ENPH354 Assignment 4 Optics and Devices Ver. W23, © Prof. J. Gao

The solar cell performance evaluator LabVIEW VI will calculate, from the measured I-V curve of an illuminated BPW34, the six solar cell parameters of the BPW34. One parameter, the power conversion efficiency, is the maximum extracted electrical power divided by the input optical power. The best way to determine the input optical power, which varies from group to group, is to use the BPW34 itself (in its measurement configuration) as a light meter. You are provided (1) the responsivity data from the data sheet, and (2) the emission spectrum of the white LED. The former was obtained by digitizing the relative spectral sensitivity graph given in the specification sheet and the numbers are unitless. The measured white LED spectrum is also unitless and has a nearly constant background noise that needs to be removed. The wavelength (column 1 for both LED and BPW34) is in nm. From the data sheet, we also know that the BPW34 can generate a short-circuit current (I_{sc}) of 47 μA when illuminated with 1 mW/cm^2 of monochromatic light at 950 nm and that the BPW34 has an active area of 0.075 cm^2. With these information you can determine a conversion factor that allows you to calculate the input optical power.

(1) (10 marks) Calculate the absolute responsivity (in mA/mW) and external quantum efficiency of BPW34 at 950 nm.
(2) (20 marks) Import the file WhiteLEDemissionspectrum_20mA.csv. Perform the following manipulations **in LabVIEW**:
    a. Remove the background count by calculating the average count for all data at wavelengths below 400 nm. This value is a noise background because the white LED does not emit in the ultraviolent. Subtract this average count from the counts data at all wavelengths.
    b. Remove all data (both wavelength and count) that are below 400 nm and over 700 nm. Save the corrected data in a new file.
    c. Display both the original data and the corrected data on the front panel.
    d. Plot the white LED spectrum with the corrected data.
(3) (20 marks) Import the provided PhotodiodeSensitivityData.csv. Perform the following manipulations **in LabVIEW**:
    a. Sort the data by wavelength since some wavelength values are out of place. Convert Relative Spectra Sensitivity to Absolute Spectra Sensitivity (also called responsivity) expressed in mA/mW. Display the modified data with an array indicator on the front panel . Plot the sorted and converted BPW34 responsivity data.
    b. Remove data points for wavelengths larger than 700 nm; display the modified data with an array indicator on the front panel.
    c. Plot the modified data in b and perform a least square linear fit to the data; display both the fit line and the data in the same x-y graph; display the fit parameters (slope and intercept) on the front panel.
(4) (20 marks) Use the corrected LED spectra data you obtained in (2), calculate the average energy (in eV) of a photon emitted by the white LED. This should be done **in LabVIEW**.

(5) (30 marks) The short-circuit current (I_{sc}) of the BPW34 when illuminated by the white LED can be calculated as:

$$I_{sc} = P_{optical} \frac{\int g(\lambda)R(\lambda)d\lambda}{\int g(\lambda)d\lambda}$$

where $P_{optical}$ is the input optical power from the white LED, g(λ) is the corrected white LED spectrum from 2b, R(λ) is the BPW responsivity in mA/mW from 3b. Calculate the ratio of the two integrals. This is the conversion factor that will allow you to calculate $P_{optical}$ from the measured I_{SC}. You do not need to derive this relation. But it is easy to see that the conversion factor is simply the weighted average of *R*, with the weighing factors being the spectral intensity of the white LED. This question should be done **in LabVIEW**. (hint: since *g* and *R* do not have the same step sizes, you can multiply *g* by the linear fit you obtained for *R* in (3).

Submission:

Due on Feb 13 by 11:00 pm via onQ; submit a PDF per group with names of group members on a cover page and answers (show formulas used) to part (1). Submit **individual** VIs for parts (2)-(5). This assignment should be done as a group. Collaboration outside of your own group is prohibited. Normal late policy applies.

Attached:
1: White LED spectra data (measured)
2: BPW34 responsivity data (digitized from the data sheet curve)