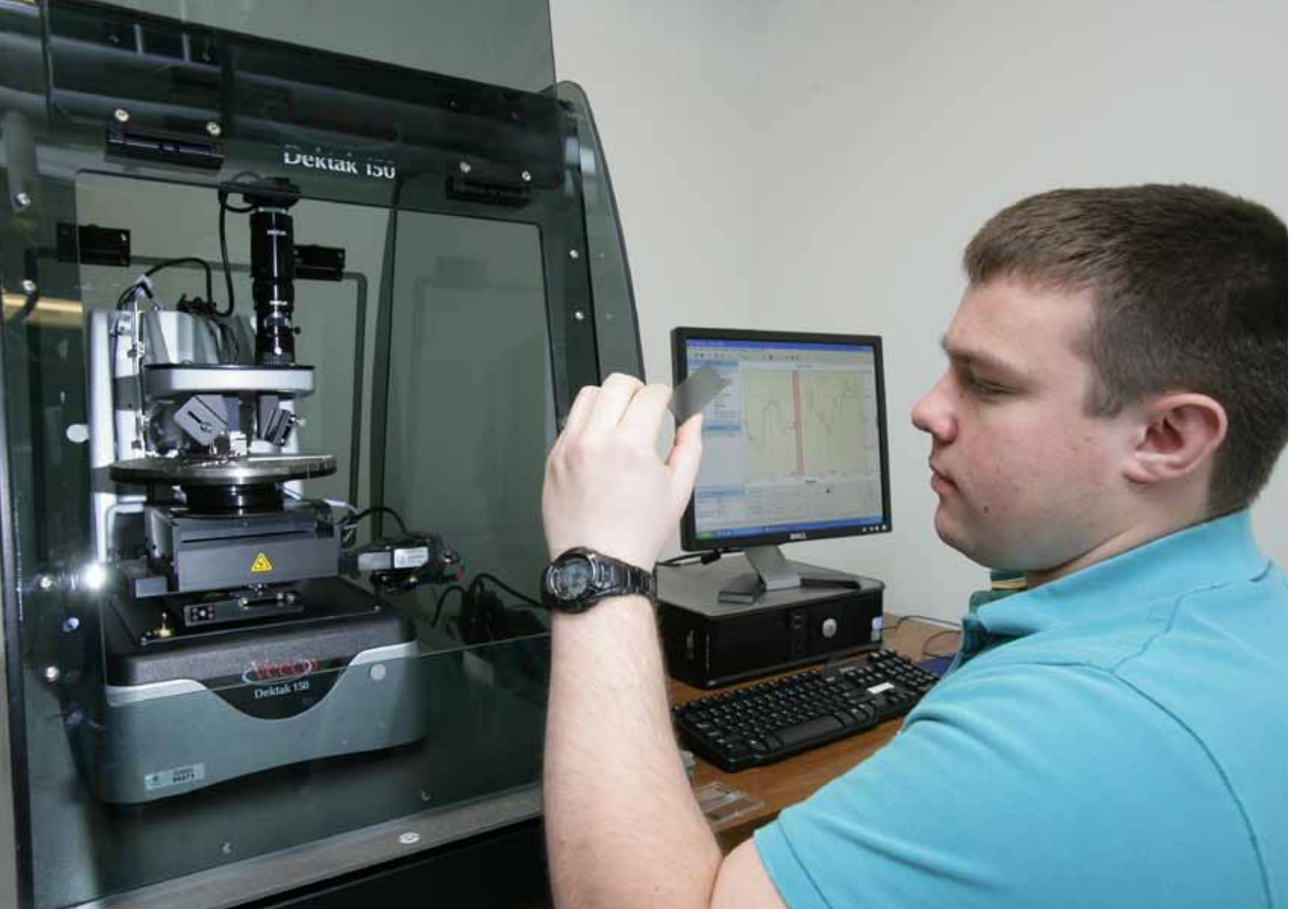
Photovoltaic Equipment Resources at The University of Toledo



Photovoltaic Equipment Resources at the University of Toledo (UT)

The University of Toledo (UT) has a long history of thin-film photovoltaic research and commercialization. Recently, these research efforts were complemented by the addition of faculty members researching nanomaterials for photovoltaic applications. As a result of the collective work, a suite of advanced instrumentation and capabilities for photovoltaics research and development has been established at UT with support from the U.S. Air Force, NASA, the U.S. Department of Energy, and Ohio's Third Frontier Program, which established the Wright Center for Photovoltaics Innovation and Commercialization (PVIC). Coupled with instrumentation that is available through the College of Engineering's Imaging Center and the College of Arts and Sciences' Instrumentation Center, UT can offer world-class collaboration opportunities to academic and corporate partners. In this brochure, is a list of capabilities that will be available to support possible joint research activities. Several of these capabilities are already installed and are available now in the Clean and Alternative Energy Incubator or elsewhere on campus. The balance will be available once the current construction phase at the Incubator is complete and new equipment is installed over the next 2-6 months.

The following equipment will be updated as new capabilities are added. Please let us know if there is a key capability missing that would be of interest to your company.

Processing and Handling of Materials and Chemicals

UT has expertise in thin-film photovoltaic devices, as well as next-generation nanomaterial devices. As a result, the wide variety of processing and handling techniques listed below is supported. UT understands the possible dangers involved with some of these materials, and, as a result, follows toxic materials and nanomaterials handling protocols. Additionally, toxic gases are monitored and instruments are interlocked for additional safety.

- Clean room
- Deposition of metallic contacts including Mo, Al, Au, Cu, Ti
- Deposition of semiconductor materials, including a-Si:H, nc-Si:H, poly-Si, CdTe, CdS, and CIGS
- Deposition of TCOs and metals (contacts)
- Deposition of TCOs including ITO, ZnO:Al, SnO2
- Differential Scanning Calorimetry
- Dual ion beam deposition
- Glove-boxes for handling samples in inert atmospheres
- Laser Scribing
- Nanomaterials synthesis
- Preparation of grid lines – lithography
- Processes including plasma chemical vapor deposition, physical vapor deposition, and sputtering
- Spin, dip, and spray deposition of nanoparticles and nanoparticle precursors
- Thermal gravimetric analysis
- Thermal processing

Optical Properties

One of the strengths at UT is the ability to measure optical properties in real time using spectroscopic ellipsometry. In addition to these real-time measurements, the following capabilities are available to measure optical properties:

- Broadband (UV to mid-IR) transient absorption spectroscopy
- Mid-IR transmission and reflectance spectroscopy and spectroscopic ellipsometry
- Photoluminescence and I/V surface mapping
- Steady-state and time resolved photoluminescence and spectroscopy
- UV-Vis-NIR optical absorption
- UV-Vis-NIR spectroscopic ellipsometry, real time and ex situ modes

Imaging and Structure Analysis:

UT has established several centers devoted to imaging and structure analysis in addition to those located at the PV research locations. All of the capabilities listed below are available for use:

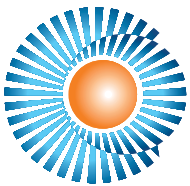
- Atomic Force Microscopy
- Raman spectroscopy
- Scanning Confocal Microscopy
- Scanning Electron Microscopy with energy dispersive X-ray spectroscopy
- X-ray diffraction
- Transmission Electron Microscopy
- Depth Profiling Auger Electron Spectroscopy

Testing

Through funding from NASA and the PVIC, UT is in the process of equipping a panel testing facility. Through other sources, UT also has instruments for testing smaller scale devices and cells. The following is a list of testing equipment available:

- Accelerated life testing at one sun equivalent and elevated temperature
- Cell I/V and efficiency testing with small area solar simulator
- Environmental and weatherization
- Inert atmosphere quantum efficiency and I/V
- Large area 1.1 m x 1.5 m off-line thin film materials mapping for thickness, index of refraction, and extinction coefficient determination
- Laser beam induced current mapping spectroscopy
- Module-scale current-voltage (I/V) testing with large area solar simulator
- Online thin-film materials mapping designed for glass panel conveyer line
- Voltage breakdown

This brochure is funded by:



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