

Flames IR for measurement on CdTe-based cells

LayTec has developed an in-line monitoring system which is capable of measuring the quality of the individual layers throughout the manufacturing process of a thin-film solar cell. The following properties are tracked: layer thickness, conductivity, effective absorption, scattering properties and roughness. This note presents the in-line application of Flames IR in a CdTe production line.

Flames IR is based on specular spectroscopic reflectance measurements (500-1600 nm). The light of a halogen light source is irradiated to a specimen and the spectrum of the reflected light is analyzed. The incident light is reflected from the surface and all interfaces within a layer stack. Thus, the spectrum of the reflected light represents an interference pattern bearing information on the refractive index n , the extinction coefficient k and the thickness d of all layers. The recorded data are evaluated in real-time by the Flames IR control computer which is also connected to the software controlling the production line.

Significant insights are gained by taking reflectance spectra after each deposition step. Hence, the optical heads are placed above 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 and a conductivity fingerprint can be derived using one optical head. 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).

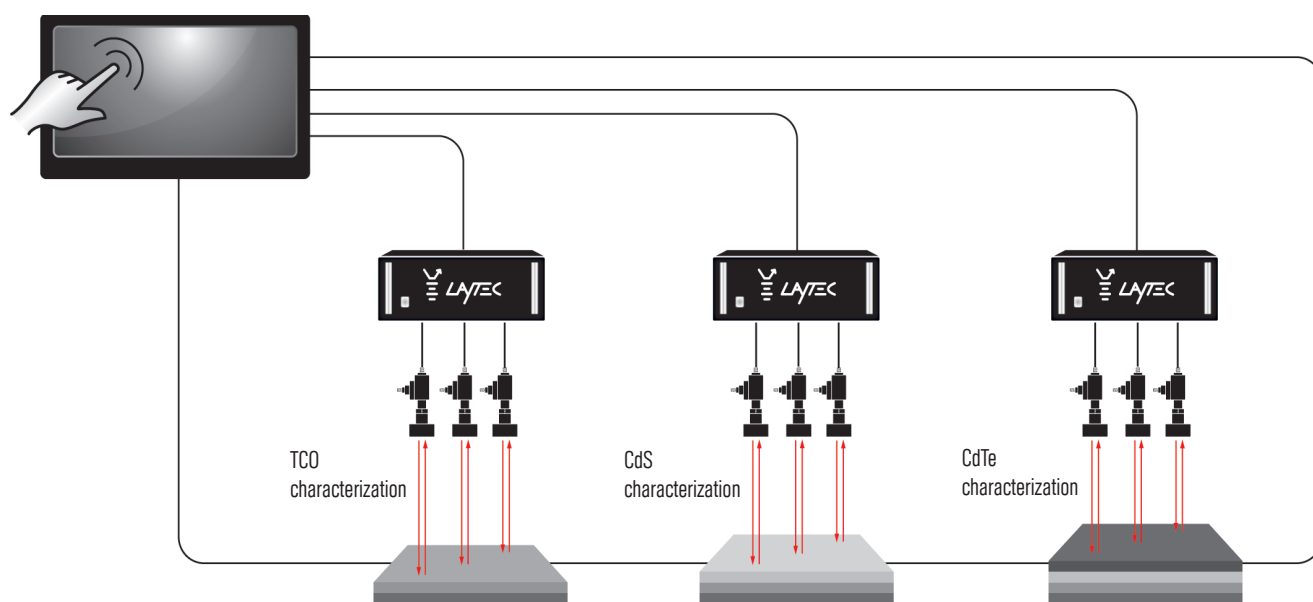


Fig. 1: Set-up of Flames IR integrated in a CdTe production line. Spectra are taken after each deposition step

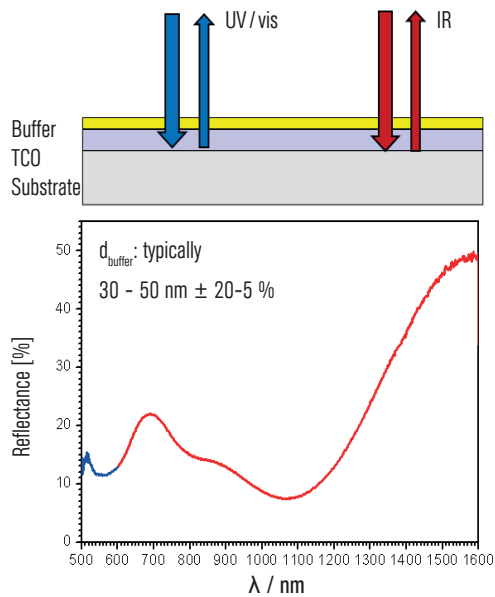


Fig. 2: CdS on TCO coated glass UV / vis reflectance (< 550 nm) and IR reflectance

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.

In order to determine the CdTe film thickness and homogeneity variations, reflectance measurements in the infra-red spectral range (1000-1600 nm) are mandatory, as CdTe is transparent for wavelength > 1000 nm (see Fig. 3) by the TCO and CdS layers.

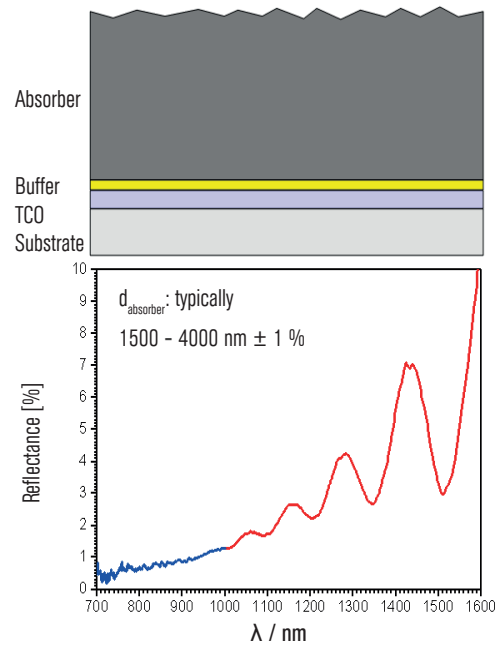


Fig. 3: Reflection spectra from a complete CdTe solar cell stack

The measurements have to be performed from the top in order to avoid absorption. Usually, CdTe layers are designed to have a very rough surface in order to achieve a decreased surface reflectivity. Flames IR measurement heads from LayTec are optimized to deal with the resulting low-intensity reflectance 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/Flames or contact info@laytec.de.