BAPVC Annual Project Report

Project Title: Development of Multicolor Lock-in Photoluminescence Methods for In-Situ Process Monitoring and Ex-Situ Mapping of Solar Cell Absorber and Interface Quality

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Summary:
The focus of the project is to develop a new photoluminescence technique to interrogate surfaces and buried interfaces that is robust in a manufacturing environment and will generate easily interpretable output so that it can be correlated to product quality or even integrated into a process control scheme. The first step is to build a prototype of the instrument, and we are about 80% of the way to a fully functional prototype. We have demonstrated the excitation wavelength dependence in samples thus far in steady state mode (not lock-in mode).

Key Accomplishments:
The schematic of the full instrument set-up is shown in Figure 1. We are setting-up the instrument in segments and have thus far demonstrated the correct modulation of the laser pulses.

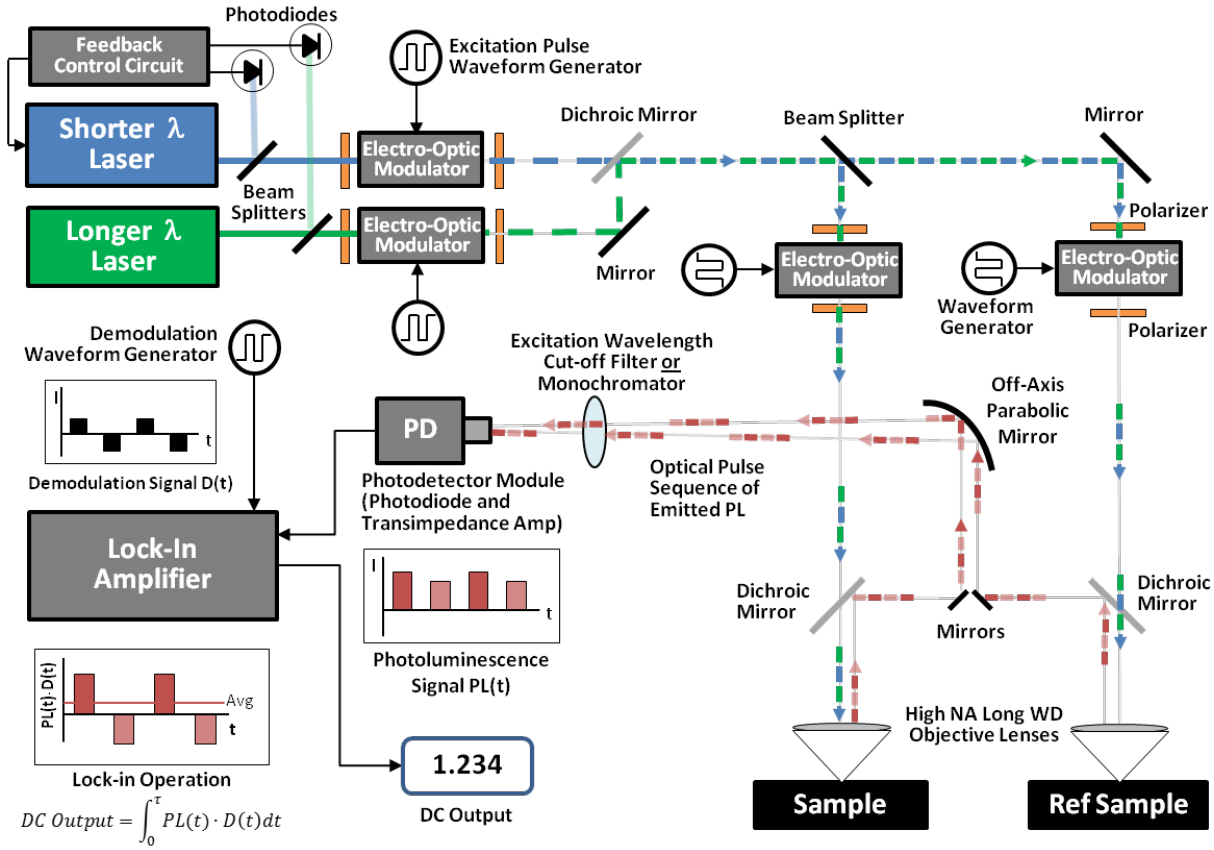

Figure 1. Initial schematic of a standalone modulated Multicolor Lock-in PL instrument that is robust to drift, fouling, and noise. The optical path from the exit of the last electro-optical modulator to the sample to the detector may be fiber coupled to avoid alignment issues.

In addition, we have demonstrated the effect of excitation wavelength on several samples in steady-state mode. Preliminary results showing the ratio of the photoluminescence spectral yield at 532 nm excitation to 785 excitation show an emission-energy independent ratio of 0.3 (see Figure 2).

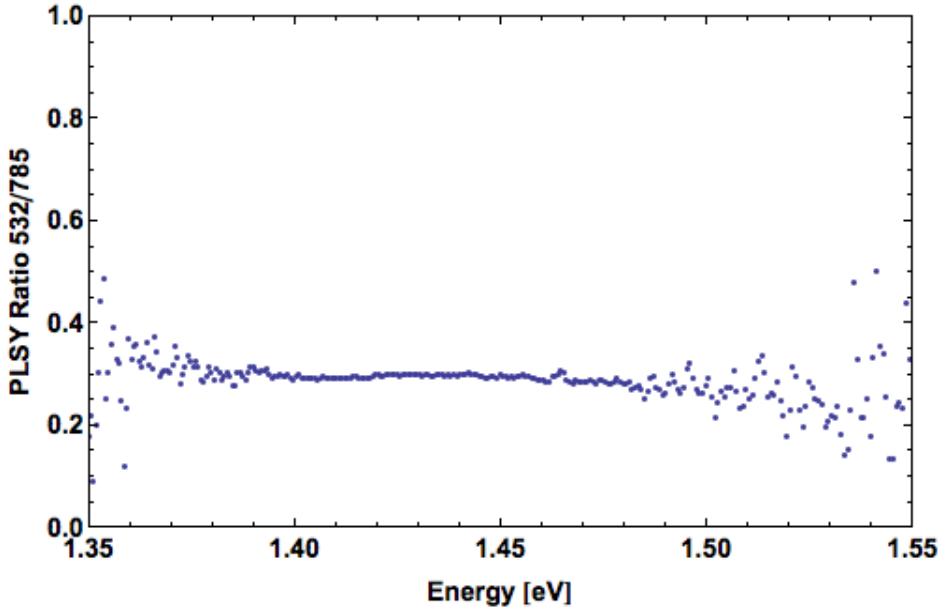

Figure 2. Ratio of the photoluminescence spectral yield (PLSY) of a p-GaAs sample at 532 nm excitation over the PLSY at 785 nm excitation. Note: PLSY is the spectrally resolved PL quantum yield per unit emission bandwidth. This shows that that surface is not passivated well. The noise at high and low energy is due to the loss of PL intensity.

Future Work:

Our next steps are to finish calibration of the individual components of the instrument and demonstrate data similar to Figure 2 in lock-in mode. We will then use the instrument to demonstrate its ability to detect and quantify surface quality and the quality of buried interfaces for CdTe and CIGSe.