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E-Futures

Organic Solar Cells Characterisation

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ASSIGNMENT COVER SHEET 2010/2011

A completed copy of this sheet MUST be attached to coursework contributing towards theme 2 assessment.

Name :	Goudarz Poursharif
Degree Course:	**E-Futures DTC**
Supervisor:	
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I declare that this work is my own and that I have made appropriate reference to any sources used. I am aware of the handbook section on ‘Plagiarism’ and declare that this work is consistent with those guidelines.

Mini-Project Mark Sheet

Student: **Grade:** fail/satisfactory/good/very-good/excellent

Supervisor:

Feedback:

	Excellent	Good	Average	Poor	Very Poor	Not Done	Not applicable
Introduction to the problem / subject							
Statement of aims							
Experimental description							
Presentation of results / findings							
Quality and depth of discussion / interpretation							
Relevance of conclusions							
Quality of English							
Use of reference material							
Evidence of external reading							
Quality of presentation							
Use of figures							

Comments:

The sun is an abundant source of renewable energy for our planet and with ever increasing rate of industrialization in developing countries and inevitable population growth, the need for efficient, stable, and low cost techniques of harvesting such energy is proving to be more vital for our world. Conventional Silicon Solar cells are deemed to be reasonably efficient and stable, but they are not the most low cost option. Also, the production of such PVs is highly energy intensive [1]. However, organic PVs or third generation PVs could provide users with lower cost energy harvesting devices which at the same time are less energy intensive. Naturally, the challenge lies in making these PV more stable and efficient (Figure 1).

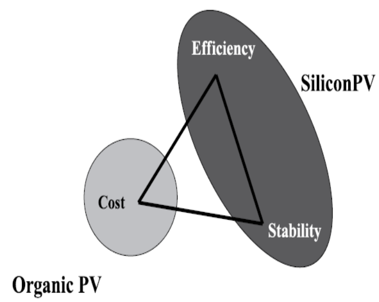

Figure 1: The Brabec triangle contrasting organic PV and silicon PV [1]

Basically, Organic PVs can provide us with the following benefits:

- Lower costs
- Flexibility
- Light weight
- Ultrafast set up and processing
- Environmental and resource efficiency

But at the same time they the following issues can hinder the commercial development and application of organic PVs:

- Low efficiency of about 5-6%
- Low stability
- Fast degradation

The main focus of this project was on the concept of bulk heterojunction (BHJ) solar cells, in which the electron donor and acceptor material are mixed together and form the active layer [1]. Figure 2 shows a schematic structure of the type solar cells which were made and tested during this project.

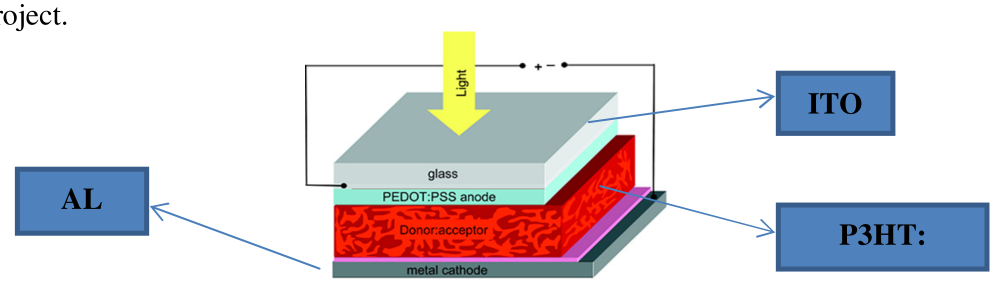

Figure 2: A typical BHJ organic solar cell [2]

The project was carried out over 8 weeks and the main objectives of the project were as follows:

1. To learn:
   a. How to make devices
   b. How to characterise them
   c. How to study them

2. To identify:
    a. The factors affecting the efficiency of the devices
    b. The factors affecting the degradation of the devices
    c. The factors affecting the stability of the devices

Over the period of 6-8 weeks various sets of devices were built and tested. The following procedure was chosen as the best practise based on the results which were produced during the tests:

1. Preparation of active solution (P3HT:PCBM) in Chlorobenzene and leaving the solution on hot plate for 24 hours
2. Cleaning the substrates
3. Oxygen Plasma treatment of substrates
4. Spin coating PDOT and Annealing(10 minutes at 120 C°)
5. Spin coating active layer
6. Evaporation and Al Deposition
7. Annealing (10 minutes at 160 C°)
8. Encapsulation and UV treatment
9. Testing in Kroto and on the roof of Hicks building

All the steps apart from the testing phase were carried out in clean rooms and/or a Nitrogen glove box, in order to avoid degradation and efficiency drop of the devices [3]. Although such measures are not vital, they have proved to be essential to ensure an acceptable level stability and efficiency in the samples. A number of different samples were prepared and tested in with the aims of:

- Determining the optimum P3HT:PCBM ratio
- Determining the optimum spin coater rotation speed for the active layer
- Determining the optimum active layer thickness
- Determining the most ideal substrate cleaning technique (NaOH or Acetone)
- Determining the efficiency drop in time

After making various devices with P3HT: PCBM ratio differing from 1:1.2 to 1:0.6, It was found that the best P3HT: PCBM ratio is 1:0.6 and the best active solution spin coating speed is 2000rpm for 30 seconds, which makes an approximately 100 nm active layer. The results also indicated that leaving the glass substrates in the oxygen plasma chamber for 10 minutes as opposed to 5 minutes and cleaning the substrates with NaOH instead of Acetone improves the PDOT layer spread on the glass substrates. The significance of active solution filtration was also observed during these tests and it was found that not filtering the active solution can cause dramatic decrease in the efficiency of the devices.

Unfortunately, the devices were only set up on the roof 1 week before the end of the project (Figure 3) and the struggle with the appropriate programme set up and bad weather led to insufficient data regarding the degradation and destabilisation rate of the devices. However, early monitoring data indicate that the efficiency of the devices tends to drop sharply during the first few days of installation, but after that it reaches a more steady shape.

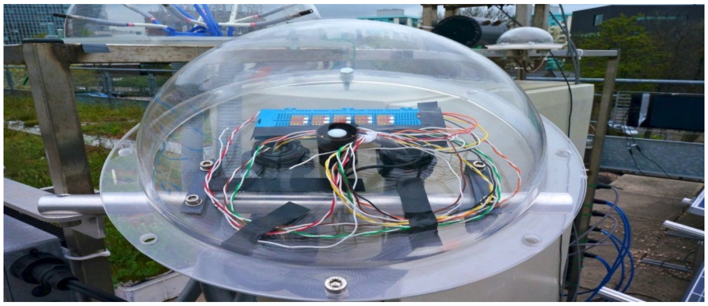

Figure 3: Devices set up on the roof of Hicks Building

In conclusion, the process of making organic PV devices requires supervision and education especially at the first few attempts, but the procedure can be performed more autonomously later on. Precision and accuracy play vital roles in the fate of the devices and fractions can affect the results, hence planning ahead and being confident are very important. General lab equipment is required and the most expensive pieces of equipment are the glove box and the evaporator (Figure 4 and 5).

Figure 4: Nitrogen glove box

Figure 5: Evaporator chamber

The overall development and application outlook of organic PVs seem bright, but there is a great need for more efficient and stable devices. These types of solar energy harvesting devices are cheaper, more flexible and easier to make than conventional silicon solar cells, but in order to become commercially successful they need to be able to offer higher efficiency (e.g. > 10%) and more resilience. Maybe development of new polymers or new processing techniques could help us achieve those ends.

In the end, I would like to thank:

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