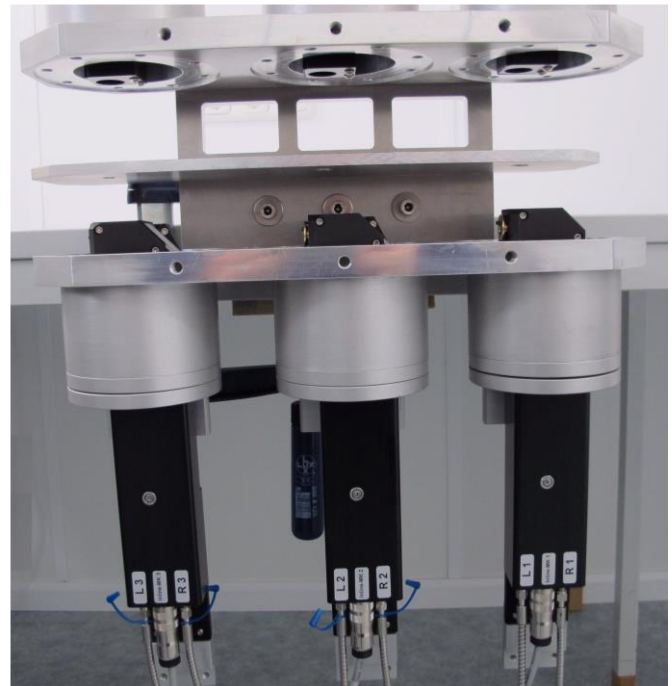
Xelas INLINE-tfs

Inline control of layer thicknesses for Thin Film Solar cells

NXT

Xelas INLINE-tfs : Thickness and n&k control for Thin Film Solar production

Solar applications have become more competitive in the recent years, with respect to quality and manufacturing costs. Wafer-based solar cells still own a large share of the global market due to fast and reliable production equipment and the drop in raw material costs.
Thin film solar cells will offer a wide range of alterantives with high potential for increasing efficiency and production yield. Both need the support of inspection equipment to keep any component under check 24h a day. Physical parameters like absolute layer thickness and material properties lay the foundation for excellent cell performance.
Special optical design of the inspection device is essential to provide accurate spectral measurements in reflectance and transmittance, from which the thicknesses are determined in fast speed.



Full 3-channel reflectance-setup for inline thickness control

Solution for TFS inline measurements

NXT offers unique equipment to measure the layer thicknesses as well as refractive and absorption index of any kind of TFS layer or stack, taking surface roughness into account. The system's optical RT-heads are designed and optimized for high-accurate and stable inline testing to guarantee absolute measurement results under production conditions.

Patented RT-Method!

Highlights of Xelas INLINE-tfs

Measurement of all types of cells:

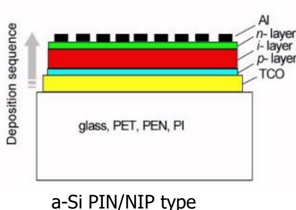
- TCO layers of any kind
- a-Si/µc-Si layers and stacks
- CIS/CIGS stacks
- CdTe based systems
- Organic solar cells

Works under real process environments

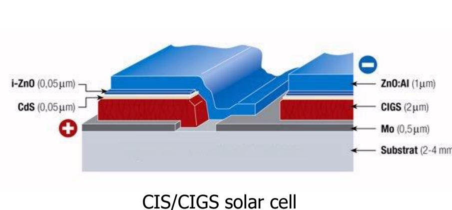
- Special design of both R- and T-head for highest value stability with respect to height and tilt tolerances
- Automatic internal calibration
- Contactless and non-destructive
- Fast measurement speed

Fiber multiplexing system for multi-channel inline control

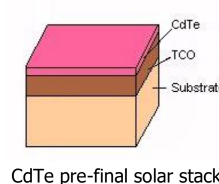
Thin Film Solar stack types for which Xelas INLINE-tfs can be used



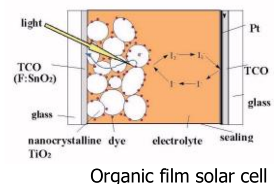
a-Si PIN/NIP type



CIS/CIGS solar cell



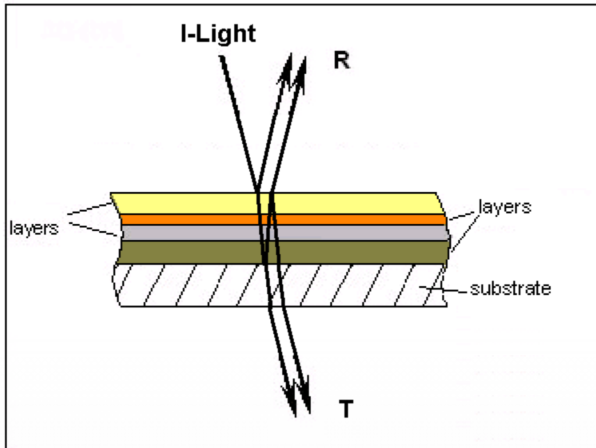
CdTe pre-final solar stack



Organic film solar cell

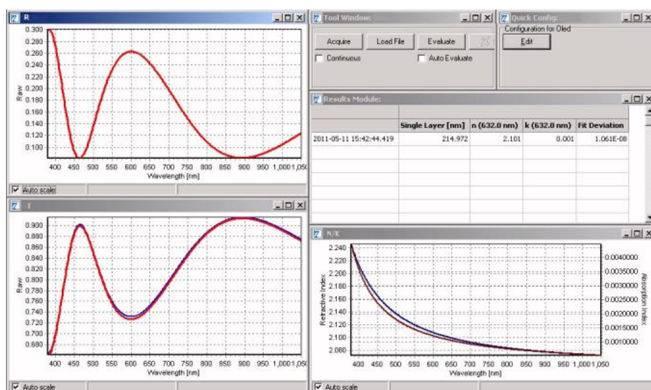
Principle of Measurement

Phase differences between the front and rear side reflection of thin layers cause interference. Absorption inside each layer changes light wave amplitude. Both of these phenomenona can be used together to measure the layer thickness and refractive and absorption index n&k of thin layers.



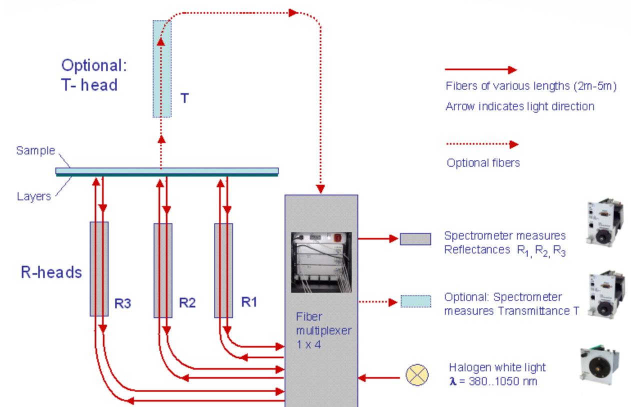
Reflectance R and transmittance T at a layer stack

After recording the specta of the sample, an automized mathematical calculation is performed in which the layer thicknesses and the parameters for the optical properties n&k are varied until model and measurement match perfectly.
A database of n&k configurations which is included will help the users to obtain the result of any layer in an easy way. The physical model for any type of material is basically the same, no special advanced knowledge about optical modelling is needed.



Spectral fit of R and T of a dielectric coating (ZnS) on a glass substrate (measurement = blue / model simulation = red). The position of the maxima and minima or R+T are related to the thickness, and the height and shape of the R+T-curves originate from the n&k data.

For TFS production, different sizes of samples and various process control procedures are currently under use and may need adaption in the near future, after new TFS technologies have been introduced. Thus, any measurement solution shall be adaptable as well to such future demands. NXT has developed a concept of open design for the position ing and for type of measurement stations.
From 1 to 9, any number of positions is possible which are all connected to one system by multiplexing. If necessary, besides reflectance for thickness control, also the inline transmittance for n&k inline inspection may be implemented or upgraded.



Principle setup for a 3-channel thickness control (bottom) with optional n&k determination at center position (top)

Inline measurements of thicknesses and n&k are the key to:

→ Stable production process
→ High layer homogenity
→ Inline n&k control possible
→ Yield optimization for any TFS type

Xelas INLINE-tfs enables producers of TFS to:

- Keep production conditions stable and increase production/process yield
- Check the product quality by detailed knowledge of thickness drifts, as well as changes in material properties
- 100% production control by automatic logging of every output data
- Stay open for future measurement requirements by simply upgrading the current installation

Ready for a-Si, CIS/CIGS, CdTe and organic solar cell production!

Product Specifications of Xelas INLINE-tfs

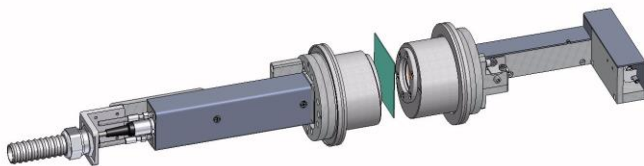
MEASUREMENT	
Measurement Parameters	Layer thicknesses of single layers and stacks / spectral refractive + absorption index (n&k)
Wavelength Range	390 ~ 1050nm or 320 ~ 800nm (other ranges on request)
Thickness Range	2 ~ 5000nm
Refractive Index Range	0.01 ~ 10.00 (all materials possible)
R+T Accuracy	± 0.4%
Thickness Accuracy	± 0.6nm (range 2nm-40nm) ± 1.2nm (range 40nm-200nm) ; ± 2.2nm (range 200nm-500nm) ± 4.5nm (range 500nm-5000nm)
Thickness Repeatability	3σ < 0.2nm (range 2nm-500nm) 3σ < 1.0nm (range 500nm-1000nm) 3σ < 2.0nm (range 1000nm-5000nm)
Refractive Index Accuracy	Silicon layers : ± 0.04 ; Conductive layers : ± 0.03 ; Dielectric layers : ±0.03 ; Others ± 0.04
Refractive Index Repeatability	3σ < 0.02

HARDWARE	
Measurement Geometry	White light reflectance (R) and transmittance (T) in normal incidence (0°)
Measurement Spot Size	~ 1mm
Measurement Speed	≤ 1.0 sec. / point for thickness ; approx. 0.3-1.0 min. / point for n&k
Sample Sizes (default)	10x10mm to 300x300mm (larger sample sizes are possible on request)
Required Positioning Accuracy of sample	Within ± 1.5mm height and within ± 0.4° tilt
Environment	Temperature range: 5-45°C (50-90°F), Humidity: < 80% (non-condensing)
Power	AC 100 ~ 240V; 50/60 Hz
Dimensions W/D/H (Width/Depth/Height) (Rack: Other types on request)	Rack with spectrometer and light source : W= 449mm ; D= 316mm ; H= 148mm Reflectance Sensor (excl. Fibers) : W= 113mm ; D= 113mm ; H= 434mm Transmittance Sensor (excl. Fibers) : W= 190mm ; D= 113mm ; H= 295mm Fiber lenghts (other values on request): 2m, 3m, 5m

PC / SOFTWARE	
Measurement Functions	Layer thicknesses / refractive + absorption index / value history
PC Requirements	Windows® 7 / 8 / 10, 8 GB RAM, >500 GB hard disc space, Intel i7 >Gen3 recommended

Setup parts

Xelas INLINE-tfs : R+T Sensors



Xelas INLINE-tfs : Spectrometer Rack

Spectral Sensors R+T for Inline Reflectance+Transmittance Measurement (left) / 3HE Rack with R+T spectrometers and halogen light source (right)

Product specifications are subject to change without notice. © NXT, 2017 www.nxt91.com

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