J = \frac{9}{8}\sum_r r \sum_o o \mu_o \theta \frac{v^2}{d^3}$$

Where $\theta = \frac{n}{n + n_\theta} = \frac{I_2}{I_1}$

Where n is the number of free charge carriers. And n_θ is the number of trapping charge carriers.

Figure (5) shows the dependence of θ on the temperature. The values of θ is tabulated in Table 1.

The activation energy also has been calculated ,It was 0.315 eV.

The study of conduction mechanism is very complicated, but it is possible to determine the more probabile of mechanism through the analysis of (1-V) characteristic and the behavior of conductivity as a function of thickness, temperatures and the field effect.

Fig. (6) shows the log. conductivity vs 1000/ $T^{1/4}$ and Fig (7) shows the log. conductivity vs 1000/$T^{1/3}$.

From Figures(6) and(7) the relation is linear and this confirms that the probability of hopping mechanism dominant [10]. However, the tunneling. mechanism is not possible because the thickness of the samples is high nearly 800 μm .Also, Schottky and Poole Frenkel mechanism are not dominate because relation between the conductivity and $E_{1/2}$ is not linear for high field.

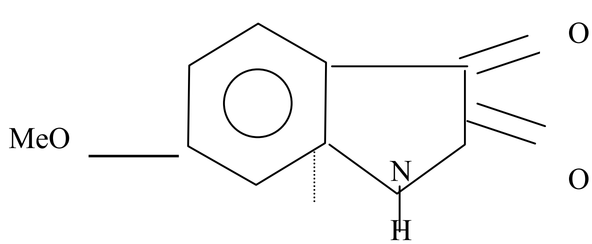


Fig.(1)The structure of 5-methoxy isatin

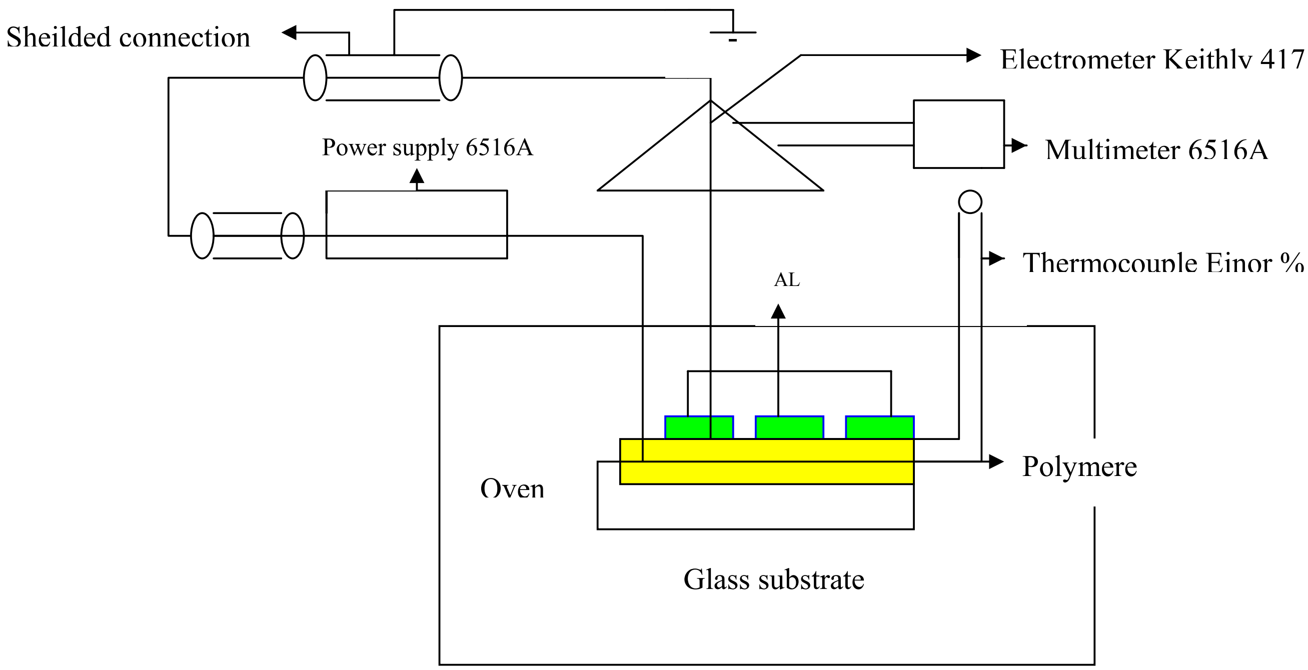


Fig.(2):Schematic of electrical measurment circut curent voltage (I-V) characterization of sample.

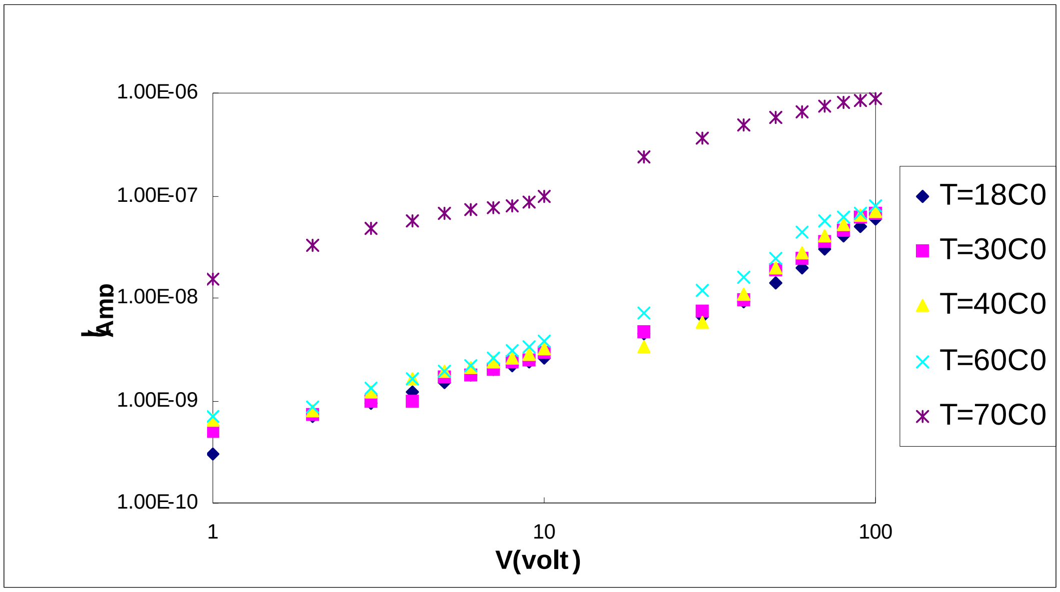


Fig.(3) relationship between current Vs>voltage sample at different temp.(18,30,40,60,70,) .

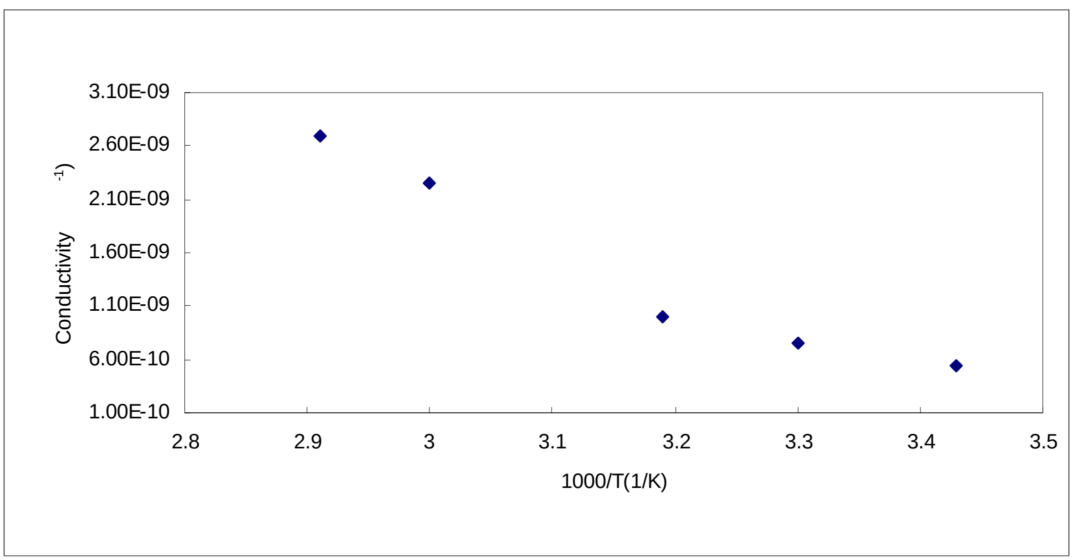


Fig.(4) The relationship between conductivity and (1000/T) for (18,30,40,60,70 ^{o}C).

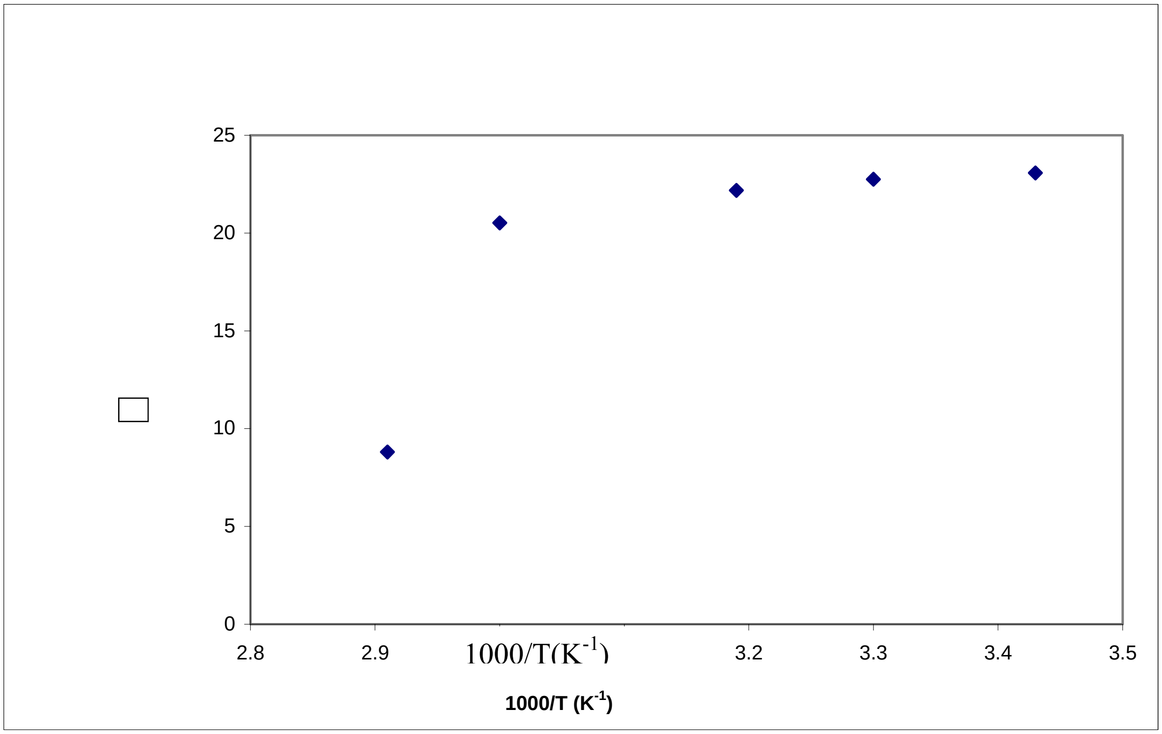
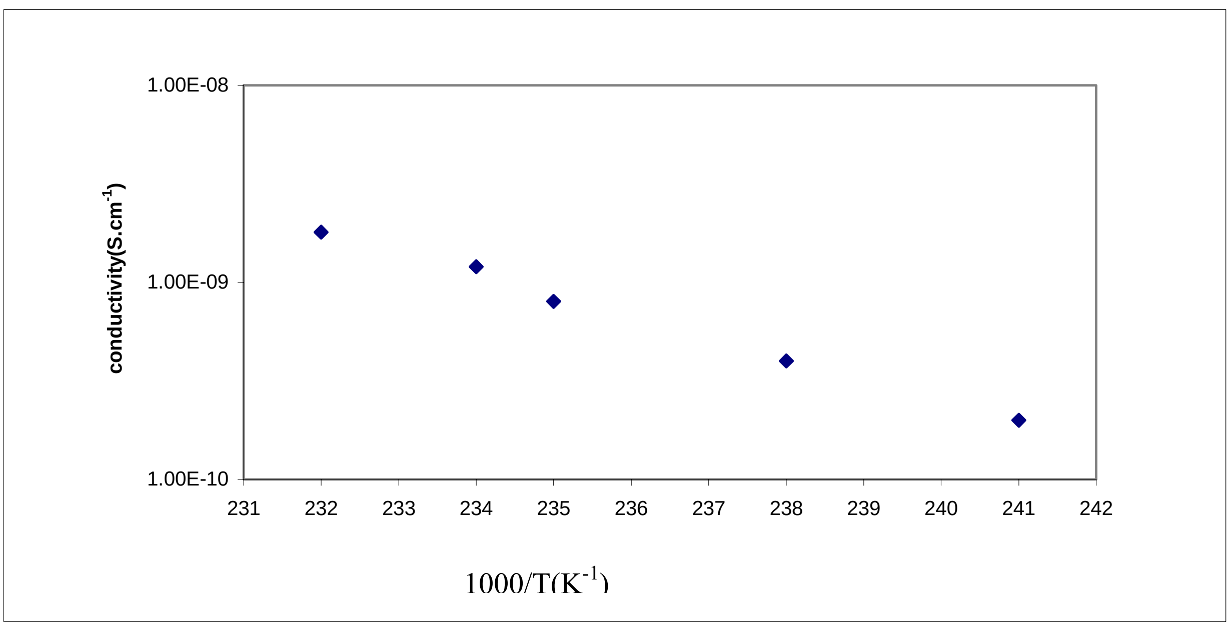


Fig.(5) The relationship between trapping center and 1000/T for (18,30,40,60,70 ^oC)



Fig(6) The relationship between conductivity and (1000/T) for (18,30,40,60,70 ^oC).

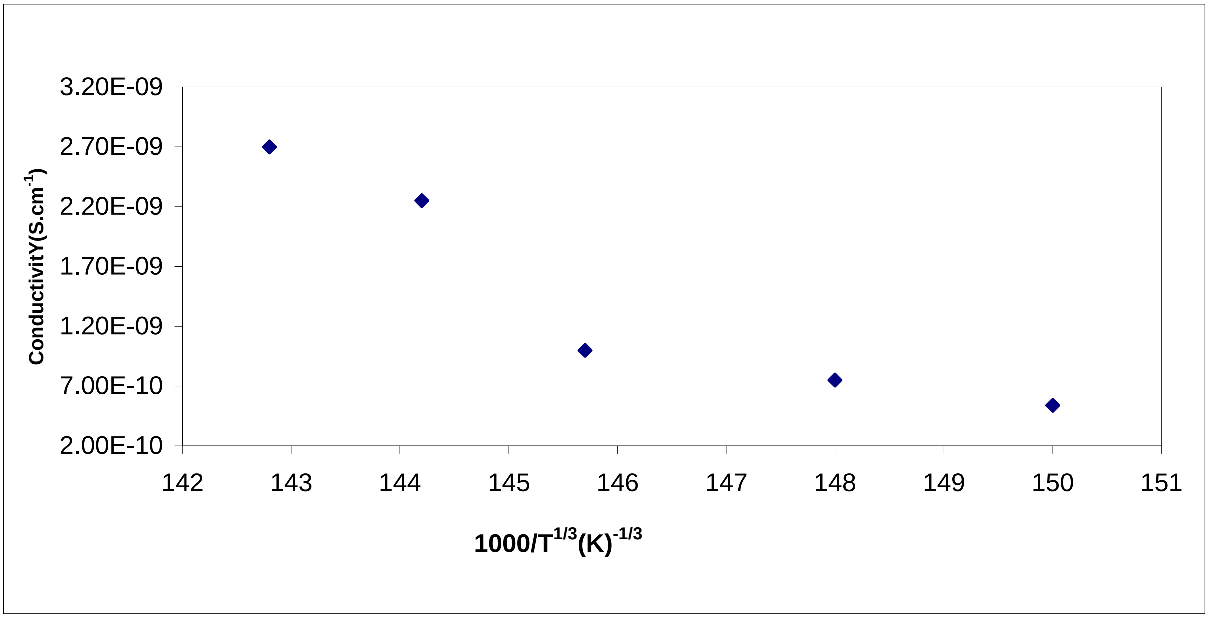


Fig.(7) The relationshp between conductivity and (1000/T) for (18,30,40,60,70 ^{o}C).

4- Conclusion

One can conclude that , the most probable conduction mechanism in this investigation was determined on the basis of current which depends on voltage and temperature. i.e. The electrical conductivity of 5- methoxy isatin increased as the temperature increasing. It is found that the hopping process mechanism is dominant. Also, the investigation shows that the (I-V) characteristics does not obey the general ionic relationships which is applied for ionic conduction.

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