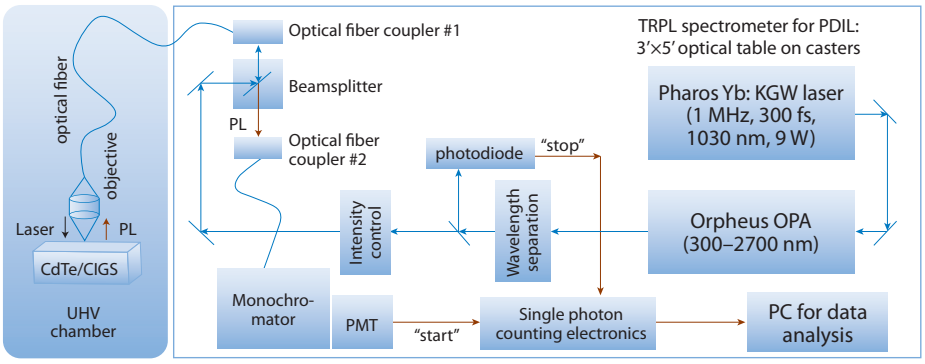
NREL Highlights
RESEARCH & DEVELOPMENT

# Vacuum-Based Time-Resolved Photoluminescence Measurement System Provides New Capability

New measurement capability measures semiconductor minority-carrier lifetimes in conditions that simulate thin-film photovoltaic manufacturing environments.

National Renewable Energy Laboratory (NREL) scientists have developed a new capability for measuring time-resolved photoluminescence (TRPL) in controlled environments, including under high vacuum and at elevated temperatures. This system enables the simulation of conditions in a thin-film photovoltaic (PV) manufacturing line. NREL's work in recent years has demonstrated a clear correlation between minority-carrier lifetime and thin-film PV device performance. Hence, the thin-film PV industry—both CIGS and CdTe—has a high level of interest for in-line metrology using NREL's TRPL system.

The system, shown below, couples femtosecond laser pulses with optical fibers while avoiding spectral or temporal broadening over a wide range of wavelengths. The optics are designed to collect and couple the TRPL signal into the same fiber used to deliver the laser pulses. The capability is coupled into a high-vacuum chamber that can heat samples to 500°C or higher and expose them to reactive ambients.




This tool will allow NREL to partner with industry to evaluate TRPL as a diagnostic at multiple stages of the manufacturing process and determine correlations to final module efficiency. The TRPL system has the potential to significantly improve manufacturing yield and throughput of current thin-film PV manufacturers.

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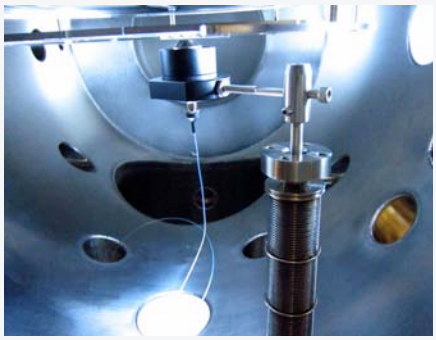

*Optical-fiber-based TRPL setup. Process Development and Integration Laboratory (PDIL) robot positions samples in ultra-high-vacuum (UHV) chamber. Optical objective is placed next to the sample to investigate thin-film PV materials and devices with 2–10-mm spatial resolution.* Photo by Darius Kuciauskas, NREL/PIX 19776

## Key Research Results

### Achievement

NREL developed a time-resolved photoluminescence (TRPL) system that can operate under high vacuum and at high temperatures.

### Key Result

Thin-film PV performance can be better assessed because of its clear correlation with minority-carrier lifetime, which can be measured by NREL's TRPL system.

### Potential Impact

Photovoltaic thin-film makers will be able to measure in-line TRPL at various stages of the manufacturing process, potentially leading to improved yield and throughput.

NREL
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