EE535-Lab4 **Fall2023**

Quantum Efficiency (QE)

Objectives:

Getting to know the QE set-up and measurement method

Measuring QE of a crystalline silicon solar cell and a perovskite solar cell.

Measuring carrier diffusion length using QE data.

Devices

A *sample* crystalline silicon solar cell of "unknown" QE with area of 0.125 cm2. In this lab, we want to find out the QE of this cell at different wavelengths (from 400 nm to 1100 nm).

A *sample* perovskite solar cell of "unknown" QE with area of 0.106 cm2. In this lab, we want to find out the QE of this cell at different wavelengths (from 400 nm to 700 nm).

A *reference* silicon photodiode of "known" QE with 0.05 cm^2 surface area. The QE of this photodiode at different wavelengths is uploaded in Drive folder, separately. Reference cell is the same in both cases.

Step1: Study

Do general reading about solar cell and their "Quantum Efficiency".
These links may be helpful:

http://www.pveducation.org/pvcdrom/solar-cell-operation/solar-cell-structure
http://www.pveducation.org/pvcdrom/solar-cell-operation/iv-curve
http://www.pveducation.org/pvcdrom/solar-cell-operation/open-circuit-voltage
http://www.pveducation.org/pvcdrom/solar-cell-operation/fill-factor
http://www.pveducation.org/pvcdrom/solar-cell-operation/quantum-efficiency

Step2: Data analysis and calculations

In your data analysis include the following:

Calculate and plot the EQE as a function of wavelength.

Calculate IQE and plot 1/IQE vs. 1/α where α is the absorption coefficient.

Step 3: Results and discussion

Answer the following questions ***in a separate section***:

1. What is the maximum QE for our sample?

2. Why does the value of QE drop at very low and at very high wavelengths?

3. What is the value of minority carrier diffusion length in the sample?

4. Using the diffusion length, calculate the mu-tau of carriers in the sample.

5. We know that the silicon sample should produce a current of 3.61 mA under the sun. Now, using the QE values we have just measured and solar flux at each wavelength, calculate the theoretical current, and see whether it matches the above-mentioned value. To do this, first calculate current at each wavelength, separately. Then add up the calculated currents to obtain total current under white light. A table which provides you with solar flux at different wavelengths is given. What is the current you obtain? How does it compare to 3.61 mA? Is there any difference? If yes, try to explain. We also measured IV of the cell in the lab, how does short circuit (Isc) current correspond to the calculated and known (3.61mA) values. If different, why?

Notes:

- For absorption coefficient values, use standard values from the literature.
- Calculate reflection when needed. Assume the sample is protected with a glass window. According to literature reflectance of silicon can be reduced by around 50% when covered with class. It can be further reduced by using anti-reflection coating.