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CONDUCTIVITY OF HOLY(3-HEXATHIOPHENE) AND ITS APPLICATION TO ELECTRICAL DEVICES

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Abstract Spectroscopic and conductivity measurerents were made in order to find if holy(3-hex athiophene) can be used in electrical devices.

INTRODUCTION

The key advantage of the organics are their structural diversity, case of fabrication and potential low cost. The recent improvements in the processibility of conducting polymers have multiplied their prospective uses.[1] Poly(3-hexathiophene) belongs to the polythiophenes family (PT) which was the first class of polymers chemically stable in air and in moisture in both their doped and undoped states. Its stability and good processibility suggested its application to electrical devices.[2]

EXPERIMENTAL WORK ON POLY(3-HEXATHIOPHENE)

Preparation of the Polymer

In order to polymerize the 3HT monomer the ferric chloride method was used.[3]

UV Spectroscopy

Ultraviolet spectroscopy was used to find the energy to promote electron from Π-Π^* levels in P3HT. It was made on P3HT undoped solution. The exact stored data values were used to make the graph $\left[\frac{A}{\lambda}\right]^2$ against $\left[\frac{1}{\lambda}\right]$ to find E_p. The obtained value for E_p in undoped polymer

was 2.45eV. The relationship $\left(\frac{A}{\lambda}\right)^2 \alpha \left(\frac{1}{\lambda}\right)$ indicated also, that the inter band absorption was a fully - allowed direct (Π-Π^*) transition.

The same spectroscopic measurement was made on P3HT film doped with I_2 vapour. The spectrum for the doped film showed the existence of the third polaron band (fig.2). Using the same method as for P3HT solution the E_p for doped film was found to be 2.06eV and the third polaron band E_3 was 1.36eV. UV spectroscopy results gave evidence for polarons in the polymer chain structure, caused by doping P3HT with I_2.

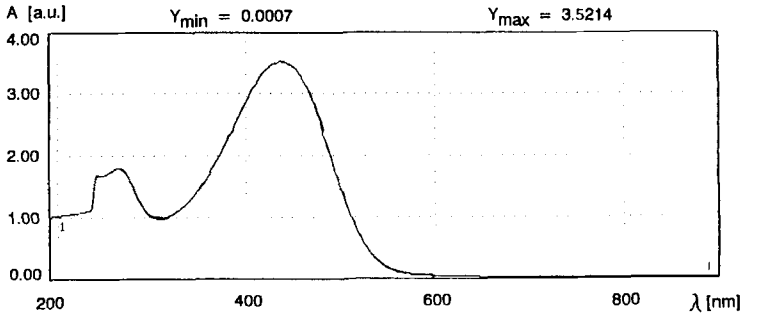

FIGURE 1. UV spectrum for undoped P3HT solution

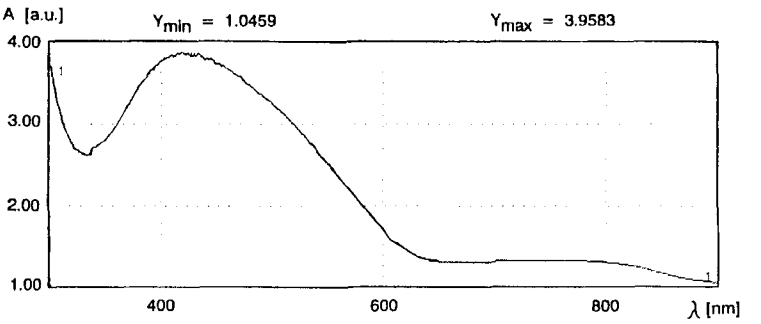

FIGURE 2. UV spectrum for P3HT film doped with I

The UV spectrum produced was run from UVIKON 940.

FTIR Spectroscopy

The spectrum of two samples of P3HT was measured using

Perkin-Elmer infrared spectrometer. Both samples were in a from of thin film cast on the silicon slice (silicon is transparent for infrared). One sample was doped with I_2 for 7 hours and then 5 measurements were taken within 2 weeks. The second sample was undoped.
The infrared spectra were used to calculate the relative intensity of the first polaron band. For the u doped film the relative intensity was 5.57E-3. For the doped sample the relative intensity was quite stable for the first week and it was about 6.0E-2, then it decreased to 3.4E-2 and again was stable during the next week. Taking these results into consideration, the life-time for the sample doped with I_2 is about one week, after this time its properties changes. As the I_2 was removed, moving of the peak to lower energy was observed.
This fact indicates that polaron band was closer to the valence band.

Conductivity Measurements

The conductivity measurements were taken using the Van der Pauw method.[4] The samples were in a from of thin film cast on glass slides. The conductivity of undoped P3HT was found to be 2.94E-5 Sm^{-1}. Then the sample was left in I_2 vapour for one night. The conductivity of P3HT doped with I_2 increased to 2.18 Sm^{-1}.

Hall Effect

The trials were made to measure Hall effect using the undoped sample but the resistance was too high (about 40 GΩ). After doping with I_2 for one night the current could reach the value of 10mA and Hall mobility was measured. The obtained value for Hall mobility was 1.007E-3 $m^2V^{-1}S^{-1}$ and Hall coefficient was 0.4616E-3 m^3C^{-1}.
The sample was doped again, this time for a few days. After that, the resistance increased rapidly. Probably,

it was too much doping which damaged the polymer structure.

Both conductivity and Hall effect measurements were made using the computer program.

pn Junction

Because the results for spectroscopy and conductivity measurements were quite promissing, the pn junction was produced. It was made on a silicon slice. The silicon was covered with P3HT, then it was doped with I_2 and gold dots were evaporated on the surface. pn junction shows a good I-V characteristics and using the curve fitting method (Fig.3) the values for the series resistance and built in potential were obtained. The series resistance for pn junction was 15695 Ω and built in potential 92.626V.

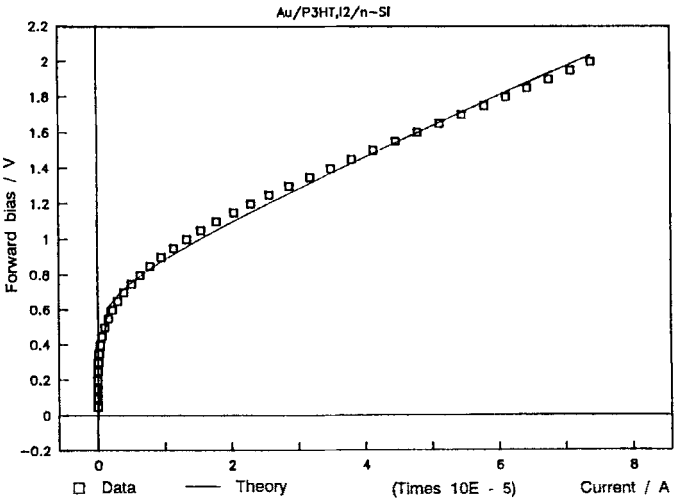

FIGURE 3. Curve-fit the pn junction I-V characteristics

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