

Process Development and Integration Laboratory



Scope. The Process Development and Integration Laboratory (PDIL) within the National Renewable Energy Laboratory (NREL) is operated by the National Center for Photovoltaics (NCPV). The PDIL is a unique collaborative facility where industry and universities can work closely with NREL scientists on integrated equipment to answer pressing questions related to photovoltaics (PV) development. We work with a wide range of PV materials—from crystalline silicon to thin-films (amorphous, nano- and microcrystalline silicon, copper indium gallium diselenide [CIGS], cadmium telluride) to organic PV. The PDIL consists of four closely integrated core competencies:

Tool Development to PDIL standards:

- Uses common sample size and transport
- Eliminates air exposure between steps
- Can sequence steps in any order.

Integrated Hardware (tools) capable of:

- PV material deposition
- Material processing
- Measurements and characterization.

Our staff in the NCPV has more than 2000 person-years experience in solar PV and semiconductor research and is uniquely qualified to collaborate with industry, manufacturing, university, and government enterprises. Our subject-matter experts in each of the areas below are able capable of collaborating with you on research, problem solving, and commercial product development.

Core Competencies and Capabilities. In addition to the existing tools listed below, PDIL staff members are developing cluster tools for both CdTe and thin-silicon-film PV, as well as sputtering diagnostic tools.

Thin-Film Silicon

- Plasma-enhanced chemical vapor deposition (PECVD) of amorphous Si and SiN:H
- Hot-wire chemical vapor deposition (HWCVD) of amorphous Si
- Plasma etching
- Sputtering of transparent conducting oxides (TCOs)
- High-resolution optical metrology (n & k)
- Photothermal deflection spectroscopy

CIGS Cluster Tool

- Co-evaporation of CIGS
- Sputtering of CdS, Mo, and TCOs

Atmospheric Processing Platform

- Ink-jet printing
- Ultrasonic spray deposition
- Sputtering deposition
- Slot coating

Contact/Web

- Kaitlyn VanSant Kaitlyn.VanSant@nrel.gov, 303-384-7863
- Web: www.nrel.gov/pv/pdil/

Integrated Data Systems that:

- Automate control via recipes
- Share data easily and securely
- Facilitate analysis.

Integrated PV Materials to:

- Mix and match in any sequence
- Provide greater device flexibility
- Allow material property studies at any step.

Measurements and Characterization (M&C)

- Spectroscopic ellipsometry
- Resonance-coupled photoconductive decay (RC-PCD)
- Photoluminescence imaging
- Auger electron spectroscopy (AES)
- X-ray photoelectron spectroscopy (XPS)
- Scanning electron microscopy (SEM)
- Atomic force microscopy (AFM)
- Reflectance spectroscopy
- Optical processing furnace
- Semilab