ORGANIC PHOTOVOLTAIC DEVICE FABRICATION AND TESTING

STUDENTS / UNIVERSITIES

Şeyma Burcu Gülşen / Sabancı University
Abdelrahman Kassem / Sabancı University
Ahmet Alper Özkan / Sabancı University

SUPERVISOR(S)

Zeki Semih Pehlivan, Murat Gökhan Eskin, Hasan Kurt, Cleva Ow-Yang

Sabancı Üniversitesi

pure PROGRAM FOR UNDERGRADUATE RESEARCH

Introduction

- OPVs offer more flexibility for integration of and in complex architectures..
- **HUMO-LUMO separations** in the active layer, **work functions** at the boundaries of the OPV architecture and the **band gaps** at the anodes, cathodes and metal surfaces like LiF (Krebs, 2008).

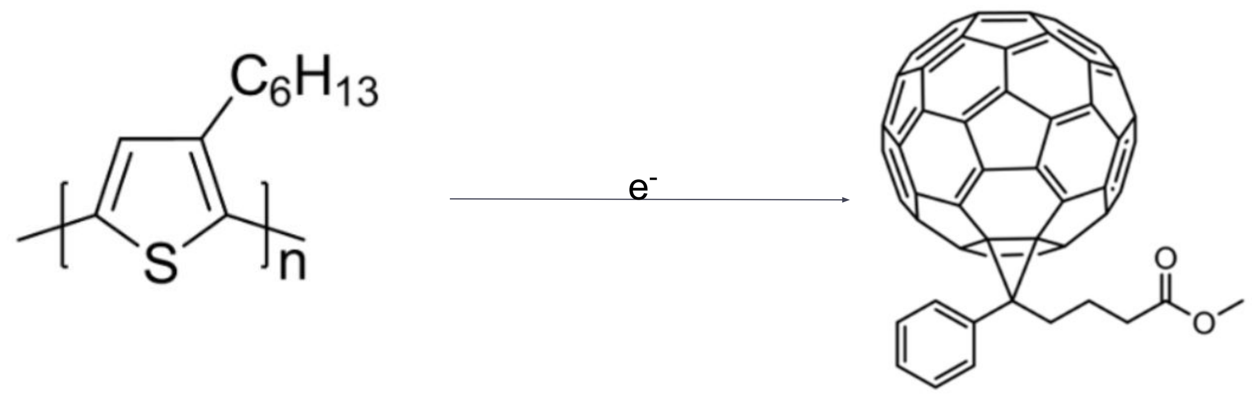

Fig. 1. P3HT transferring an electron to $PC_{60}BM$ (Adapted from Redondo, 2014)

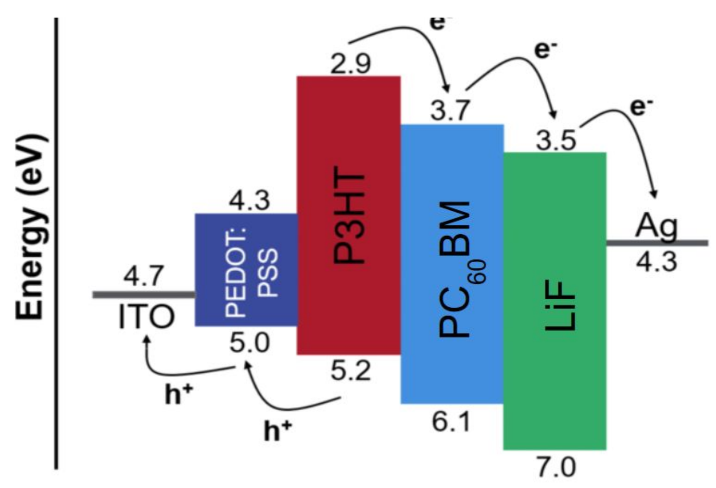

Fig. 2. Electronic structure of a prototype bulk heterojunction (BHJ) OPV, showing the relative positions of donor-acceptor energies.

Aim

- **Learning to fabricate** and **analyze OPV prototypes,**
- **Finding the parameters affecting OPV efficiency** and optimizing them in our production processes to determine causalities.

Methods and Experimental Setup

Cleaning glass substrates → **Coating** on the active layer mixture and ETL/HTL → **Evaporating** on the ETL/HTL and the cathode → **Encapsulation** of cells to ensure protection

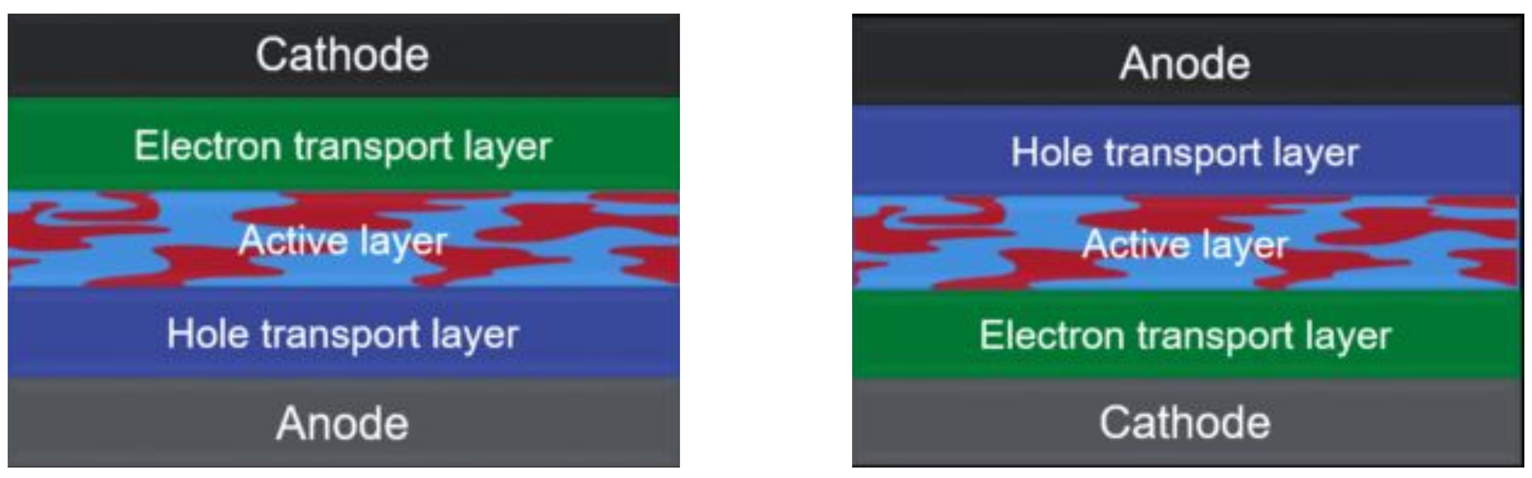

Fig. 3. Conventional (left) and inverted (right) structure of solar cells (Ossila, n.d.)

- Instruments used for characterization were Keithley Model 2400 Sourcemeter, Newport Class 3A Solar Simulator and Ossila ZIF Test Board.
- Current-Voltage graphs of each solar cells' pixels were made using Microsoft Excel.

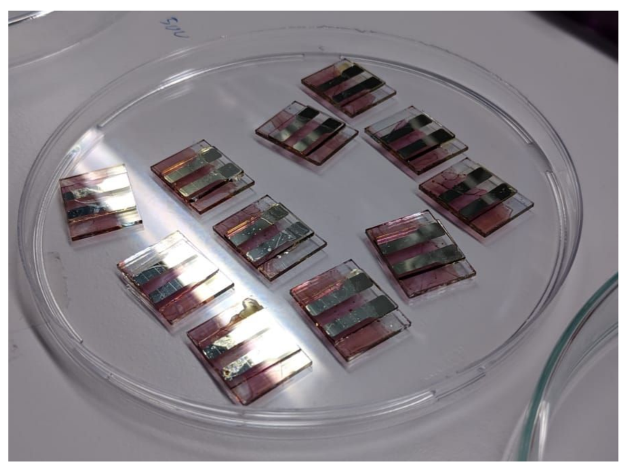

Fig. 4. Encapsulated and finished organic solar cells

Fig. 5. Keithley Model 2400

Results

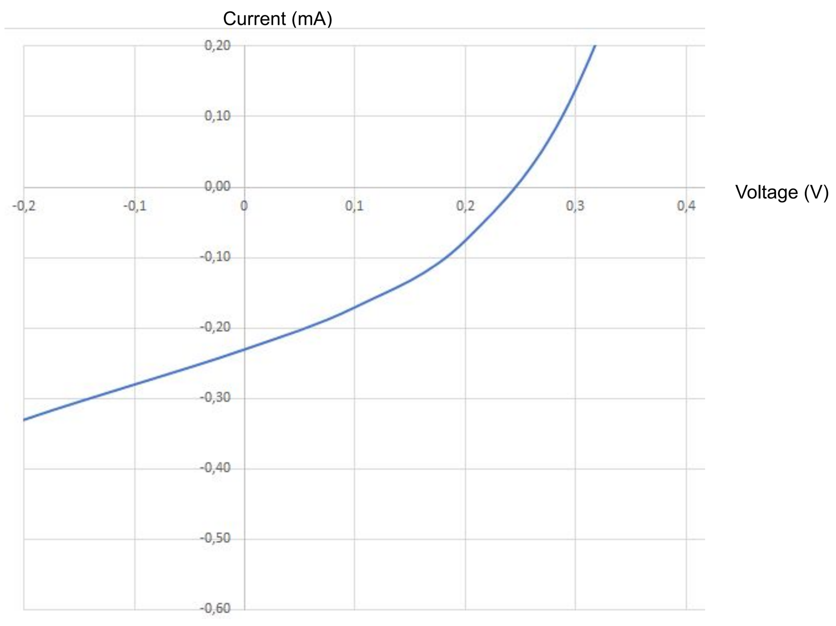

Fig. 6. Inverse structure with 2000 RPM on spin-coating of ZnO

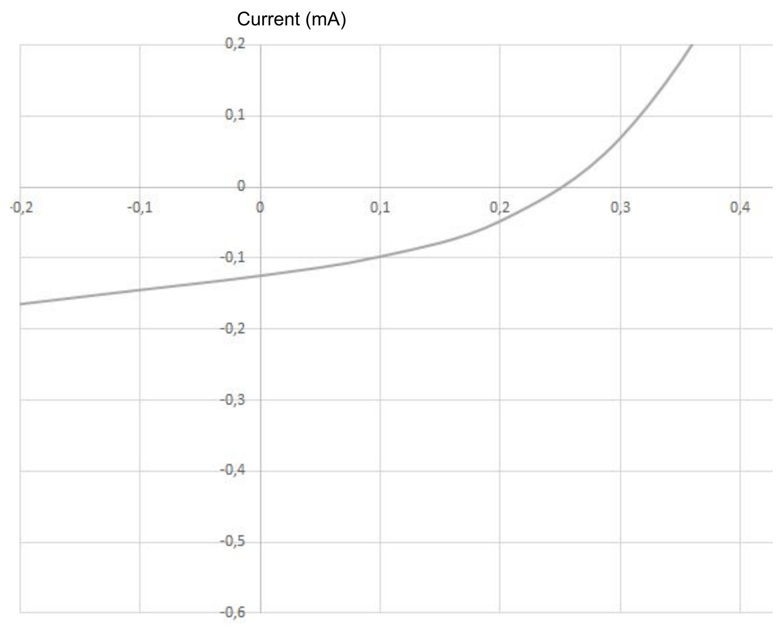

Fig. 7. Inverse structure with 1500 RPM on spin-coating of ZnO

I_{SC}	-0,23 mA	-0,124 mA
V_{OC}	0,245 V	0,25 V
I_{MP}	~-0,1 mA	~-0,06 mA
V_{MP}	~0,18 V	~0,18 V
P_{in}	100 mW/cm^2	100 mW/cm^2
Pixel area	4,8 mm^2	4,8 mm^2

Table 1. Variables for 2000 RPM and 1500 RPM (rotation speed for ZnO coating) samples

$$FF = \frac{JmpVmp}{JscVoc}$$

Fig. 8. Fill factor equation used for calculating quantum efficiency

$$\eta = \frac{IscVocFF}{Pin}$$

Fig. 9. Quantum efficiency equation

Conclusion

- Between our samples with different RPMs, 2000 RPM gives us comparably more efficiency based on the equations (Table 1, Fig. 8 & Fig. 9)
- Fabrication process has to be done in an oxygen-less environment to prevent oxidation of the layers

References

- Redondo, C. S. (2014). *Organic Photodetectors* (Master's thesis). Technische Universität Dresden, Germany.
- Krebs, F. C. (2008). (Ed.). *Polymer Photovoltaics: A Practical Approach*, USA: Bellingham, Washington.
- Ossila Ltd. (n.d.). *The stacks used in a conventional and inverted OPV cell, where the layers are not given to scale.* [Image]. Retrieved from https://www.ossila.com/pages/organic-photovoltaics-introduction

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