

Turn
sun



into
gold

SolR in-line monitoring system
for thin-film photovoltaic processes

As the world's fastest growing power generation technology, the photovoltaic (PV) industry demands increasing efficiency. The **LayTec SolR** provides a unique approach to monitoring thin-film PV processes that greatly improves traditional off-line and batch sampling methods. The **SolR** is an in-line system that is capable of measuring the properties and thickness of all layers – transparent conducting oxide (TCO), absorber and buffer layers – throughout the solar cell manufacturing process.

Thin-film PV producers have realized a lot of benefits through the ability to control their production on-line. Production anomalies are quickly identified and corrected, development cycles are accelerated, transfer and ramp up of established processes to new lines are facilitated and conditions are easily re-established after maintenance. This all adds up to greater yields and reduced costs – the most important factor in today's PV cell production!

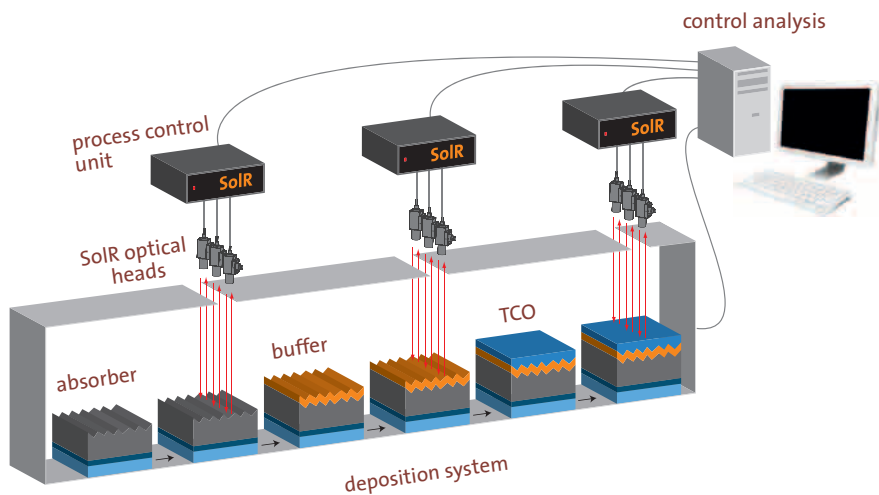
The **SolR** monitoring system is based on specular spectroscopic reflectance measurements. It is designed for a perfect in-line control of all thin-film PV processes. **SolR** is available in various editions for copper indium gallium selenide (CIGS), cadmium telluride (CdTe), amorphous microcrystalline Si and organic material based thin-film solar cells. Set-ups for roll-to-roll applications are available as well.

SolR can be adapted to virtually any PV thin-film deposition system. It is designed to be integrated into typical in-line and roll-to-roll processes and applicable to all major types of substrates and PV cell designs.



SolR features:

- adaptable to every in-line process via customized optical heads and mounts
- spatially resolved thickness measurements through multiple heads
- fast data acquisition for in-line measurements on moving substrates
- automated film thickness analysis (incl. algorithms for rough layers and LayTec dispersion database for all PV materials)
- PV-line software integration via Profibus, Ethernet, TCP/IP or other protocols for automated operation



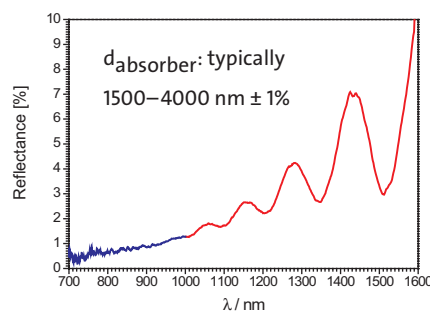
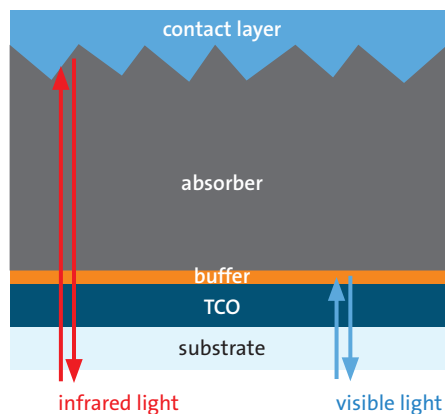
SoIR ensures precise homogeneity control through multiple heads in-line!

Reflectance measurements after each deposition step are mandatory for a precise thickness determination of thin layers on rough materials. The position and number of interference fringes measured are automatically analyzed and fitted to determine the film thickness on-line.

While the TCO and CdS film thicknesses are detected with a spectrometer operating in the visible to near infrared spectral range (500–1000 nm), a determination of the film thickness of the absorber layer requires an infrared reflectance measurement, as these materials are designed to completely absorb visible light.

The thickness measurement accuracy is typically 1–2 %. LayTec’s expertise on fitting optical data and deriving accurate optical properties (n and k values) of the layers in a multi-layer process is applied for the most precise automated thickness analysis available for thin-film PV today!

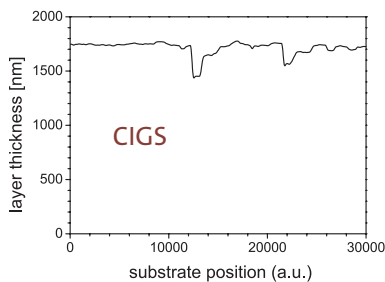
In-line characterization of each layer in CdTe structure



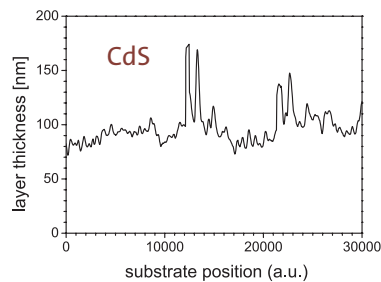
- visible light provides information on the buffer and TCO layers
- infrared light probes the whole stack
- measurement after each deposition step is performed to obtain the precise film thickness of each layer

Real-time thickness determination and conductivity fingerprints of thin-film PV layers in-line

In-line position resolved thickness measurements

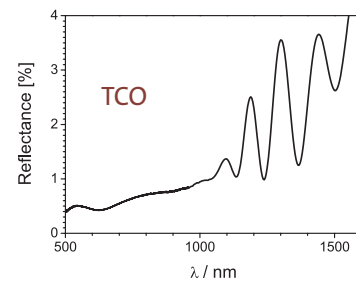


1800 nm CIGS: accuracy $\pm 1\%$



100 nm CdS: accuracy $\pm 2\%$

In-line spectra



250 nm TCO: accuracy $\pm 2\%$



SolR provides in-line access to key parameters of each layer:

- film thickness
- homogeneity
- effective absorption
- conductivity fingerprints
- interdiffusion effects
- roughness and texture information

Founded in 1999, LayTec has become a major provider of in-situ and in-line optical metrology systems for thin-film processes. In 2009 LayTec belongs to the 50 fastest growing technology companies in Germany according to the Deloitte Fast 50 ranking.

LayTec's optical in-situ and in-line sensor systems are used in a broad range of thin-film applications such as compound semiconductors, photovoltaics, oxides and organic materials. It combines advanced measurement techniques such as reflectometry, emissivity-corrected pyrometry, laser deflectometry and reflectance anisotropy spectroscopy to create products with unique benefits. LayTec's integrated metrology provides access to all key thin-film parameters in real-time – either in-situ during the deposition process or in-line.

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