SolR® for measurement on CdTe-based cells

LayTec has developed a new in-line monitoring system that is capable of measuring the properties of the layers throughout the solar cell manufacturing process: layer thickness of each layer, conductivity of transparent oxide layers, effective absorption and roughness. This note presents the in-line application in a CdTe production line.

SolR® is based on specular spectroscopic reflectance measurements (500-1600 nm). Since light is reflected from the surface and all interfaces within a layer stack interferes, the spectrum of the reflected light shows an interference pattern bearing information on the refractive index n, the index of absorption k and the thickness d of all layers deposited in the PV thin-film process so far.

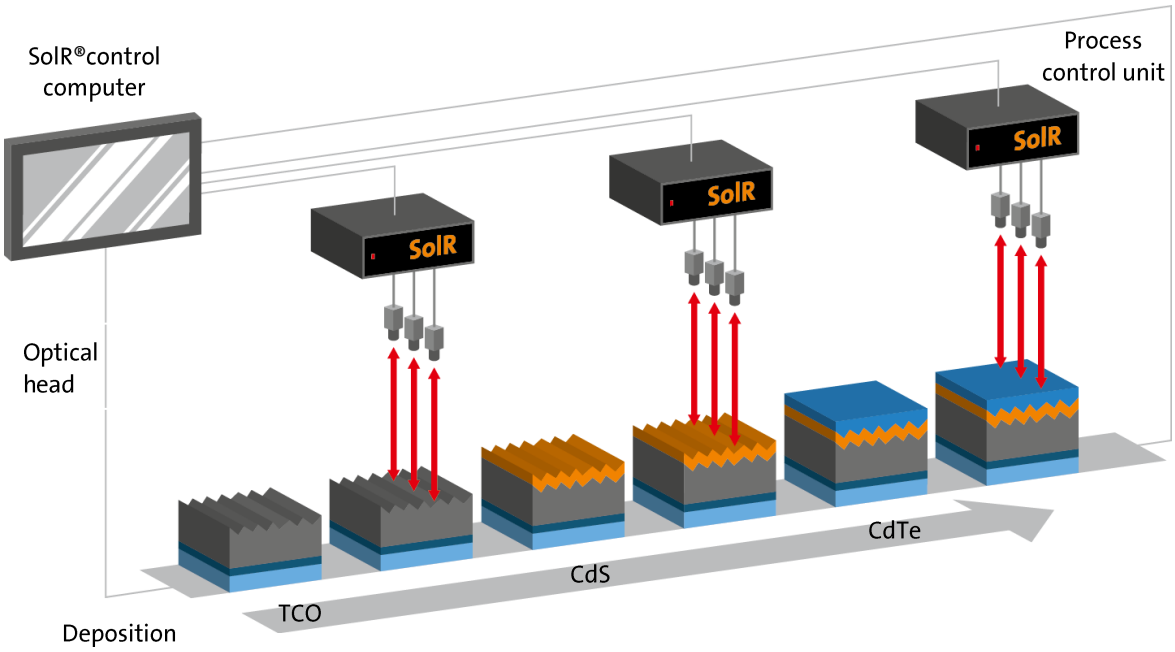

Fig. 1: Reflection spectra from a complete CdTe solar cell complete stack

The **SolR®** control computer communicates with the production line control software to assure that measurements and reflectance spectra are taken after each deposition. The optical heads are positioned in the transfer lines between the deposition chambers (see **Fig. 1**). In the following typical spectra from a CdTe based solar cell process are discussed.

For TCO layers a measurement of the TCO thickness, the haze and a conductivity fingerprint can be derived out of one measurement head (see **LayTec**´s Application Note 4 for more details). For CdS layers on top of TCO/glass the film thickness can be determined accurately by spectral reflectance measurement (**Fig. 2** shows a typical spectrum). Reflectance measurements on the same position before and after CdS deposition ensure the most accurate way to determine the CdS layer thickness in-line. The interference structure is slightly broadened.

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In order to measure the CdTe film thickness accurately and determine homogeneity variations reflectance measurements in the infra-red spectral range (1000-1600nm) are mandatory, as the CdTe is transparent for wavelength >1000 nm only (see **Fig. 3**). These measurements have to be made from the top side as the TCO and CdS layers would partially absorb the measurement light when measuring through the substrate.

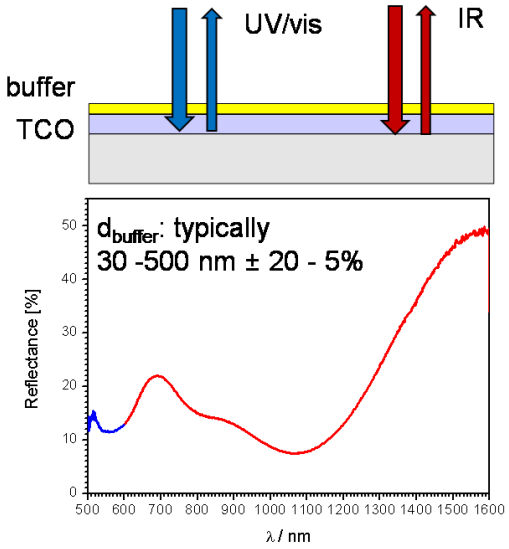

Fig. 2: CdS on TCO coated glass UV-vis reflectance (< 550 nm) and IR reflectance. The reflectance spectrum of CdS layer thickness thickness with d_{buffer} typically 30 -500 nm ± 20-5%

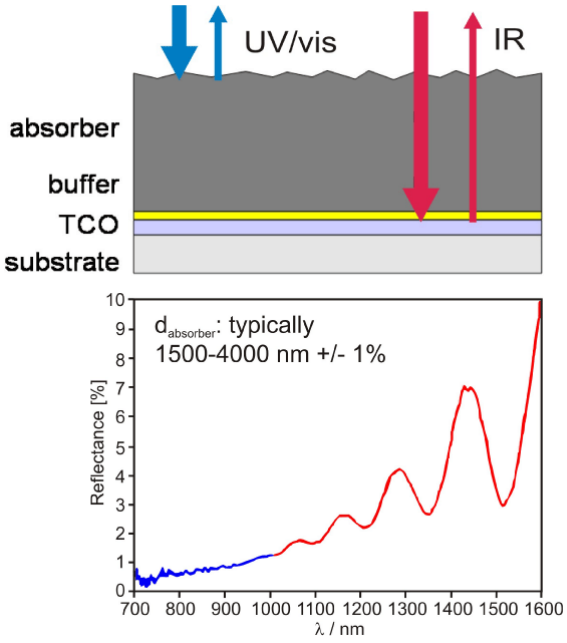

Fig. 3: Reflection spectra from a complete CdTe solar cell complete stack

Usually CdTe layers intentionally have a very rough surface resulting in a decreased surface reflectivity caused by stray light. **SolR®** measurement heads from **LayTec** are optimized for this specific low-intensity reflectance application and hence the CdTe film thickness can be determined within 1-2% typically.

A good lateral resolution for the detection of inhomogeneities is achieved by the multi-head concept.

For more information please visit www.laytec.de or contact info@laytec.de.