Electrical properties of Fullerene with different concentrations of MEH-PPV

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ABSTRACT

This work is one of a series of assessments on various areas of the solar cells as renewable energy , we prepared 3 samples of organic photovoltaic cell devices by using (polymer and fullerene) MEH-PPV/C_{60} composites with different concentrations of polymers and characterized by short- circuit current and open- circuit voltage, for Fullerene of weight 0.304g with changing the concentrations of MEH-PPV (0.0549,0.0529,0.0509)g shows that the efficiency increases in the range with increasing concentration of polymer(MEH-PPV) of (0.064-0.051).This means that increasing concentration of MEH-PPV, increases efficiency due to the increase of carriers concentrations as shown by theoretical relations since they acts as a donor and a acceptor respectively.

Keyword : *polymer solar cells, conjugated polymer, doping, fullerene*

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1. INTRODUCTION

Polymer solar cells (PSCs), considered as a promising source of renewable energy[1], have at-attracted much attention because of their low-cost, compatibility with flexible substrates and large-area applications[2-3].

The discovery of much of the new exciting chemistry and physics in the field of conducting polymers [4-5], it is possible to control the electrical conductivity of polymer over the range from insulating to highly conducting (metallic)state. This process is referred to as doping.

In the solid state physics terminology, the use of an oxidizing agent corresponds to p-type doping and that of a reducing agent to n-type doping. The oxidation or reduction of the polymer can be achieved electrochemically by subjecting the polymer to the appropriate oxidizing or reducing voltage in an electrochemical cell.

In this work, we report the fabrication of an organic photovoltaic cell utilizing poly[2-methoxy,5-(2'-ethylhexyloxy)-1,4-phenylene-vinylene] (MEH-PPV) and C_{60} composites with various concentration of MEH-PPVand give the characteristics of the device. We observed the incident light intensity dependence of the short circuit current (I_{sc}) in a device with a 0.304g (weight of C_{60})[6].

2. EXPERMINTAL

All the devices were fabricated on patterned indium tin oxide (ITO) coated glass the spin coating is a process for creating thin polymer films from solution. A drop of the polymer solution is dispensed onto a substrate, which is held fixed by means of vacuum onto a substrate holder (disc). The disc with the sample is then rotated at a high speed and the spinning motion of the substrate causes the solution to spread out and form a thin solid film on the substrate.

Bulk-heterojunction solar cells were prepared with different concentrations ratios between polymer/ fullerene and ranging from the ratio of 0.0549,0.0529,0.0509 g of polymer and 0.304g for fullerene using chloroforms as solvents. The devices were characterized by current-voltage curve and measurements of the electrical properties for the different sample .

A polymer solar cell is a layered structure consisting of an active layer sandwiched between two electrodes Figure 1. The bottom electrode (anode) is transparent, usually indium tin oxide (ITO) on glass, covered with a thin film of a conducting polymer poly(2-methoxy, 5-(2'-ethyl-hexoxy)-1,4-phenylene vinylene)MEH-PPV doped with fullerene C_{60}. The layer of MEH-PPV/C_{60} smoothens ITO surface and helps to prevent short-circuits due to spikes in the ITO. The active layer, i.e. a thin film, is usually obtained by spin coating the active materials from solution directly onto the ITO/MEH-PPV:C_{60} surface. The top electrode is a Sliver (Ag).

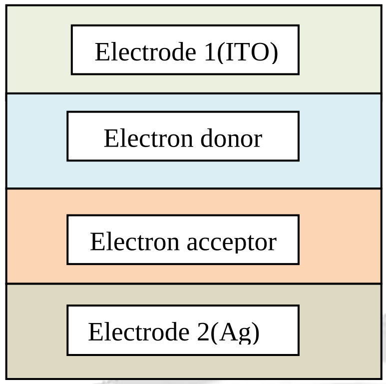

Figure1diagram of Bilayer solar cell device

Since we are interested in studying electrical and optical properties of polymer solar cell we chose the polymer and fullerene for the novel properties The polymer studied was MEH-PPV provided by American Dye Source. MEH-PPV is an orangish-red colored, luminescent polymer easily solvable in common organic solvents, and prepare 3 sample with different concentrations by using a chloroform as the solvent, at first the ratio of fullerene C_{60} is fixed 0.0304 and changing the ratio of MEH-PPV as(0.0549,0.0529,0.0509)g. it were spin-coated All the devices onto indium tin oxide (ITO) (round on about two minutes) coated glass substrates with polymer as donor and fullerene accepter and the intensity of light is about 1000W from Sodium lamb. photovoltaic cell. The OPV device output current was measured using I-V characteristics curve.

3. RESULTS AND DISUCTIONS

For the organic solar cells fabricated using MEH-PPV as the electron donor and C_{60} as the electron acceptor, with structure of ITO/MEH-PPV: C_{60} /Ag. three samples were prepared at different concentrations of polymer**.**
The electrical circuit used to measure I-V curves as shown in diagram in figure (2,3,4). By varying the resistance of the potentiometer the voltage across the cell can be found. The advantage of this circuit is due to measuring the output. The intersection with the voltage axis (I = 0) is the open circuit voltage while the intersection with the current axis (V = 0) is the short circuit current. This measurement also gives us the maximum power, fill factor and efficiency table1.

Voltages and currents were written down in table by taking reading from the multimeters. Electrical contact was made using two small, silver clips. An improved method of characterization would be to automate the generation of an I-V curve using a combination of software and hardware.
Table.1performance for C_{60}/MEH-PPV solar cell for C_{60} concentration 0.0304 with different concentration of MEH-PPV

No	Sample C_{60}/MEH-PPV	I_{sc}	I_{oc}	V_{oc}	V_{mp}	P_{max}	FF	η
1.	0.304/0.0549	29.80	26.36	0.1411	0.1389	3.6614	0.8708	0.064
2.	0.304/0.0529	22.44	20.92	0.1532	0.1480	3.0961	0.9003	0.055
3.	0.304/0.0509	23.90	22.05	0.1526	0.1492	3.2898	0.9021	0.051

A solar cell is characterized on a basic level by the graph of its current as a function of voltage, known as its I-V curve. An example of such a graph is shown in Figure (2.3,4) for different concentrations of MEH-PPV. From these graphs a few important performance parameters can be extracted, mainly the open circuit voltage, short circuit current, fill factor, and maximum power ,efficiency. Open circuit voltage is the voltage the cell produces when it is sourcing no current and represents the maximum voltage of the cell. The short circuit current is the current the cell can produce when the two electrodes are shorted together(V= 0).
The power is the product of voltage and current, the point on the graph that forms the largest rectangle with the two axes represents the point of maximum power output. Maximum power that is.

$P_{max} = I_{mp} V_{mp}$

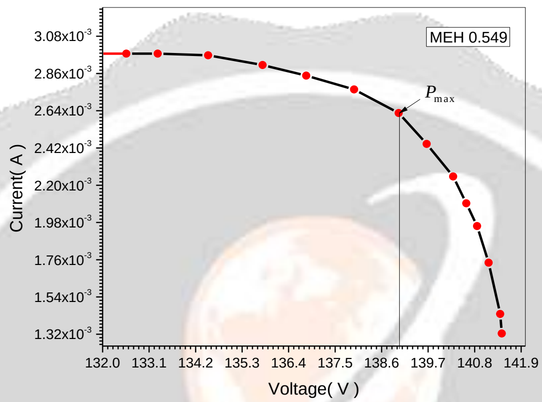

Figure 2 the I-V characteristic the graph shows I-V curves for C_{60}=0.304g with MEH-PPV =0.0549g

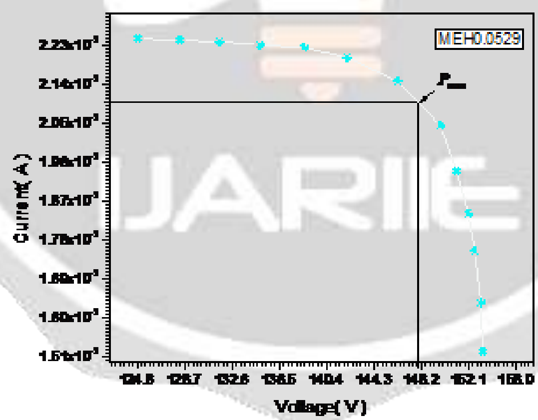

Figure .3 the I-V characteristic the graph shows I-V curves for C_{60}=0.304g with MEH-PPV =0.0529g

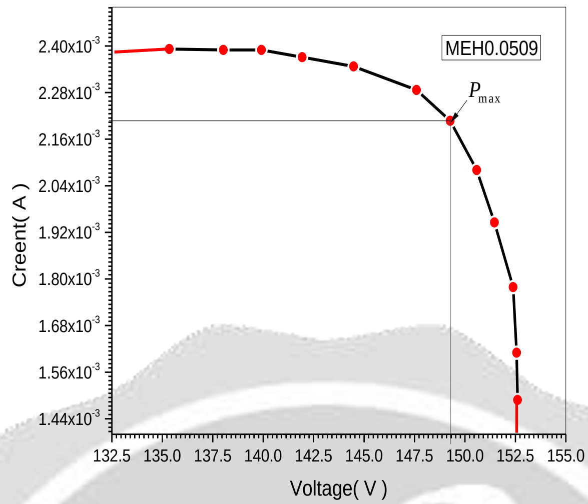

Figure .4 the I-V characteristic the graph shows I-V curves for C_{60}=0.305g with MEH-PPV =0.0509g

4.CONCLUSION

The basic goal of a photovoltaic device is to convert energy in the form of light to energy in the form of electricity. The samples were prepared with the concentration of Fullerene 0.304g is fixed and the concentration of MEH-PPV is varied from(0.0549,0.0529,0.0509)g. The results show that the efficiency obtained is in the range(0.051-0.064%) as shown by figure (2,3,4).Thus increasing MEH-PPV concentrations increases the efficiency a cordoning to the theoretical relation.

The studies show that the polymer solar cells photovoltaic response of conjugated polymer -fullerene materials can be significantly enhanced through electrical characterizations.

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6.REFERENCES

[1] Liu Xiao-Dong, Zhao Su-Ling, Xu Zheng,Zhang Fu-Jun, Zhang Tian-Hui, Gong Wei, Yan Guang,Kong Chao, Wang Yong-Sheng, and Xu Xu-Rong ,2011,Performance improvement of MEH PPV:PCBM solarcells using bathocuproine and bathophenanthroline as the buffer layers.,
[2] Yu G, Gao J, Hummelen J C, Wudl F and Heeger A J, ,2009,*Science* 270 1781995
[3] Dennler G, Scharber M C and Brabec C J , Adv.Mater. 2009,21 1323
[4] K. Gurunathan*, A. Vadivel Murugan, R. Marimuthu, U.P. Mulik, D.P. Amalnerkar,1999, Electrochemically synthesised conducting polymeric materialsfor applications towards technology in electronics,optoelectronics and energy storage devices.
[5] Proceedings of the International Conference on ConductingPolymers, J. Phys. (les Ulis Fr.) 44, C3 1983.
[6] Heejoo Kim, Jin Young Kim and Kwanghee Lee, ,2000, Conjugated Polymer/Fullerene Composites as a new class of optoelectronic material: application to organic Photovoltaic cells.