Solar Cell Design and Processing – Fall 2004

Homework #2 - Due 28 October 2004

Consider the multijunction solar cell idea. Work with the solar spectrum (contained in the EXCEL file at the solar class website) and determine the optimum configuration for a 5 junction cell. Specifically, figure out what the current density and voltage generated by this system would be.

Make the following assumptions:

1. Each of the 5 junctions is wired in series – requiring that each junction collect the same amount of photocurrent.
2. The voltage generated from each single junction will be 0.40 volts lower than its band gap. Thus silicon at 1.1 eV would generate 0.7 volts.

Procedural Advice:

1. Convert the solar spectrum into a graph of: number of photons in each wavelength segment.
2. Make a new column in the spreadsheet that is the **sum** of the number of photons in each wavelength segment up to that point. → This is a critical step: you need to integrate the spectrum up to an arbitrary point so that you can segment it into regions.
3. Recognize that you don't know how much of the solar spectrum will be discarded because it has photons that are *even lower energy than the lowest band-gap layer* that you use. Define a cell somewhere in your spreadsheet that then defines the fraction of photons that you will discard. Insert a test value in that cell – this will be your initial estimate and you will need to vary it later to find the optimum configuration.
4. Key issue: *from the remaining photon quantity (that is captured usefully)* divide this into $1/5^{th}$ – this will be the number of photons that each band-gap layer must capture.
5. Work through the spreadsheet and find band-gap values that segment the photon quantity into each partitions.
6. Then for each wavelength segment – recognize that the energy captured will be 0.4 eV lower than the bandgap value of the layer that captures it.
7. Make a new column that has the product of the number of photons and the energy that is recovered from those photons captured in that layer.
8. Add up all those incremental energies.
9. Current is the number of photons generated by any one layer – NOT the sum of photons captured by all 5 layers.
10. Total system voltage will be the sum of the (E_g-0.4) values for the 5-layer stack.