I–V characteristics of 5,14-dihydro-5,7,12,14-tetraazapentacene by Zinc

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Abstract: - In this research, the current–voltage (I–V) characteristics of Zinc/5,14-dihydro-5,7,12,14-tetraazapentacenes (L_5H_2) doped surface-type structures were investigated in the air at ambient temperature. The conventional forward bias I–V methods were used to extract the diode parameters. The I-V profile demonstrates a rectifying behavior. Furthermore, the charge transport behavior was evaluated using the I-V conventional method and Schottky diode analysis. The current density-voltage (J-V) characteristics were evaluated in both dark and light conditions to determine the key parameters of the photovoltaic effect.

Key-Words: - Zinc/5, 14-dihydro-5,7,12,14-tetraazapentacenes (L_5H_2), a forward bias I–V method, Schottky diode.

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1 Introduction

The organic semiconductor is a type of material, which has recently drawn special attention in the field of electronics. It is a hybrid material that consists of both organic and inorganic materials. Organic semiconductors are having unique properties that make them stand out in the field of electronics. The key properties that are held up in their popularity are being low-cost, tunable optoelectronic properties, and high thermal stability. These materials are lightweight, flexible, and can easily be produced in large quantities, making them a cost-effective alternative to traditional inorganic semiconductors. Furthermore, organic semiconductors have a tunable optoelectronic behavior, which means that their electrical and optical properties can be controlled by changing the molecular structure [1-3]. Organic semiconductors have already found widespread applications in various electronic devices. One of the most popular applications of organic semiconductors is in the production of OLEDs (Organic Light Emitting Diodes). OLEDs are lightweight, flexible, and can be produced at a lower cost than traditional light-emitting diodes. Another application of organic semiconductors is in the development of organic solar cells that can generate electricity from sunlight. Organic photovoltaic cells have high power conversion efficiency and can be produced using low-cost materials. Other applications of organic semiconductors include organic thin-film transistors, organic field-effect transistors, and organic sensors. In conclusion, organic semiconductor materials are achieving popularity due to their unique properties, low cost, and tunable optoelectronic behavior. They have already been put into operation for various types of electronic devices such as OLEDs, organic solar cells, and organic transistors. The prospects of organic semiconductors are promising, and we can expect to see them being used in a variety of electronic applications in the future [4-6]. The usage of organic semiconductors is expected to grow in the coming years. Many research groups have been working on developing advanced organic semiconductors that have even better properties than the current ones. Some of the areas where organic semiconductors are expected to find applications in the future include flexible electronics, wearable electronics, and printed electronics.

5,14-dihydro-5,7,12,14-tetraazapentacene (L_5H_2) with molecular formula $C_{18}H_{12}N_4$ was used for the fabrication of Schottky diodes. The molecular structure is shown in Fig. 1.

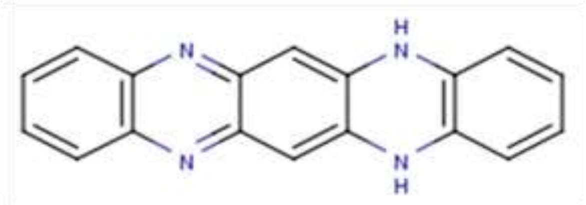

Fig 1. The structure of 5,14-dihydro-5,7,12,14-tetraazapentacene (L_5H_2)

Zinc/5,14-dihydro-5,7,12,14-tetraazapentacenes is a complex molecule consisting of a Zinc ion bonded to a molecule of 5,14-dihydro-5,7,12,14-tetraazapentacene, which is an organic compound with a fused five-ring structure containing four nitrogen atoms. It has potential applications in organic electronics as a catalyst. This molecule has potential applications in electronic and optoelectronic devices due to its unique properties.

2 Materials and Methods

2.1 Sample Preparation

The thin films of L_5H_2 and Zinc were deposited by evaporation from a resistive heating element in an oil-pumped vacuum system onto the Indium Tin Oxide (ITO) glass substrates. ITO is a mixed oxide of indium and tin with a melting point within the range of 1526–1926°C (1800–2200 K, 2800–3500 °F), depending on composition. ITO is a transparent, conductive oxide. It has several electrical properties; including having a high electrical conductivity, and being an ideal material for conducting electricity in electronic devices. ITO has a rather low resistance in a way that allows it to be used in electrodes for a variety of devices. A schematic view of the sample is shown in Fig. 2 [7-10].

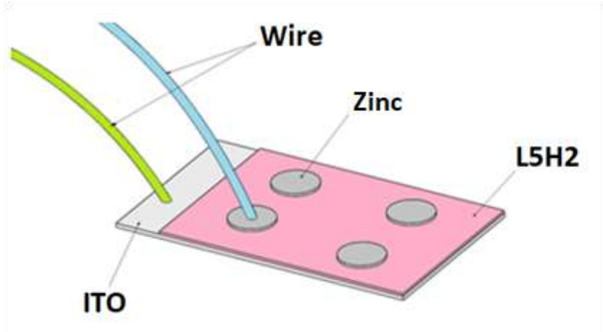

Fig 2. A schematic view of a sample

I-V measurements were carried out on the sample using a Keithley 230 Programmable Voltage Source and a Keithley 485 Pico-Ammeter.

Applying the OLEDs technology has caused the efficiency and lifetime of white OLEDs to reach the maximum level. The new technology of OLEDs has taken over other semiconductor display devices because of having striking feature [11-12].

3. Results and discussion

The plot of I-V for the Zinc/5,14-dihydro-5,7,12,14-tetraazapentacenes (L_5H_2) contact shows rectification characteristics (Fig 3). The rectification ratio in a diode is the ratio of the DC (direct current) output voltage to the AC (alternating current) input voltage of a diode rectifier circuit. It is a measure of how well the circuit can convert AC input to DC output with minimum ripple. The rectification ratio is calculated as the average value of the output voltage divided by the maximum value of the input voltage. The higher the rectification ratio is, the better the diode can convert and smooth out the AC signal. The range of rectification ratio in a diode is the ratio between the number of charge carriers crossing the PN junction in the depletion region during forward biasing and the-number of carriers diffusing across the junction during reverse biasing. It indicates the rectifying efficiency of a diode, which means how well it blocks the flow of current in one direction and allows it towards another. The higher the rectification ratio, the better the rectifying efficiency of the diode will be. The calculated rectification ratio is 1 at 17°C at room temperature.

Series resistance in a diode refers to the resistance presented by components in series with the diode in a circuit. This may include resistors or other components that are placed between the voltage source and the diode. Series resistance can affect the behavior of a diode, particularly in terms of the voltage drop across the diode and the amount of current that flows through it. Some factors such as the value of the series resistance may cause the forward voltage of the diode to drop, and the applied voltage can all impact the behavior of the diode in a series circuit. The series resistance is $4.1 \times 10^4 \Omega$.

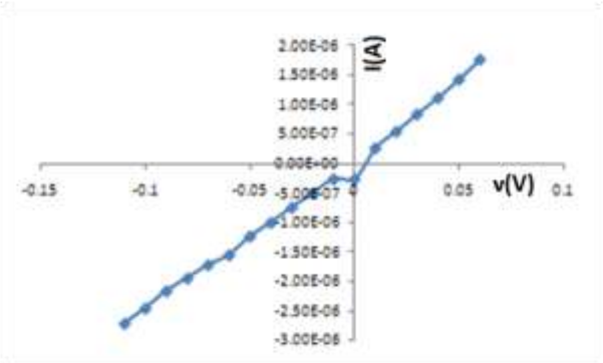

Fig 3. I-V Characteristic curve of Zinc/5, 14-dihydro-5,7,12,14-tetraazapentacenes (L_5H_2)

4 Conclusion

In this paper, the rectification ratio is 1. It means that the output voltage of the rectifier is equal to the input voltage. On the other hand, there is no change in the voltage level, and the rectifier has not rectified the alternating current (AC) signal. Also, when the series resistance in a diode is high, it means there is a significant amount of resistance in the circuit that limits the current flowing through the diode. This can result in a reduction in the amount of current that can flow through the circuit, which may impact the overall performance of the circuit. In practical terms, a high series resistance can result in reduced power output, slower response times, and increased heat distributed in the diode. Although 5,14-dihydro-5,7,12,14-tetraazapentacenes (L_5H_2) is a semiconducting material, when it is connected with zinc metal, it shows ohmic behavior according to Fig 3. In case, aluminum metal shows non-ohmic behavior for the Schottky diode.

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Contribution of individual authors to the creation of a scientific article (ghostwriting policy)

Hassan Ghalami Bavil Olyaee has carried out all of the scientific works belonging to this research consisting of calculations, simulation, and extraction of the results.
Seyed Alireza Mousavi Shirazi has organized the paper.

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