Measurement Sheet

Lab #11: Silicon Photovoltaics

MIT Nanomaker_Spring 2013

Experiment #1: Qualitative Characterization of Spin-on dopant

You've been given a piece of boron-doped silicon as a starting material, and a phosphorous spin-on dopant (Filmtronics P509).

What type of dopant is boron, p-type or n-type? ________
What type of dopant is phosphorous? _________

Each member of your group should use the spincoater to spin on a layer of P509 at a different spin rate (1000 RPM, 2000 RPM, or 4000 RPM) for 30 seconds, followed by a 10-minute bake on the hotplate at 200°C. Each spin rate will produce a film of a different thickness and color, and the color of the film will further change during the bake on the hotplate: what causes the color to change during baking? ____

The phosphorous-rich film on the silicon is primarily glass. Use the color of the thin film, after baking, to estimate its thickness using the oxide color chart provided at the HteLabs website (http://www.htelabs.com/appnotes/sio2_color_chart_thermal_silicon_dioxide.htm).

↓Spin rate	**Film color**	**Approximate film thickness (nm)**
1000 RPM (Sample 1)		
2000 RPM (Sample 2)		
4000 RPM (Sample 3)		

Experiment #2: Doping and Qualitative Characterization of Thermal Oxide

Give your sample to the TA to place in the tube furnace for 90 minutes at 1000C. The high temperature will cause the phosphorous to diffuse into the sample to form a p-n junction beneath the surface of the silicon. It will also cause a thermal oxide to grow.

Estimate the thickness of the thermal oxide based on color __________________

Experiment #3: Metal contacts and IV Characterization

With the help of the TA, apply small spots of Armour Etch glass etchant cream to the front and back of your sample to etch away portions of the spin-on dopant film and the thermal oxide. This will allow you to make electrical contact to the front and back of the solar cell. Etch the sample for 30 seconds, rinse the sample with water to remove the cream, and dry with compressed air. Metallize the front and back of the cell as described by the TA.

Using a variable DC power supply and your multimeter, measure the current through the different cells as a function of applied voltage (e.g. an IV measurement).

Voltage (V)	Current (Sample #1)	Current (Sample #2)	Current (Sample #3)
-1.50			
-1.25			
-1.00			
-0.75			
-0.50			
-0.25			
0			
0.25			
0.75			
1.00			
1.25			
1.50			

Describe the IV measurement. Is it linear? ______________________

Experiment #4: Photocurrent vs. Incident Illumination Angle

Repeat the photocurrent and open circuit voltage measurement procedure from last week's dye-sensitized solar cell lab.

	Sample #1		Sample #2		Sample #3	
↓Illumination incident angle	Short Ckt (I)	Open Ckt (V)	Short Ckt (I)	Open Ckt (V)	Short Ckt (I)	Open Ckt (V)
0°						
15°						
30°						
45°						

Follow-up Questions:

- **For a solar system rated at 2kW$_p$, provide an estimate of energy it will produce a year. Assuming the location receives, on average, 4 kWh/m2/day from the Sun.**

- **Solar resources**
    - **What does AM stand for in the context of solar spectra (ex: AM0 and AM1.5)? And what do AM0 and AM1.5 mean?**
    - **What physical phenomenon is responsible for the differences between AM0 and AM1.5 radiation?**

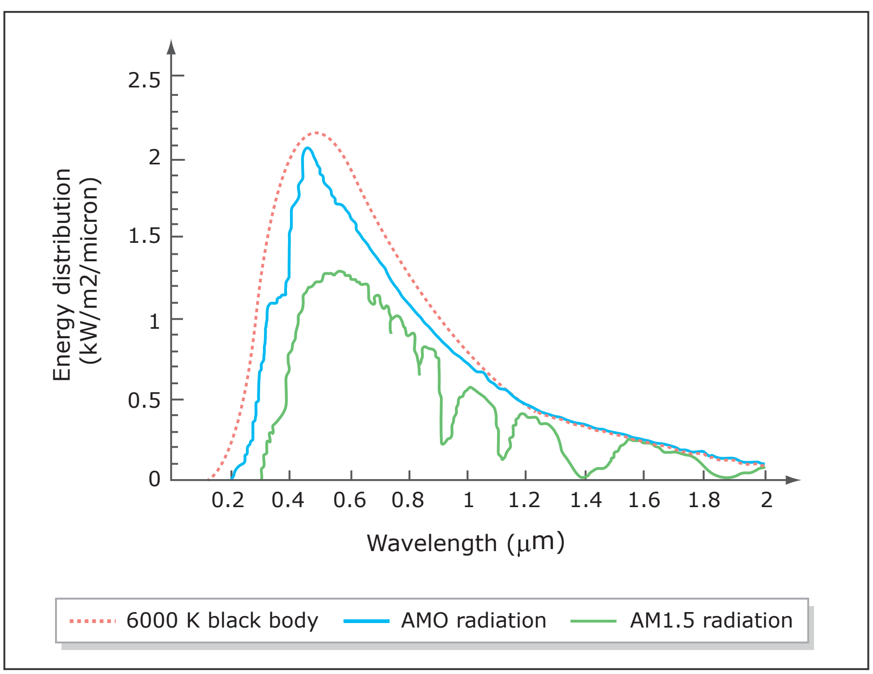

Image by MIT OpenCourseWare.

- **Consider three photons, with wavelengths of 300 nm, 885 nm, and 1600 nm. For GaAs (E_g = 1.4 eV), specify which photons are correlated with the transitions below. And also on the figures, indicate where thermalization losses and non-absorption losses are present.**