

1. Dependence of power on the area of the solar cell



Introduction

Solar cells are available in different sizes. With this experiment the dependence of the characteristic values voltage, current and power on the solar cell area should be investigated.



Learning Objects

Measure the voltage and the current and determine the power of a solar cell with different active areas!

What relationship between the area and these three measured values can you identify?



Concepts

Principles of electrical circuits
Voltage and current



Time Frame

1 lesson



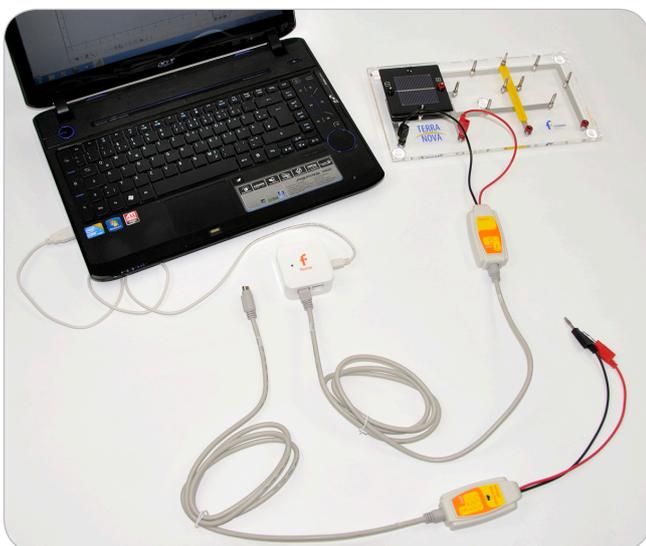
Equipment

1. Main board
2. 1 large solar cell
3. 3 solar cells cover sheets
4. 1 voltage sensor
5. 1 current sensor
6. NOVA LINK



Equipment Setup Procedure

1. Launch MultiLab.
2. Connect the USBLink to the USB port on the computer. The green LED will turn on when the USBLink is successfully connected to the computer.
3. Plug the solar cell onto the main board (left position).
4. For current measurement connect the current sensor parallel to the solar cell and to I/O 1 port of the USBLink.
5. For voltage measurement connect the voltage sensor parallel to the solar cell and to I/O 1 port of the USBLink.
6. Be aware not to connect both sensors at the same time





MultiLab Setup

1. Click .
2. Click **Next**.
3. Set **Select rate** to **Manual**.
4. Set **Select recording mode** to **Add**.
5. Click **Next**.
6. Set **by samples** to **50**.
7. Click **Finish**.



Notes

The calculated power of the solar cell is higher than the real maximum power, because voltage V and current I are not measured at Maximum Power Point (MPP) but at open circuit voltage V_{oc} and short circuit current I_{sc} . This procedure makes the experiment much easier but nevertheless the qualitative results will be true.



Experimental Procedure

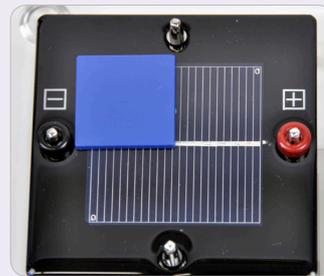
1. Connect the current sensor as described in the equipment setup.
2. Put all 3 covers onto the solar cell.



3. Click .
4. Take one cover away from the solar cell, so that there are two covers left



5. Repeat step 2 to 3 until no cover is on the solar cell.



6. Click .
7. Connect the voltage sensor as described under "Equipment Setup Procedure".
8. Repeat point 1 to 4.
9. Click .

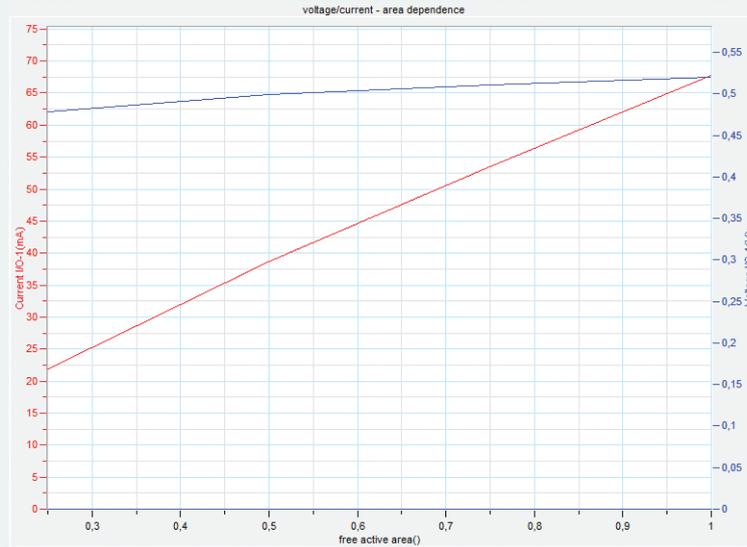


Data Analysis

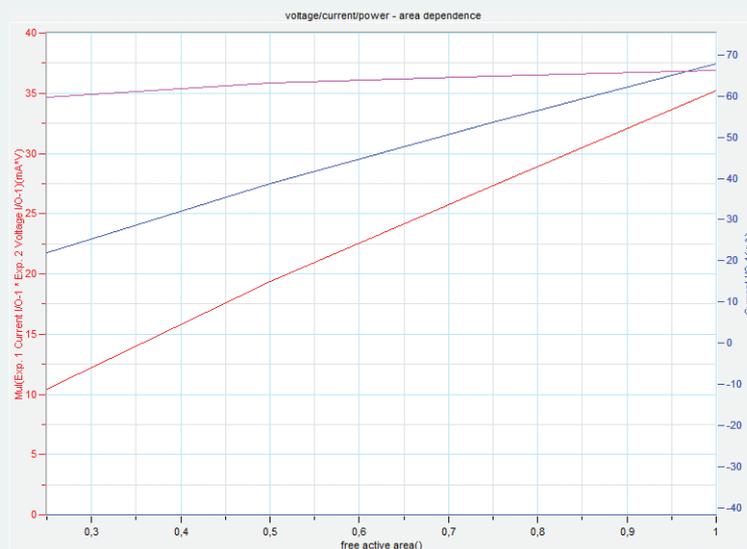
1. Click f_x .
2. Click **Functions**.
3. Set **Functions** to **Multiply**.
4. Set **G1** and **G2** to voltage and current measurement data.
5. Click **Ok**.
6. Go to **Table > Add manual column**.
7. Set **Column name** to **free active area**.
8. Click **Ok**.
9. Click .
10. Add the columns of free active area, the current and voltage measurement and of the calculated power function.
11. Click **Ok**.
12. Click .
13. Click Y_x .
14. Set **X-axis** to **free active area**.
15. Set **Y-axis** to the measured current and voltage data points.
16. Set the **Graph title** to **"Voltage / Current / Power - Area Dependence"**.
17. Click **Ok**.



Expected Results



The voltage stays nearly constant. In contrast, the current increases with the active area. It is directly proportional to the solar cell area.



Because power P is the product of voltage and current, it also increases with active area and is also directly proportional to the solar cell area.



Questions

1. How does the voltage V depend on the solar cell active area size?
2. How does the current I depend on the solar cell active area size?
3. What can therefore be conclusion for the power P ?
4. Advanced: Give an explanation for this behavior!
5. Advanced: In the experiment kit only relative small solar cells are included. In practice mostly so called 6-inch solar cells are used. They have a size of 156mm x 156mm. Apply a linear fit to your data and calculate the current and power of a 6-inch solar cell under the conditions of your experiment.



Answers

1. The voltage is constant. It is independent of the solar cell area.
2. The current increases linearly with larger active area.
3. Because power P is the product of voltage V and current I , it also increases linearly with the active area size.
4. The voltage of the solar cell does not change because it is a material constant. It mainly depends on the solar cell material but only slightly on illumination density (it depends on the illumination density by a logarithmic law). The solar cells in this kit are made of silicon and therefore have a voltage of 0,5V under sun light.
5. The reason that the current on the other hand increases with area is the following: The larger the area of the solar cell the more photons (light particles) are collected by the solar cell. Each photon can excite one electron. This means that with larger area more photons are collected and more electrons are excited. And more electrons means more current.



Further Suggestions

You can also compare the two different kinds of solar modules included in the kit. The larger one has a size of 52mm x 52mm and the smaller one of 52mm x 26mm.