

ILMetro R2R – an integrated metrology station for quality control of roll-to-roll-processed thin films

Based on its ILMetro in-line metrology platform, LayTec has developed an integrated metrology station which has been particularly designed to meet the specific requirements of roll-to-roll-processed thin film production. By combining various thin film metrology methods, ILMetro R2R allows for a fully automated and comprehensive characterization and quality control of all process steps in an industrial production environment.

LayTec's ILMetro R2R metrology system is able to measure various thin film properties of roll-to-roll-coated (R2R) foils. Parameters like layer thickness, sheet resistance and transparency can be automatically determined with freely adjustable scanning densities or patterns along the entire foil length. Recently, the first system has been

successfully commissioned at a leading manufacturer of flexible photovoltaic modules. It controls a winder system at high precision for positioning the foil underneath the measurement head and characterizes all critical layers of the film stack for a self-sufficient, comprehensive quality control of the layer properties.



Fig. 1 ILMetro R2R metrology system as recently installed by a leading manufacturer of flexible photovoltaic modules. Here the system is directly integrated into a winder system for transporting the foil to the appropriate measurement positions for quality control purposes.

The characterization of thin layers deposited on flexible foils is becoming more and more important from a technological point of view. The layer thickness of these functional layers is usually in the nanometer range and therefore requires high-precision measurement methods. While such layers on non-flexible, planar substrates can regularly be characterized fully automatically by means of optical methods like spectral reflectance, measurement on flexible foils has so far been a major challenge due to the generally unavoidable residual waviness of the foils, which usually disturbs the focusing of the optics and thus prevents a sufficient measurement accuracy of a few nanometers from being achieved.

To enable such measurements, the measurement head is equipped with an automated unit for focus tracking. Consequently, even with significant residual waviness in the film, it can be ensured at any time that focused measurements are carried out and the maximum measurement accuracy is achieved (here in the single-digit nanometer range). Furthermore, all motion-sensitive optical components are integrated into the movable measuring head itself so that any relative movements and thus interference with the optical signals are avoided.

To allow the analysis of small-size R&D-samples, the system was also equipped with a separate compartment for the manual handling and analysis of such samples (Fig. 2).

In addition to autonomous measuring stations in mapping mode, ILMetro R2R can also be integrated in-line directly into the production line transport system so that the process flow triggers the measurements and the measurement results can be directly fed into the production database and used for process control.

Depending on the requirements of the production process for a particular thin film device, ILMetro R2R can be equipped with a combination of any of the following metrology methods:

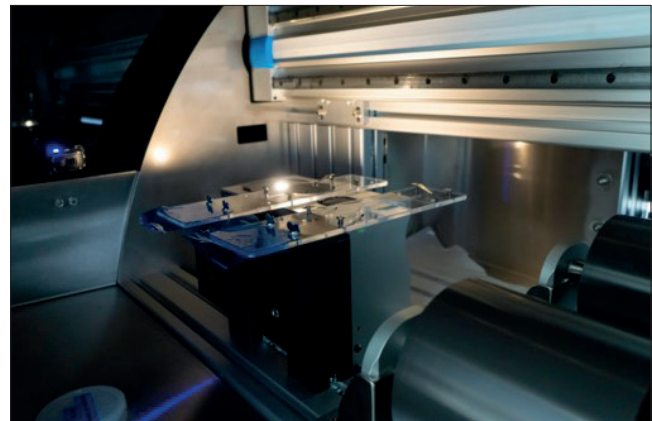


Fig. 2: Separate sample compartment for the manual characterization for small-scale R&D samples.

- Spectral reflectance (VIS, NIR)
- Spectral transmittance (VIS, NIR)
- Eddy-current measurements
- Spectral photoluminescence
- Time-resolved photoluminescence

By applying these metrology methods the following parameters can be monitored:

- Film thickness
- Wavelength-dependent reflection
- Wavelength-dependent transmission
- Wavelength-dependent absorption
- Color
- Sheet resistance
- Effective band gap of semiconductors (possibly also composition if related to band gap)
- Electronic carrier lifetime (down to 5ns)

For more information about the ILMetro metrology system please visit www.laytec.de/ILMetro or contact info@laytec.de.

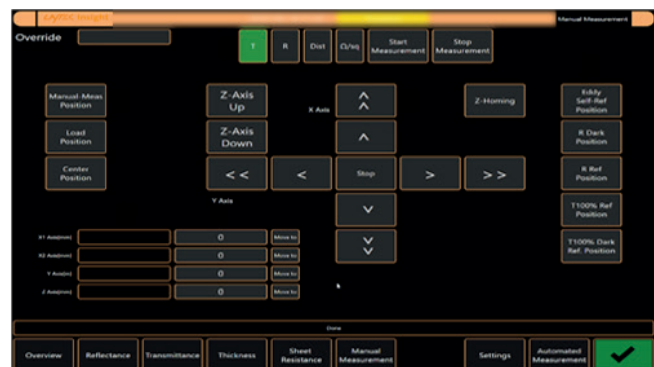
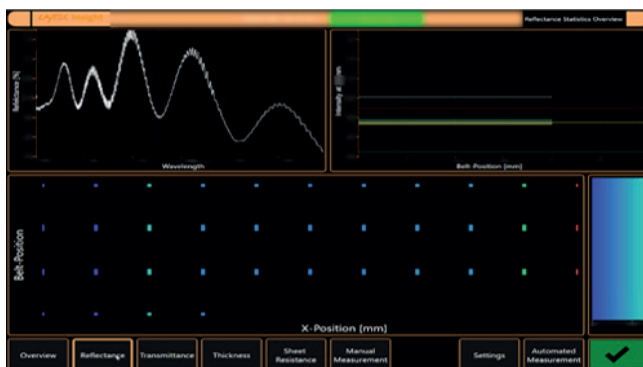


Fig. 3 Views of the ILMetro R2R software GUI. Left: View for reflectance data displaying the current spectrum as well as a corresponding distribution map and SPC chart. Similar views are provided for each method. Right: View for winder control.

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