Preparation and Characterization of Polymer Solar Cell

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ABSTRACT

The various energy constraints dictated by a series of global economic and environmental social factors require the international scientific community to find viable alternatives to conventional energy sources. Renewable energies such as photovoltaics is among the most coveted and developed energy sources worldwide. Technology of inorganic semiconductor-based silicon and other developed considerably and responds more to the desired energy goals Technology of inorganic semiconductor is very expensive and requires considerable resources making it limited to the most powerful country in the world The technology of organic semiconductor is much easier and more accessible which promises a very bright. It can be considered as a real alternative for countries with limited resources for the widespread use of solar energy. This research is in the field of preparation and characterization of organic solar cells based on semiconducting polymers. After having carried out a scientific statement on the technology of organic semiconductors have been able to achieve in collaboration with the Department of Industrial Chemistry a multilayer organic cell where the polymer is polyaniline. The disadvantage of this type of solar cells is its low efficiency. The cell we have developed to present a comparison of the performance the literature. This technology must be improved to increase its performance may not be on inorganic cells but enough to meet domestic needs.

I. Introduction

Organic solar cells possess many advantages [1,2]. In the conversion process of sunlight energy into electricity in the organic solar cell, the same processes can be distinguished [2,3]. The efficiency of solar cell is a product of the efficiencies of particular processes [2,4,5], and can be improved by incorporation of nanoparticles into the active layer.

Organic semiconductor materials carry a potential for development in the search for photovoltaic modules relatively low cost for the production of domestic electricity. Unlike inorganic silicon cells and other. The organic photovoltaic cells can be fabricated more easily and on flexible substrates, allowing them various applications.

Recently, the research on organic photovoltaic (PV) devices has made significant progress. However, the achieved organic photovoltaic power conversion efficiencies are still lower than those of inorganic solar cells. The main limiting factor of the high-efficiency organic PV devices realization is the short exciton diffusion length in most organic semiconductors (typically a few nanometers). Currently, donor–acceptor (D-A) bulk heterojunctions (BHJs) fabricated by controlling phase separation in D-A mixtures are widely utilized to avoid such an exciton diffusion bottleneck [6].

Fadila Tahiri et al [7], present a theorical study of the Predictive Vector PWM-based Couple Direct Control (DTC-SVM-predictive) of a permanent magnet synchronous motor (PMSM) powered by a photovoltaic (PV) source for improving the torque and flow of a PMSM using the DTC-SVM-Predict command

Our goal in this work is the realization and characterization of organic solar cell Schottky whose constitution is as follows (SnO2:F/poly thiophène / AL) And allso conversion efficiency of this organic photovoltaic cell type.

II. Organic Semiconductors

An organic semiconductor is an organic compound, in the form of a crystal or a polymer, which shows properties similar to semi - inorganic conductors. These properties are the conduction by electrons and holes, and the presence of a band gap. These materials have resulted in organic electronics or plastic electronics [8]. By organic is meant that the molecules used are carbon-based, is said organic versus inorganic semiconductors, such as silicon. The organic semiconductor p-type (electron donor), may be mentioned:

- Le Tétracène, l'Anthracène
- Le Polythiophène
- Le P3HT - poly(3 – hexylthiophène)

MDMO - PPV – poly [2 – méthoxy – 5 - (3, 7 – diméthyloctyloxy) – 1, 4 – phénylène – vinylène]

MEH-PPV – poly [2 – méthoxy – 5 - (2 – ethyl - hexyloxy) - 1, 4 - phénylène-vinylène]

PEDOT – poly (3, 4 - éthylènedioxythiophène)

- PEDOT : PSS – poly (3, 4 – éthylènedioxy thiophène) : poly (styrène sulfonate)

Les polymères semi-conducteurs de type n (accepteurs d'électrons) on peut rencontrer :

- Le Fullerene
- Le PCBM - [6, 6] – phényl – C61 – butyrate de méthyle
- Le PCNEPV – poly [oxa – 1, 4 – phénylène - (1-cyano – 1, 2 – vinylène) − (2 – méthoxy – 5 - (3, 7 – diméthyloctyloxy) - 1, 4 – phénylène) – 1, 2 - (2-cyanovinylène) - 1, 4 – phénylène] [9].

III. Electronic Representation of Organic Materials

The valence band (BV) groups HOMO states: it is full at zero temperature. The conduction band (BC) groups LUMO states, it is empty at zero temperature. The evolution of the HOMO energy levels (Highest Occupied Molecular Orbitals) shows the levels of highest occupied energy and LUMO (Lowest Unoccupied Molecular Orbitals) represents the lowest energy levels unoccupied) of an organic semiconductor system. The area between the BV and BC is called band gap "gap" is characterized by its width Eg . For semiconductor gap width is between 0 and approximately 2 to 3 eV. (Figure 1) .

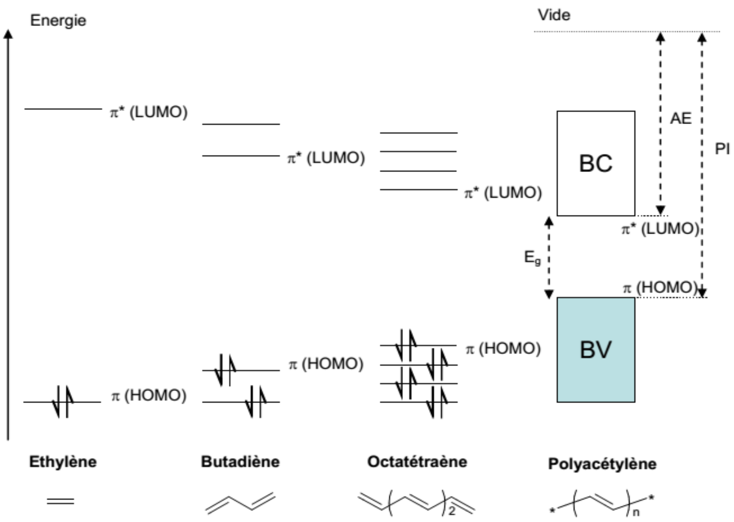

Figure 1: The energy levels of materials organic semiconductors [9]

At zero temperature, BV is completely filled and BC is empty. The charge carriers can be activated by various stimuli, from thermal or optical. For the insulation of the gap, width is greater than 4 eV. In keeping the width of gap, thermally excited carriers in BC is very difficult [10].

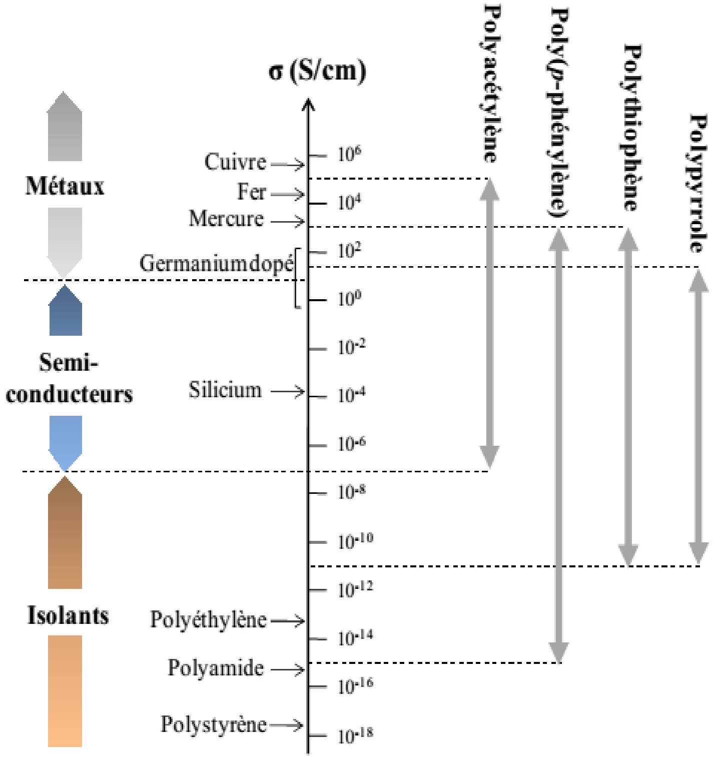

Figure 2: electrical conductivity of different materials at 300 K [10].

As in the case of inorganic semiconductors semiconductors polymers have forbidden bands of varying widths depending on the type of polymer areas. The diagram of Figure 2 shows some energy levels highlighting the gap polymers.

Mainly, in operation of the photovoltaic cells in the initial step is the penetration of light into an organic photovoltaic converter and the final step in which electrons are collected by the electrodes. Several intermediate physical processes occur in succession from the beginning to the end of photovoltaic conversion. These processes determine the effectiveness of the photo conversion system. The current low yields is due to the mechanisms involved in the organic photovoltaic effect [11].

IV. Experimental

VI.1. Characteristics of Organic Solar Cells

The structure of a photovoltaic cell should have essentially the active part that performs the process of converting optical power and electrodes to recover the electric charges released from the photon excitation, all deposited on a rigid or flexible support called substrate as shown in the diagram of Figure 3.

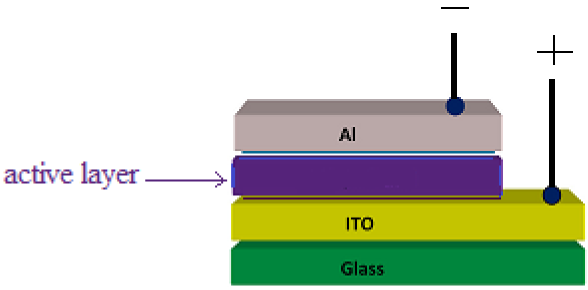

Figure 3: Structure of an organic photovoltaic cell

The synthesis of polythiophene has been studied extensively in recent decades, and several synthesis routes are described in the literature. Despite their diversity, these methods do not allow direct access to poly electrolytes having a backbone conjugated thiophene. For this type of polymer, it is necessary to synthesize in a first step a carrier polythiophene ester, soluble in an organic medium and in a second step to perform the hydrolysis of the functional groups carried by the side groups. Going through an intermediary soluble organic solvent has a significant advantage. Indeed, it allows to fully characterizing the samples from the set of characterization techniques commonly used (IR, SEM, DSC, NMR ...) for the organo-soluble polymers. The interest of the semiconductor polymer is highly dependent on its chemical electrochemical optical properties, and solubility. The polymer synthesized in this work is in the form of very fine amorphous powder with colors varying from dark red to brown. It is quite stable in air. Ce polymère est totalement insoluble dans les solvants connus, organiques ou aqueux. Sa caractérisation chimique est très restreinte.

On a cependant effectué une analyse élémentaire de la poudre pour vérifier la teneur respective des atomes composant le polymère et pour quantifier les principales impuretés présentes dans la poudre.

VI.2. Characterization of an organic solar cell Schottky (SnO_2: F / poly thiophene / AL):

We achieved organic photovoltaic cell consists of a Schottky junction where active semiconductor polymer and polythiophene (PTH)-type. Major constituents are deposited on a glass substrate on which is deposited all parts polythiophene and a pair of electrodes made of copper and the other of aluminum.

Figure 4: Photo of the photovoltaic cell made on the basis of P-doped poly thiophene

The surface of the active part of the cell is estimated to 1.5 cm (Figure 4). The characterization of our photovoltaic cell is two steps, and the electronic characterization photonics characterization.

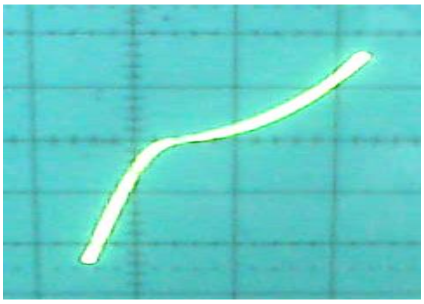

Figure 5: View of the oscilloscope to the electrical characteristic
I = f (V) of the organic cel

The electronic characterization consists in the detection of the semiconductor junction by determining the curve of the electric current I which passes through the junction as a function of the voltage V thereacross (Figure 5). It appears clearly that the photovoltaic cell thus produced has a characteristic similar to that of a conventional diode.

Table I: Values Of Electrical Voltage Electric Current And Cell

	
illumination	dark
V = 0.929 Volt	V = 0.324 Volt
I = 22 μA	I = 6 μA

The optical characterization makes it possible to demonstrate the influence of the radiation received at the surface of the cell and the voltage on the output generated (Table 1) electrical current.
The cell efficiency is dependent on the power delivered under illumination radiation power per unit area exposed. The expression efficiency can be determined by the following expression:

$$\eta = \frac{p_{max}}{S * G}$$

S = 1.5 cm2 et G = 500 W/m2 (1)

η= 0.032 %

The cell efficiency is very low compared with that they may encounter in inorganic cells. The results are promising for the future, a finer organization, and further different layers forming the particular cell layer of semi conductive macro molecules will improve and increase the efficiency of organic cells.

VI.3. Effect of Time On the Schottky Cell

The decrease in the time of the corrosion resulted in the decrease of the current generated by the effects of the "oxidation of" aluminium electrode cell of PTH + DDAB dope P / Al shown in figure 6.

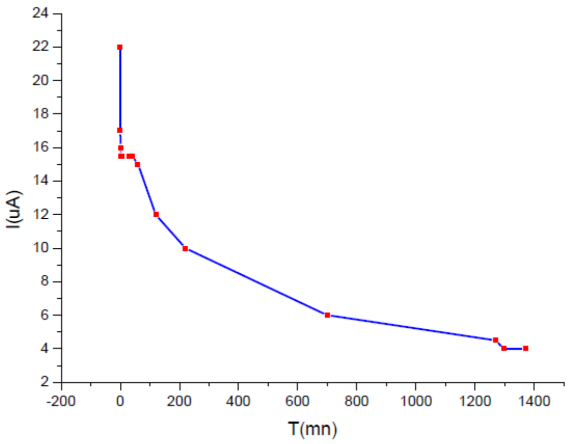

Figure 6: short-circuit current of change generated by the PTH + Contact DDAB dope P / Al as a function of time under illumination.

V. Conclusion

The energy from solar cells is considered strategic in the context of sustainable development. Up to now, the systems are marketed mainly bases on silicon technology, however, PV cells based on organic materials require further investigation to improve the conversion efficiency and stability.

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