Student Guide for E. Wattson Organic Solar Cell Kit

Guide for students for measuring the performance of solar cells using the E. Wattson Organic Solar Cell Kit.

Background

Solar cells are devices that convert the energy of sunlight into electricity. Figure 1 shows the working principle of organic solar cells.

1. When the light is incident on the solar cell, it gets absorbed by an active layer (Donor and acceptor material).
2. The absorbed lights create an electron-hole pair called an exciton.
3. At the donor-acceptor interface, the exciton will dissociate and generate free charges (holes and electrons).
4. The electron will be donated to the acceptor material, whilst the hole remains in the donor material.
5. The generated charge is collected by the electrodes, and used to do work on the external circuit of the cell thus producing a current.

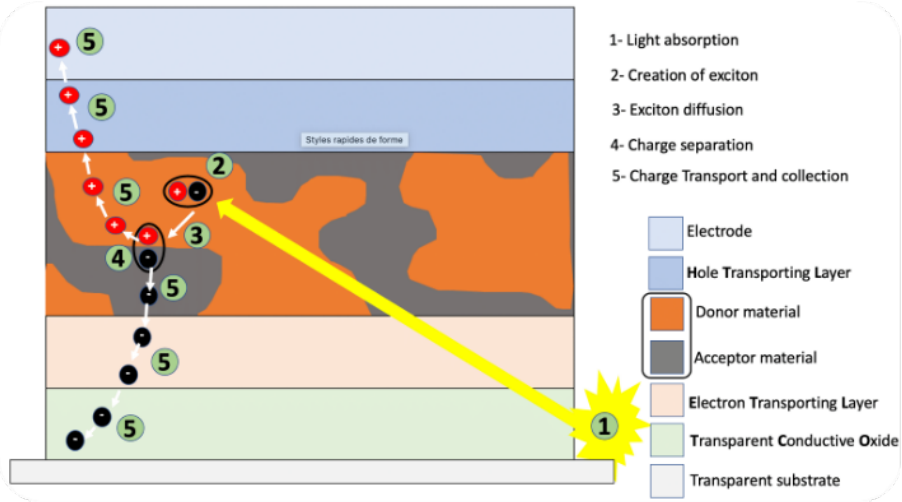

Figure 1: Working Principle of Organic Solar Cell (OSC), Image Accessed from https://dracula-technologies.com/what-is-the-third-generation-of-photovoltaic

Solar Cell Test

In this experiment, students measure how much voltage and current a solar module can generate. Use E. Wattson and select the parameters under which you are going to measure the solar cells.

What do you need for measurement?

- Solar Cells (check out the E. Wattson Solar Kit)
- Multimeter to measure volts and current (check out the E. Wattson Solar Kit)
- Alligator clip leads (check out the E. Wattson Solar Kit)
- Sunlight or other strong light sources, such as a 100-watt incandescent bulb

Experiment 1 (Measuring the Current)

- Place the solar cell under the lamp and measure the current on the multimeter under mA mode.

- The current measured is the short circuit current (Isc) of the solar cells. Isc depends upon factors such as the spectrum of the light and its intensity, optical properties (absorption and reflection) of the solar cell.
- Enter this current value in the E. Wattson.

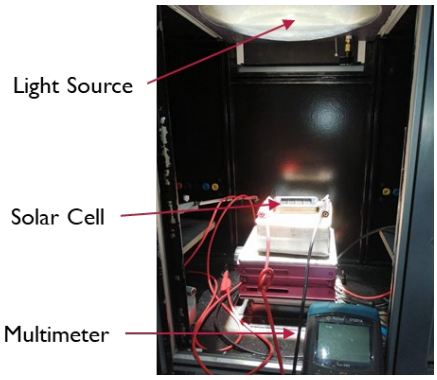

Figure 2: Experiment setup for measuring the current and the voltage of Solar cells

Experiment 2 (Measuring the Voltage)

- Similarly, measure the voltage across the solar cells.
- The voltage measured is called the open-circuit voltage (Voc). It is the voltage at which no current flows through the external circuit. It is the maximum voltage that can be generated.
- Enter the voltage in E. Wattson.

Power Output Calculation

- In the next step, measure the active area of solar cells. For the SDU module, the area is 7.2cm^2
  - You can see the power conversion efficiency (PCE) in the next step:
    The power of a solar cell is the product of the voltage across the solar cell times the current through the solar cell
    The maximum theoretical power from the solar cell, Pmax, is the product of the Voc and Isc.

$$Pmax = Voc * Isc$$

  - The maximum efficiency, PCE, of the solar cell, is the electrical power out divided by the solar power incident on solar cells.

$$PCE = \frac{(Voc * Isc * FF)}{Pin}$$

  - Fill Factor (FF) is essentially the measure of the quality of solar cells. It is the ratio of power (maximum power point power) from the solar cell to the product of $Voc * Isc$ (theoretical max power, Pmax). For the organic solar cells in the 2Imprezs you can use 0.5.

  - Pin is the intensity of light incident on the solar cells. The solar intensity on a sunny day over a given area at the surface of the earth is approximately 1000 watts/m2 or 100 mW/cm^2, thus:

$$Pin = Intensity\ of\ sunlight\ or\ lamp * Area\ of\ the\ solar\ cells$$