APPLICATION NOTE

SPECTROSCOPY IN SOLAR PANEL PRODUCTION

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The measurement needs of the solar industry are quite diverse, ranging from process control applications in the manufacturing of thin film photovoltaic panels through direct solar measurements and solar simulator characterization. Avantes has worked closely together with a number of industrial and research customers in the solar industry to design spectroscopy and spectroradiometry systems that meet the demands of this fast-growing industry.

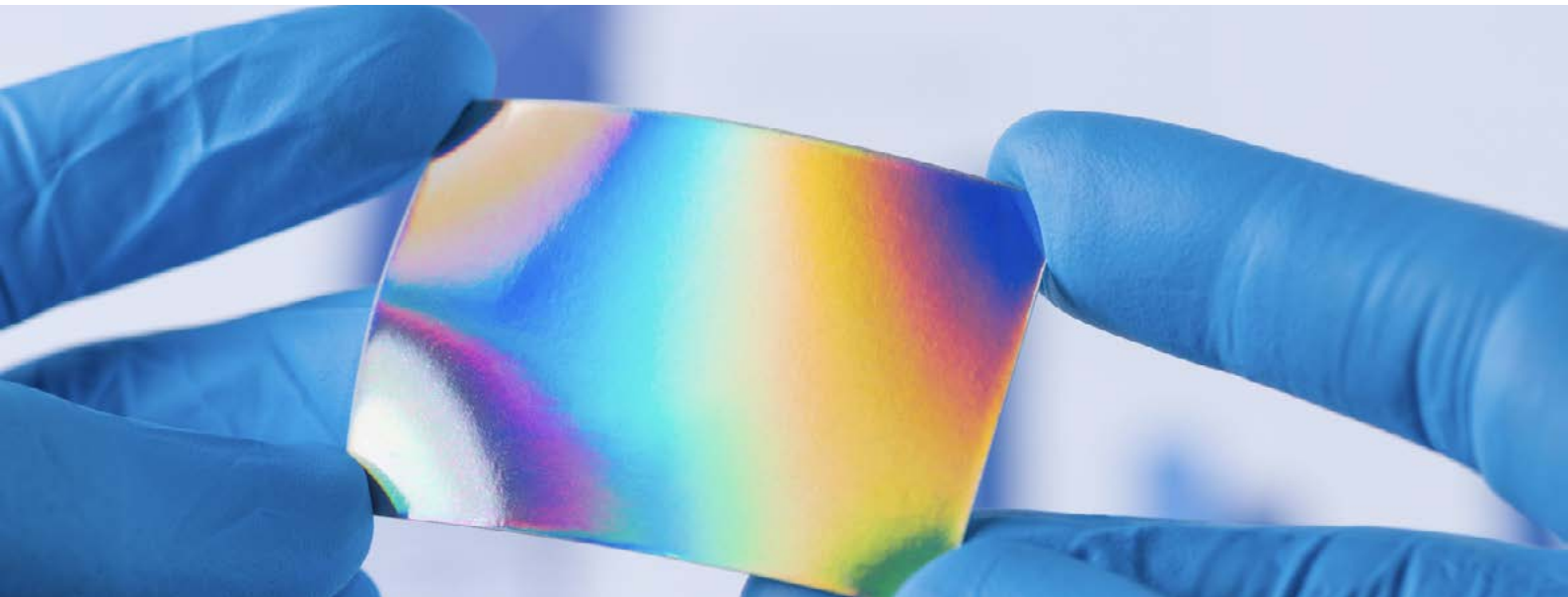
In this application note we highlight a couple applications in the solar industry in which spectroscopy is implemented.

MONITOR THIN FILM PRODUCTION & QUALITY CONTROL

In-line monitoring of thin film solar panel manufacturing is a process control function which requires high speed, 24/7 spectral data acquisition over long duration production runs. Typical applications involve real-time plasma emission monitoring or reflection measurements in the range from 200-1700 nm during the deposition process of CIGS, CdTe and other materials on substrate materials. Multi-point monitoring in various stages of the process and at regular intervals across a web of material is often desirable. Avantes industrial, multi-channel AvaSpec spectrometers are ideally suited to inline spectroscopic measurements.

Capable of supporting up to 10 simultaneously spectrometer channels, the rackmount platform can accommodate a number of detector options from low cost, front-illuminated CCDs to high sensitivity back-thinned CCDs and InGaAs detectors for the NIR range. Fiber optics enable porting of the measured signals from the detection point to a control modules nearby or up to hundreds of meters away. The AvaSpec-ULS2048CL-EVO and AvaSpec-NIR256-1.7-EVO are ideally suited to this application because of their high speed processing capabilities, high resolution and excellent throughput in the wavelengths of interest.

Quality control inspection of thin film solar panels can also be achieved with Avantes spectrometers. This process may include a quantitative thin film reflection measurement to measure single or multilayer coatings. The AvaSpec-ULS2048CL-EVO provides an excellent instrument for thin film metrology from 200-1100 nm and the AvaSpec-NIR256-1.7-EVO extends the range out to 1750 nm. Avantes OEM modules are an affordable alternative for high volume manufacturers that prefer to integrate spectrometers into their manufacturing control systems. All of Avantes instruments are available as lab instruments or OEM modules.

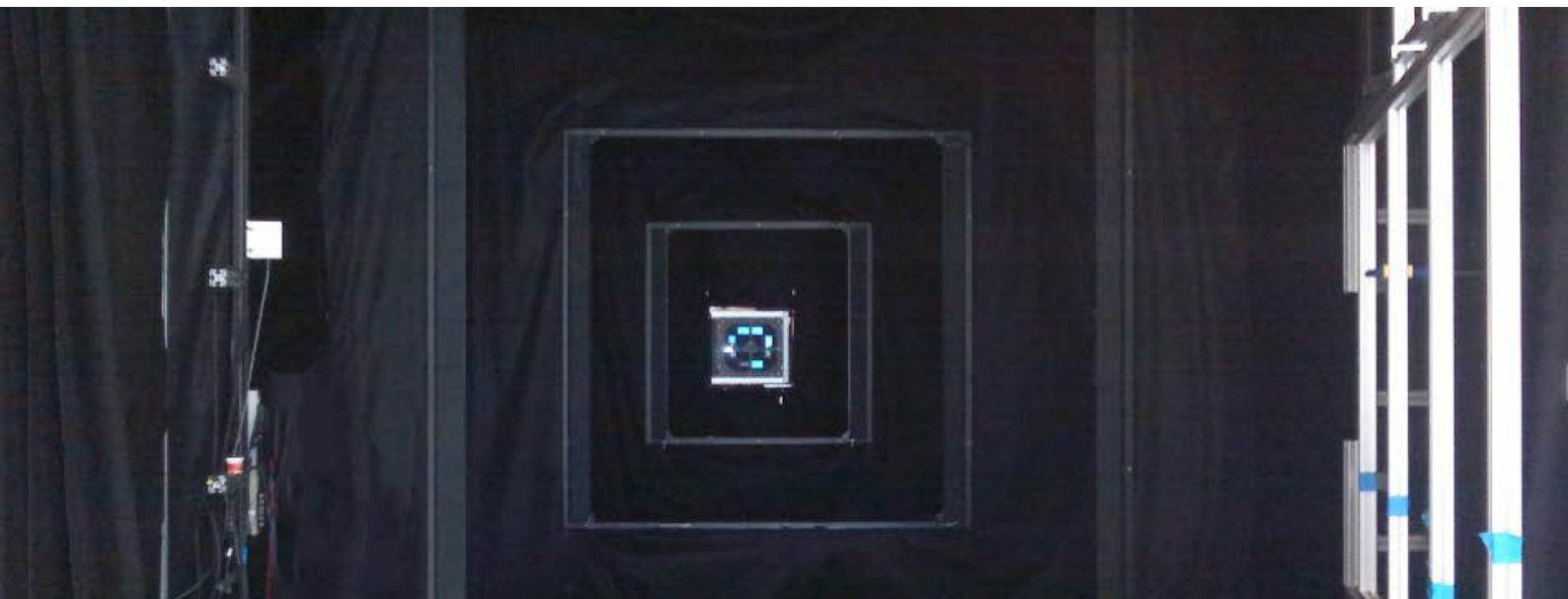


SOLAR SIMULATOR CHARACTERIZATION

Solar simulators are a critical tool for test and measurement of photo-voltaic arrays, but their characterization can difficult as each manufacturer has different design features to meet the needs of the many photo-voltaic panel manufacturers.

ASTM E927 – 10 Standard Specification for Solar Simulation for Terrestrial Photovoltaic Testing and IEC 60904 Photovoltaic Devices are standards which provide testing procedures for measuring pulsed and continuous wave solar simulators. The class of solar simulator is defined by the similarity of the measured spectrum to the Air Mass 1.5 Global (AM1.5G) reference spectrum. Avantes spectroradiometer solutions consist of a spectrometer, fiber-optic cable and a sampling head which is typically a cosine diffuser or an integrating sphere. These components are irradiance calibrated using an NIST traceable source and delivered as a calibrated system. Avantes' SensLine series of back-thinned CCD instruments is well suited to this application due to the relatively high quantum efficiency of the detectors in the UV (250-400 nm) and NIR (>900 nm) range.

The AvaTrigger is a device used to facilitate triggering Avantes instruments to enable measurement of pulsed solar simulators. Avantes spectrometers have the unique ability to collect and store spectra to on-board RAM. This capability provides ultra-fast data collection and storage which is often required for characterizing the uniformity of pulsed solar simulators. The DLL package we offer enables our customers to develop their own code for demonstrating adherence to the various photovoltaic standards. The DLL package comes with samples programs in Delphi, Visual Basic, C#, C++, LabView and many other programming environments.



PRODUCT

HIGHLIGHT

Avantes' SensLine spectrometers are the ideal solution for typical demanding applications such as fluorescence, luminescence and irradiance. The SensLine include several high-sensitivity, low-noise spectrometers. A number of these models contain high-performance, thermoelectrically cooled detectors with back-thinned technology. The other models feature standard CCDs, upgraded to high-performing instruments as a result of Avantes' unique detector cooling technology. The back-thinned CCD detectors featured in the SensLine are high quantum efficiency detectors with excellent response in the ultraviolet, visible and near-infrared range from 200 to 1160 nm. All AvaSpec SensLine instruments are fully integrated with Avantes' modular platform, allowing them to function as both stand-alone and multi-channel instruments. Every instrument is available as lab instrument or OEM module, for integration into existing systems.

DIRECT SOLAR MEASUREMENT

Measurement of direct solar radiation is necessary for both research and industrial applications. Government labs and many university researchers use Avantes spectroradiometer systems to measure solar radiation for research on climate change. Industrial customers may use Avantes systems to quantify solar concentrators, monitoring heliostats or as a alternative technology for a spectro-heliometer.

Avantes solutions for direct solar measurements typically consist of a dual-channel spectrometer covering 250-1700 nm or 250-2500 nm depending upon the needs of the customer. A specialized bifurcated fiber-optic cable is used to couple the spectrometer to the sensor head which is normally a cosine function diffuser (CC-UV/VIS/NIR or CC-UV/VIS/NIR-8 mm) with a 180 degree field of view or a 5 degree cosine function diffuser (CC-UV/VIS/NIR-5.0) for solar tracking. The flexibility of fiber optics enable placement of the sensor head at a distance several meters away from the spectrometer which is typically housed in a temperature regulated environment. Our AvaSoft software enables the integration of two more spectra from each spectrometer into a single combined spectrum for the range of interest.

AVANTES
MEMBER OF THE NYNOMIC GROUP

CONTACT

WE'RE HAPPY TO HELP

Curious how spectroscopy can help you reveal answers by measuring all kind of materials, in-line, at your production facility, in a lab or even in the field? Please visit our website or contact one of our technical experts, we're happy to help you.

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