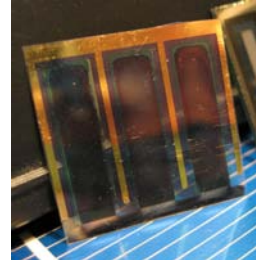


PV Characterization Lab

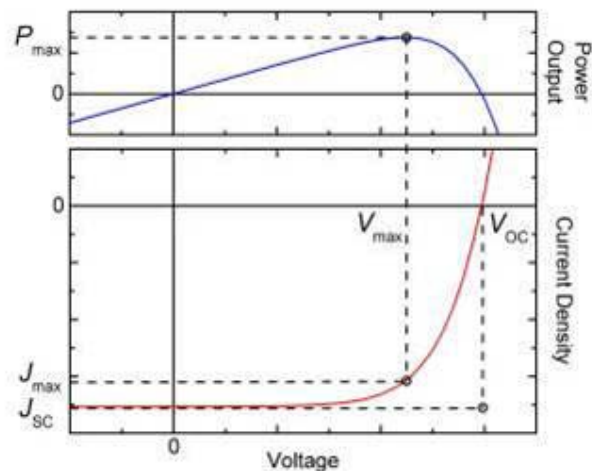
Purpose

In this lab you will measure the current versus voltage for several photovoltaic cells using computer probeware. The cells are tested under varying resistance loads and varying light levels.



Background

Solar cells are characterized using a voltage- current curve. Researchers build test cells using different materials and techniques and then test them in a controlled way. A common test is to create a voltage current plot. The curve goes between the open circuit voltage (V_{oc}) and the short circuit current J_{sc} . If you measure the voltage of solar cell with no load, that is the open circuit. The maximum voltage occurs when there is no resistance and no current. If you have an infinite resistance on the circuit there is no voltage but a maximum current. Somewhere between these extremes is the peak power, a combination of current times voltage which can be seen as the elbow on the voltage current curve. In this experiment a variable resistor is used to obtain a series of voltage and current pairs. The resulting curve is a measure of the overall performance of the cell. The fill factor is the degree to which the J/V curve approximates the ideal which would be a straight line going horizontal with constant current to the V_{oc} where the current drops to zero.



Researchers usually use computers to collect and analyze PV performance data. The Pasco voltage/current probe connected to the USB link provides an easily visible display of solar cell performance.

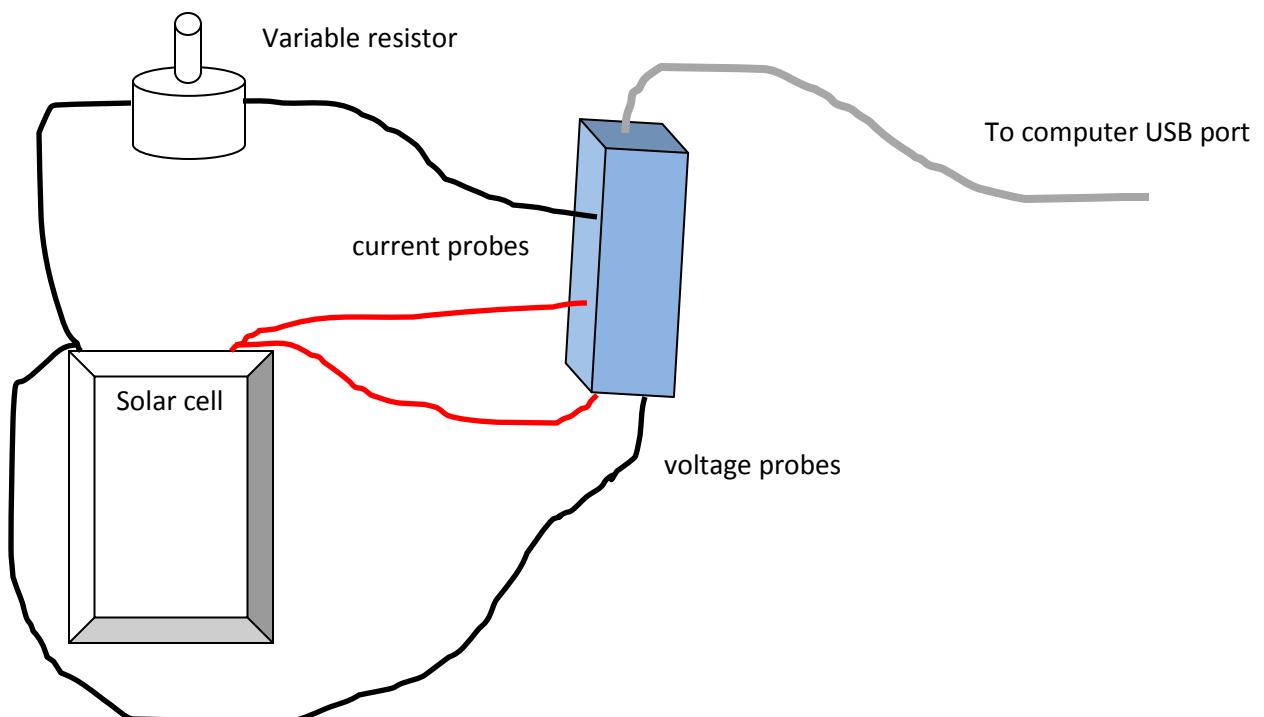
Materials

- USB link interface- Pasco
- Current Voltage Probe- Pasco
- 0-1K ohm (precision- 10 turn) variable resistor
- Computer
- 1 crystalline silicon solar cell (c-Si)
- 1 amorphous silicon solar cell (a-Si)
- 1 copper indium gallinide diselenide solar cell (CIGS)

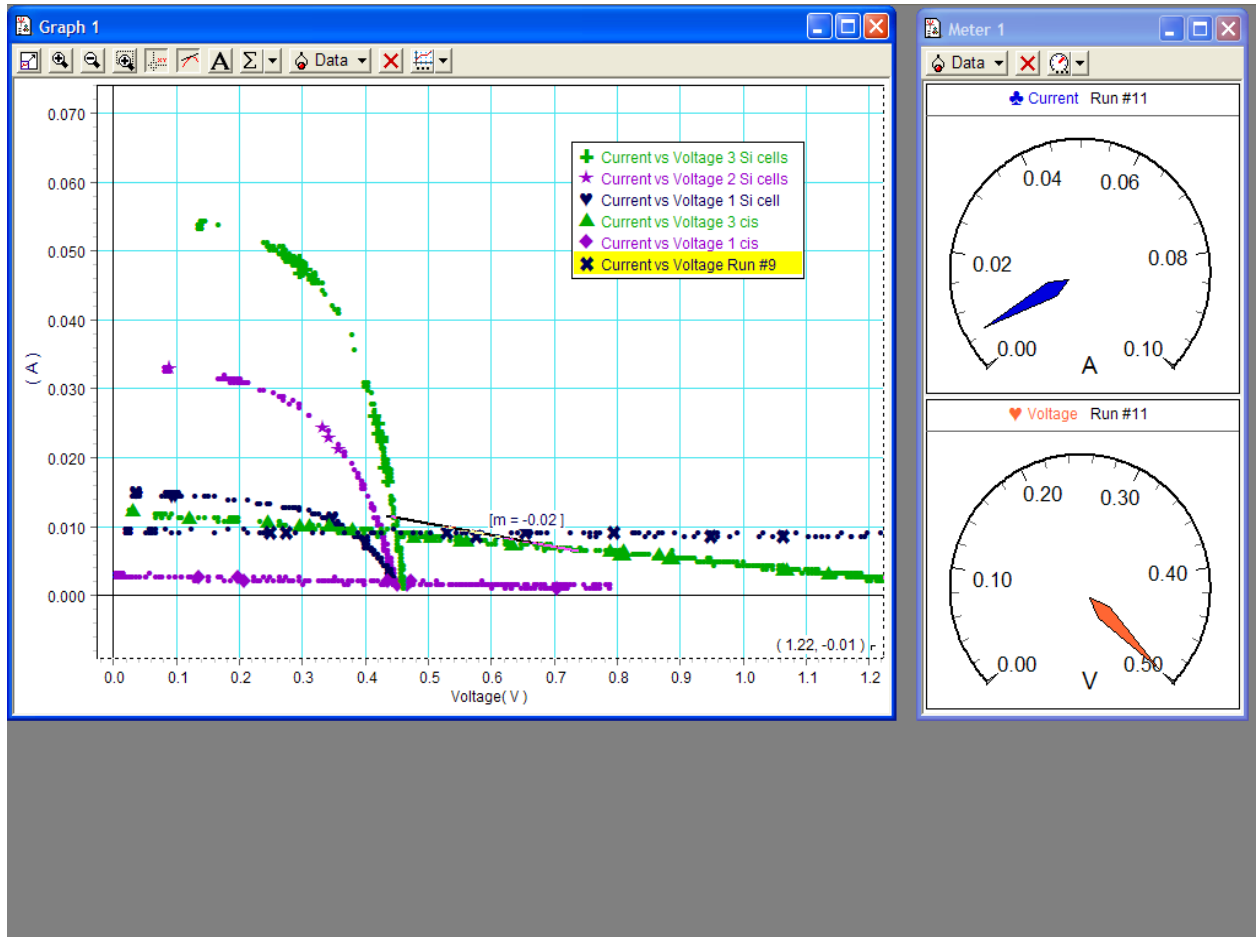
Procedure

To set up the experiment follow these directions:

- 1) Set up a solar cell at a set distance from a light source or in full sun. Be sure to keep illumination constant through the measurements.
- 2) Connect the voltage probe to output of the solar cell using the black lead to the negative.
- 3) Connect the current probe to the output of the solar cell in series with a variable resistor. The resistor will be used to decrease the current from **J_{sc}** where there is maximum current but no voltage (since it is essentially a short circuit), to a maximum resistance **V_{oc}** at which time there is no current flowing through the resistor but maximum voltage. Variable resistors will have to be carefully chosen; 0-100, 0-500, 0-1000 are possibilities.



- 4) Open the DataStudio activity called JVcurve.ds. It will display a graph with amps on the y axis and volts on the x, and a dial display for current and voltage meters. The sampling option is set to “Manual Sampling” and “Keep data values only when commanded. On both meters and graph the appropriate range is 0-.1 amps for current and 0-.5 volts.



- 5) Click “Start” to begin viewing the current and voltage. The “Start” button turns to “Keep” with a red stop square to the right. Each time you click “Keep” a data point is added to the graph at the instantaneous current and voltage levels. This data set is known as a “run” and is noted in the data summary area on the left with a matching icon on the graph. (An alternative method is to set the sampling method to timed and then repeatedly change the potentiometer to fill in the curve. Since this is continually collecting x-y points it can result in a large number of redundant pairs but is more impressive as a dynamic display).
- 6) Adjust the variable resistor from 0 ohms to full resistance in a series of steps. You’ll notice that as the resistance increases the voltage increases and the current decreases. Carefully adjust the variable resistor so that you get readings every .05 volts.
- 7) Click the red square to stop data collection. Click “start” to begin a new data set.
- 8) Repeat this measurement with different solar cell types.
- 9) Repeat this measurement for a single cell with different levels of illumination for example by moving the lamp

10) Establishing the load level for the point of peak power for the given light conditions. Under the conditions for peak power apply different colored filters. Record the wavelength of the transmitted light and the power.

Filter transmission wavelength (nm)	Current (J) milliamps	Voltage (V)	Power (JxV) milliwatts

Lab Report

Create a Standard Lab Report with the following sections.

- Introduction
- Materials
- Methods
- Data
- Results and analysis

In the results section answer these questions.

1. Identify the J_{sc} , V_{oc} , and peak power for each type of cell.
2. Label the area of the graph that is considered the “fill factor”
3. What effect did changing the level of illumination have on your graph?
4. Based on your results which the solar cells has the best efficiency?
5. Graph the action spectrum for each solar cell. What differences do you detect?

Links and References

http://www.nrel.gov/learning/re_photovoltaics.html

<http://www.ccmr.cornell.edu/education/modules/documents/PhotovoltaicCells.pdf>

<http://www.infinitepower.org/pdf/No19%2096-828B.pdf>

<http://www.nrel.gov/midc/unlv/> live insolation data for Las Vegas

http://en.wikipedia.org/wiki/Solar_cell

<http://www.powernaturally.org/Programs/SchoolPowerNaturally/InTheClassroom/kitlessons.asp?i=9#Lesson14>

Sources for kit materials

- http://scientificsonline.com/product.asp_Q_pn_E_3085037 \$2.95 each CIS solar cell
- <http://store.pasco.com/pascostore/showdetl.cfm?did=9&partnumber=PS-2100A&detail=1>
Pasco PASPort USB link \$59
- <http://store.pasco.com/pascostore/showdetl.cfm?&DID=9&PartNumber=PS-2115&groupID=192&Detail=1> voltage/current probe \$99
- (alternative to Pasco version) <http://k8.vernier.com/products/interfaces/> Vernier Go!Link USB interface