LayTec: Company Overview and TF-Displays

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LAYTEC
Knowledge is key

Outline

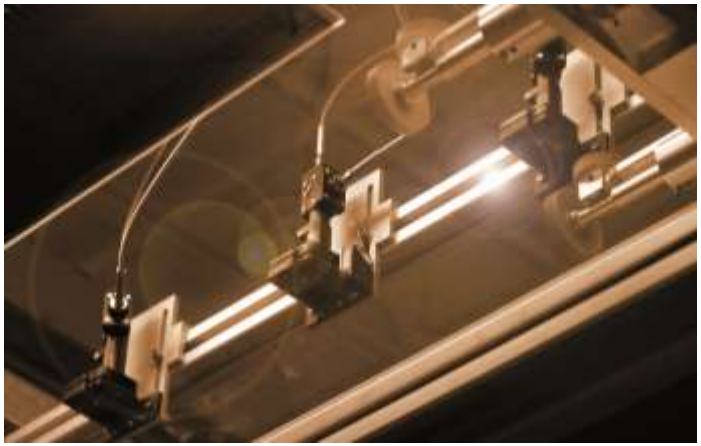
- **Applications**
- System setup
- TF-Display
  - a-Si functional layers
  - OLED
- Summary
- About LayTec

Markets, Methods, Measured parameters

Market	Methods	Parameters
LED LASER	Reflectance, deflectometry, pyrometry	Layer thickness, growth rates, composition film
PV	Reflectance, PL, EVA crosslink	Layer thickness, conductivity, composition, surface roughness
Display	Reflectance, transmittance, EddY current	Layer thickness, sheet resistance
LED LASER	Layer thickness, PL	

Display

- Layer thickness/sheet resistence measurement of ARC and functional layers
- Multilayer structures (SiOx, SiNx, a-Si, LTPS, IGZO)
- Feedback control
- 100-1000Hz measurement rate



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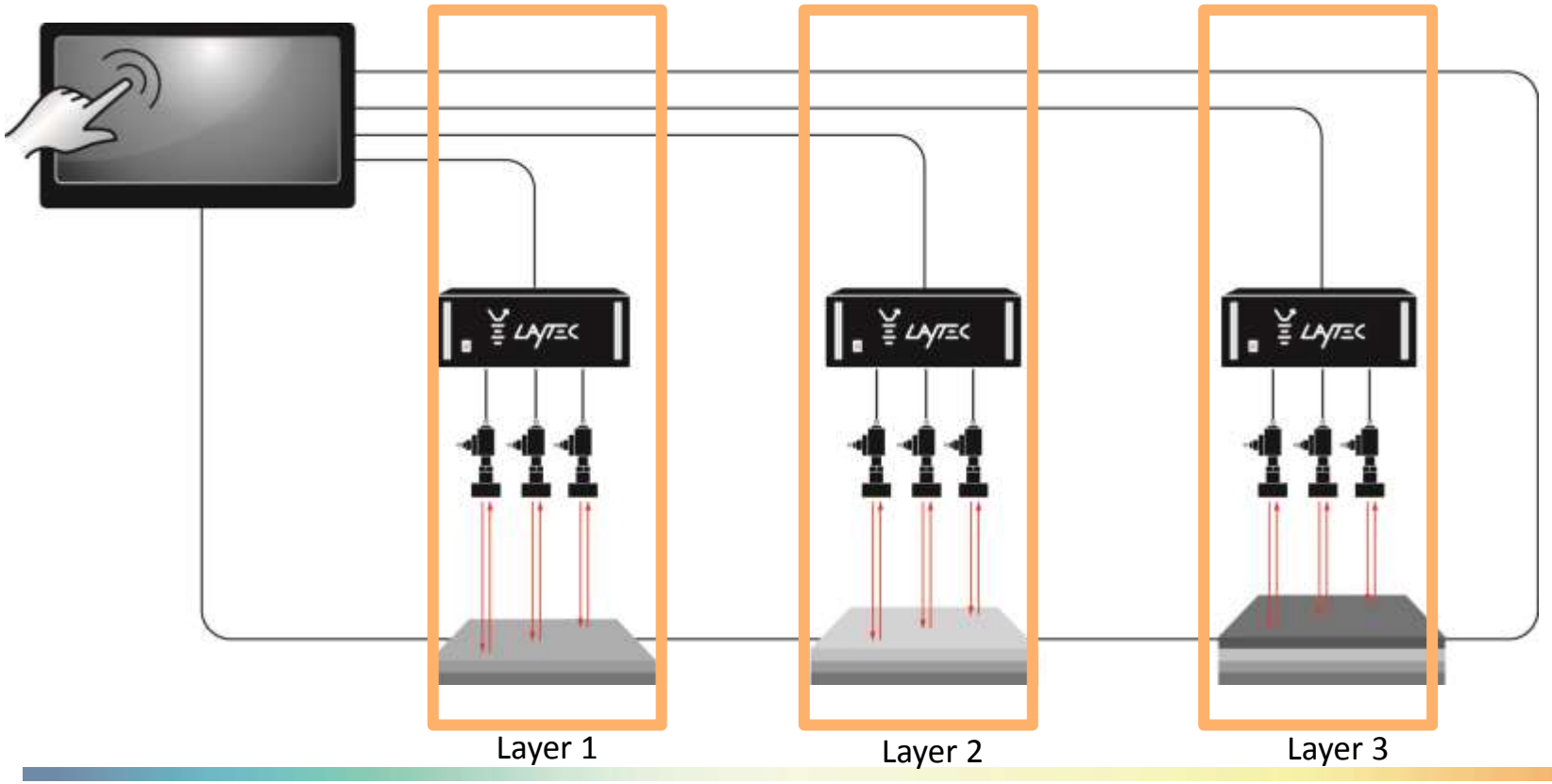
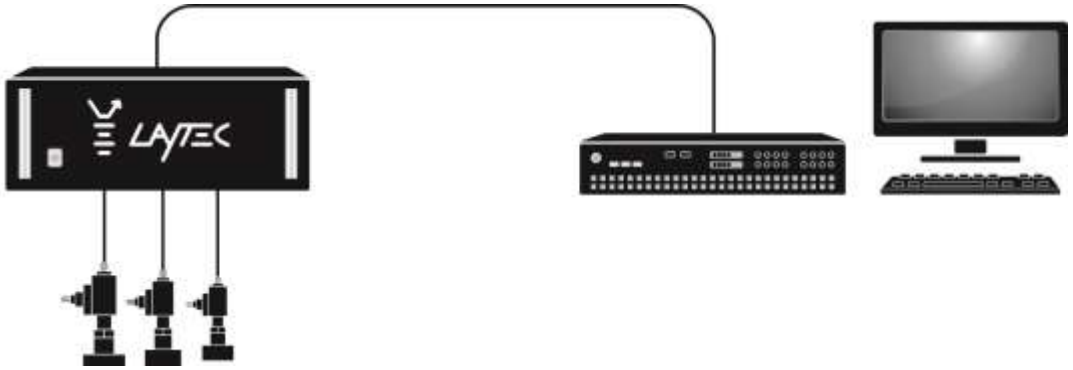
In-line control



In-line optical spectroscopy during thin-film processes in multi-chamber systems

Main components of LayTec metrology systems



Optics heads

Small
Versatile
Vacuum

Controller

Robust 24/7
Low maint.
HQ Optics

Computer
Display,
Storage

Equipment
All interfaces
Feedback

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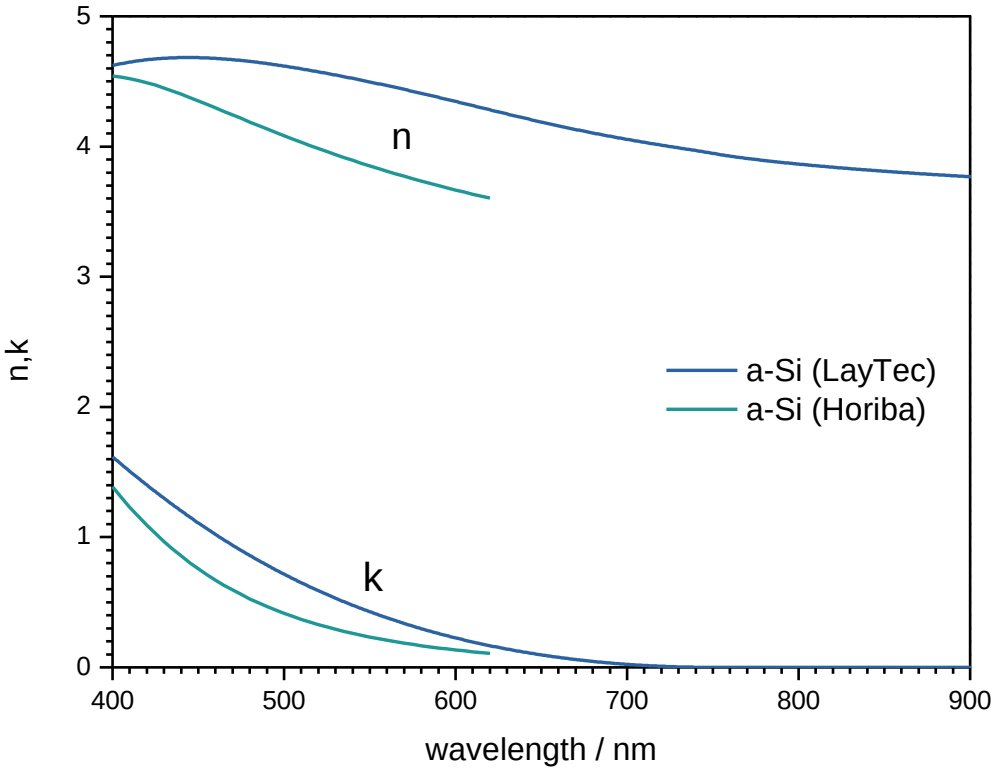
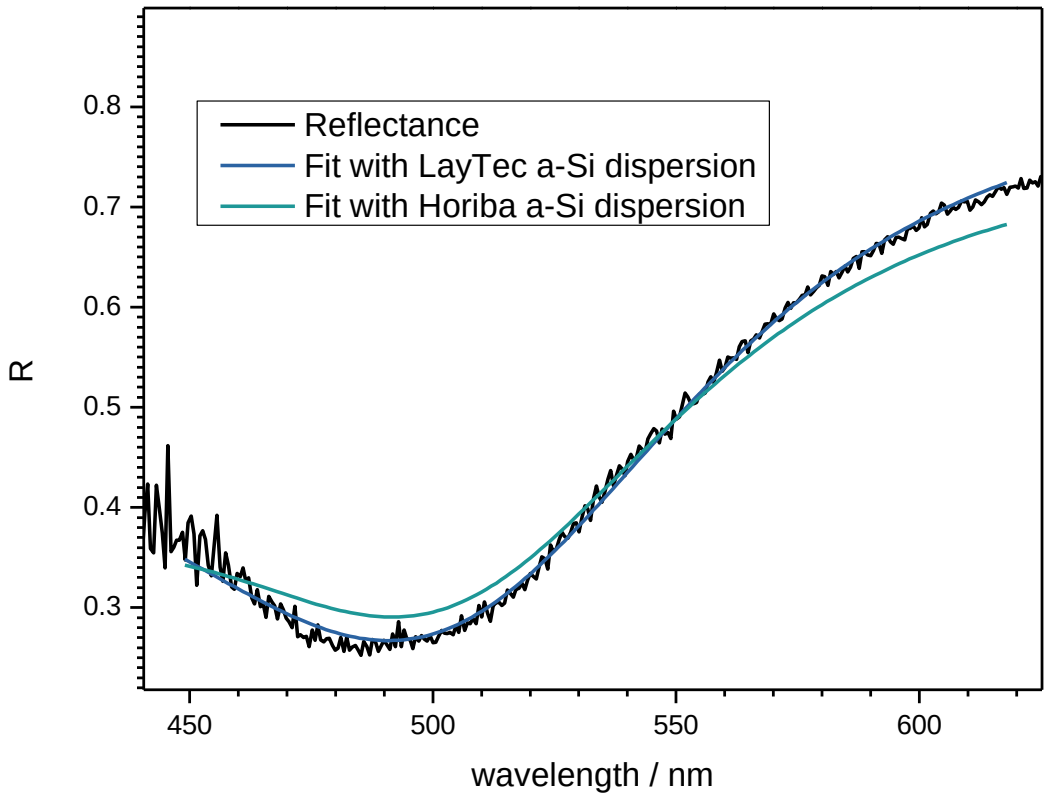
LayTec maintains own database of optical properties

- Accurate results by adapted dispersion
- Performance equal to lab systems



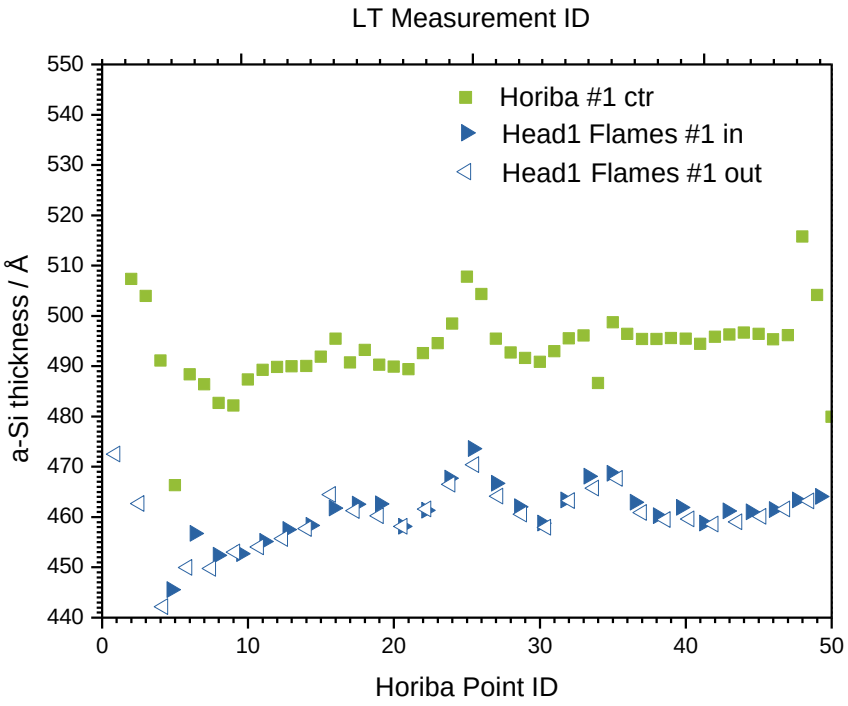
Every process is correlated with specific optical properties. LayTec's thin-film dispersions are parametrized and can be adopted.

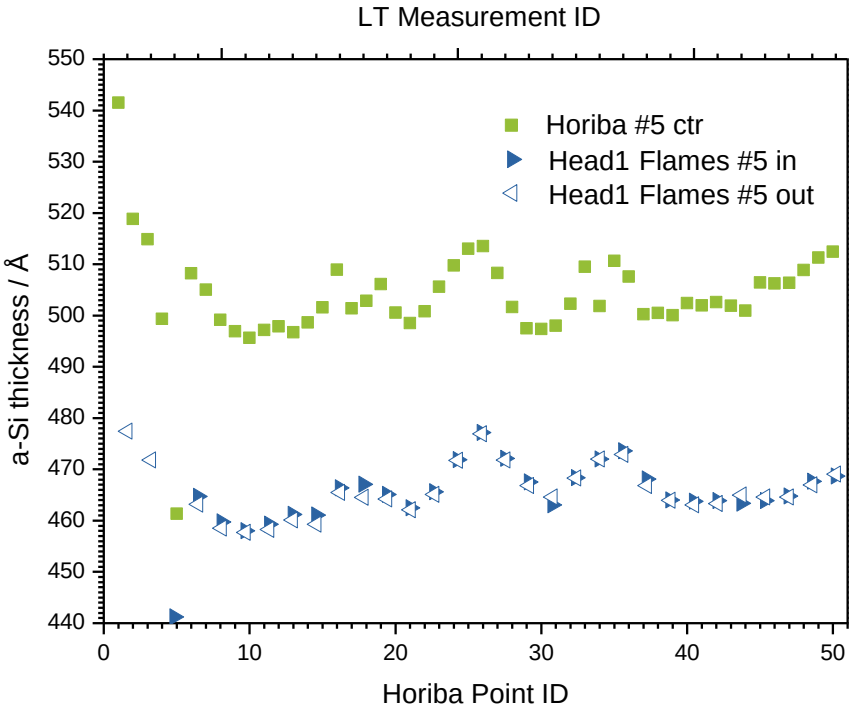
Reflectance fit of in-line produced a-Si layer



Reflectance spectra can be fitted more accurately using LayTec dispersion > thickness resolution: 1 nm (typically)

a-Si thickness on two substrates A and B





a-Si layer determined by off-line ellipsometer is thicker due to smaller refraction index. Same thickness fluctuations are resolved by both measurements.

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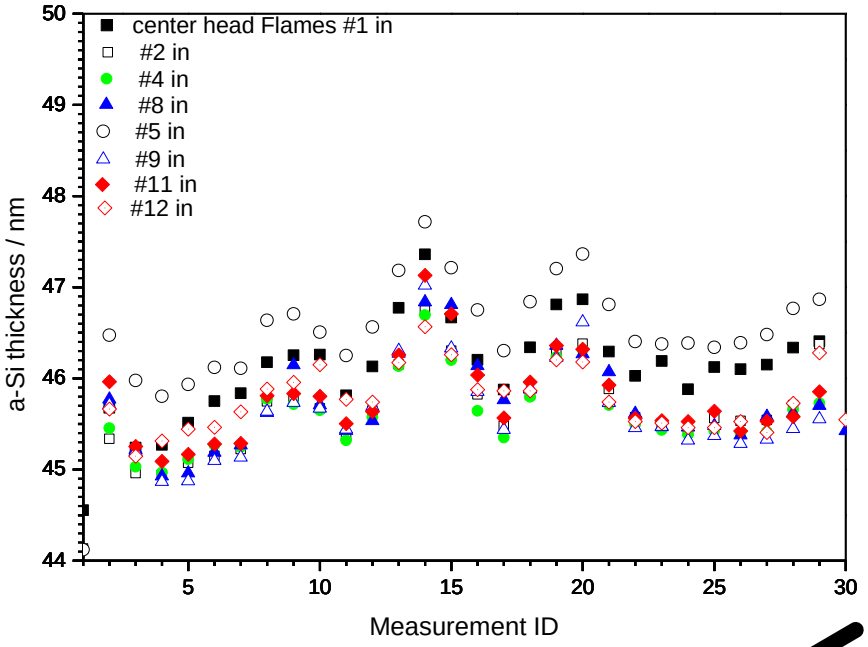
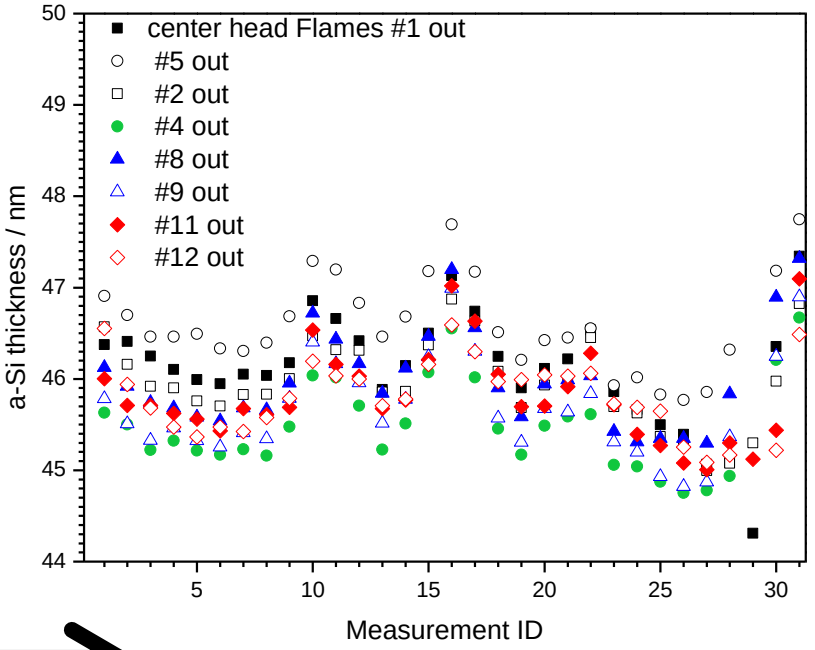
In-line in-out repeatability test

in



out

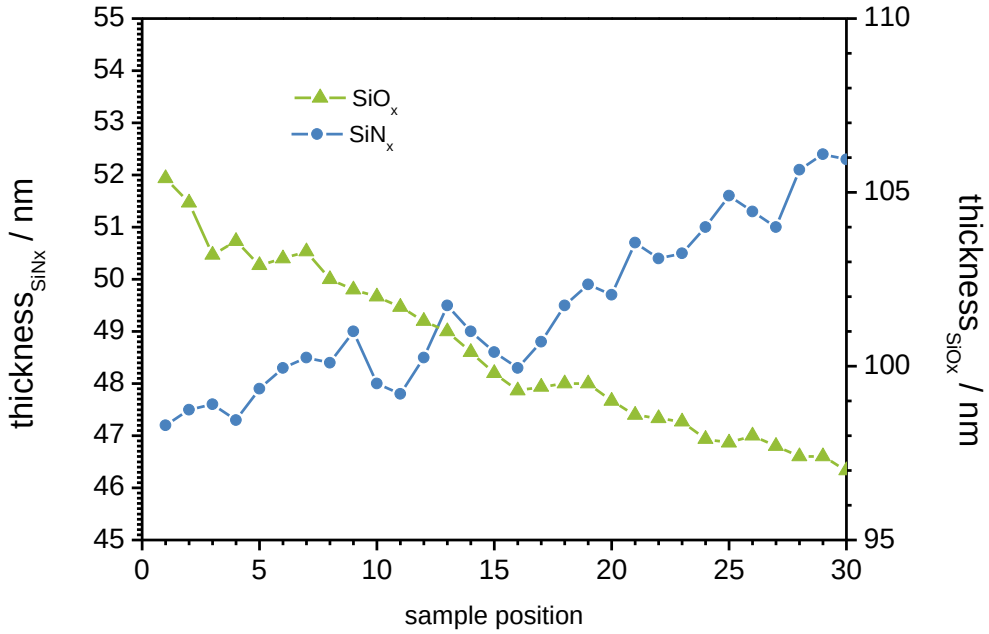


mirrored

a-Si can be resolved on nanometer scale!

Stack 50nm a-Si / 100nm SiO_x / 50nm SiN_x

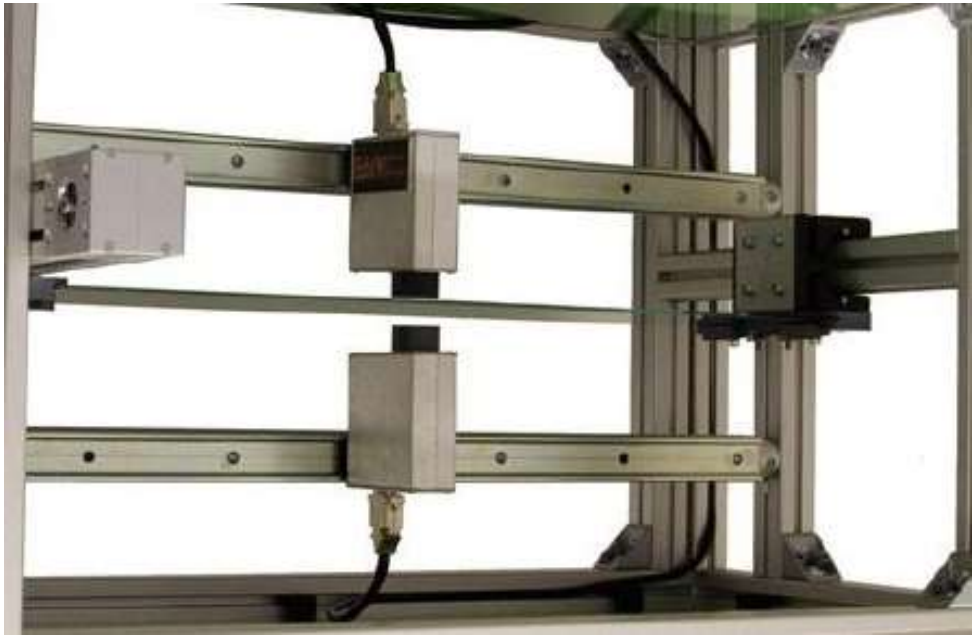
SiO_x and SiN_x thicknesses for nominal stack **45nm a-Si / 130nm SiO_x / 50nm SiN_x** can be resolved after proper optical adjustment.



LayTec offers nanometer accurate in-line monitoring of a-Si, SiN_x, and SiO_x layers for 100% production control.

Sheet resistence measurements (EddY)

- Quality assurance of low and high conductive thin-films
- Sheet resistivity monitoring from 0.01 – 50 Ohm/square by use of calibrations
- Other specifications on request

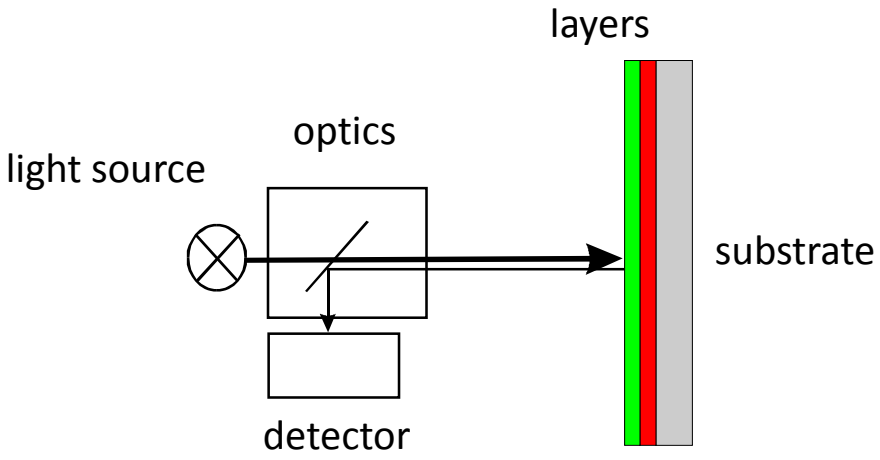


Characteristics of EddY

- Contact-free and real-time
- Customized systems considering design requirements of application
- Single-point or multi-point measurement at up to 16 positions
- Suitable for vacuum application on demand
- Production flow up to 100 mm/s

OLEDs: Principles of in-line spectral reflectance

- White light is irradiated to the sample
- Reflected light is detected spectrally resolved
- Most robust geometry: normal incidence
- Applicable to non-transparent substrates
- Other geometries possible on request



In-line spectral reflectance after each deposition step

- Yields layer thickness directly
- Yields spectral optical properties (for optical coatings)
- Straight forward if nd > l
- Requires more sophisticated analysis for nd < l

ETL: electron transport layer

HBL: hole blocking layer

EML: emitting layer

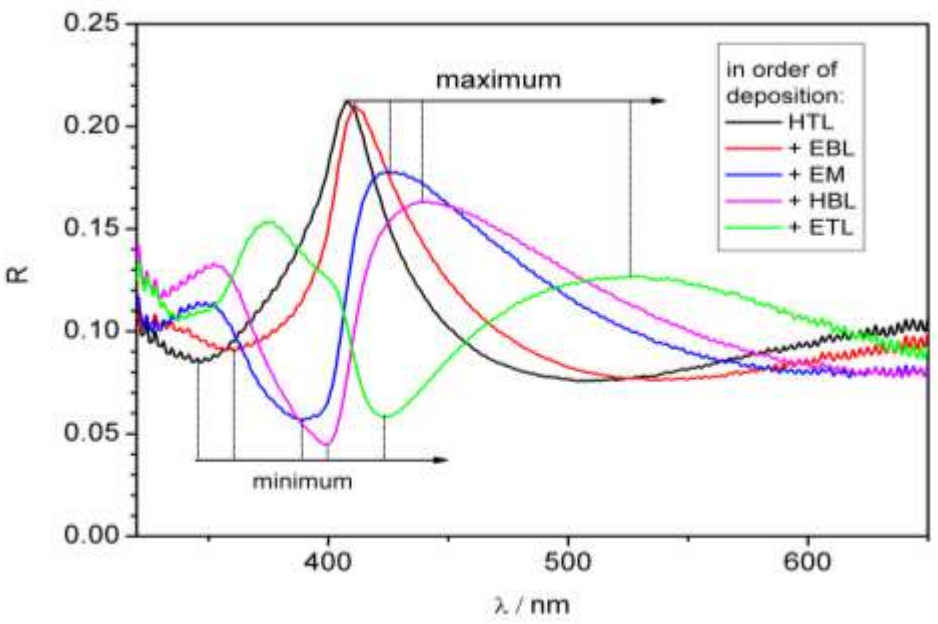
EBL: electron blocking layer

HTL: hole transport layer

Challenge: Large variety of organic materials, intermediate layers, polarization effects.

Full OLED structure on glass

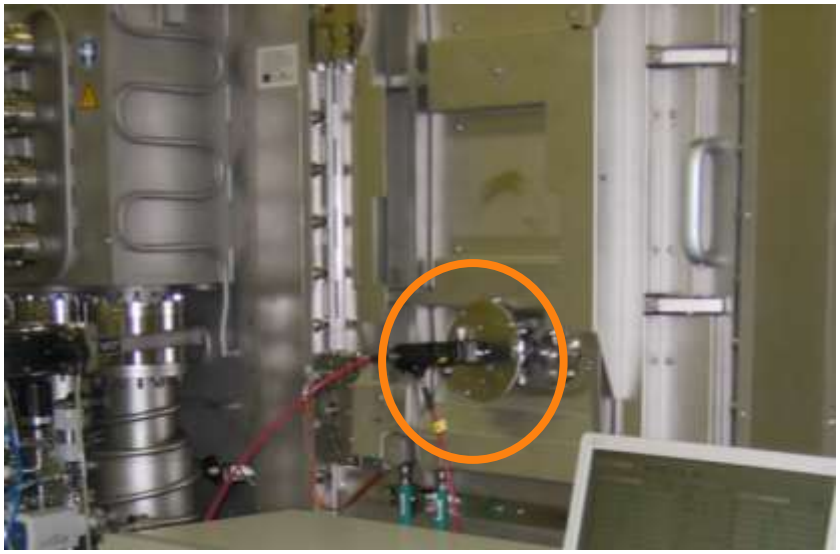
- All OLED layers clearly resolved
- Signal-to-noise ratio is excellent
- Quantitative analysis of thickness (all layers) by using n,k data base



All functional layers (HTL, EBL, EM, HBL and ETL) give a characteristic spectrum.

In-line measurement on glass of complex OLED structure

	d_{refl} / nm	d_{prof} / nm
HTL	143 ± 1	150 ± 5
+ EBL	7 ± 1	10 ± 5
+ EM	30 ± 1	24 ± 5
+ HBL	9 ± 1	10 ± 5
+ ETL	37 ± 1	39 ± 5

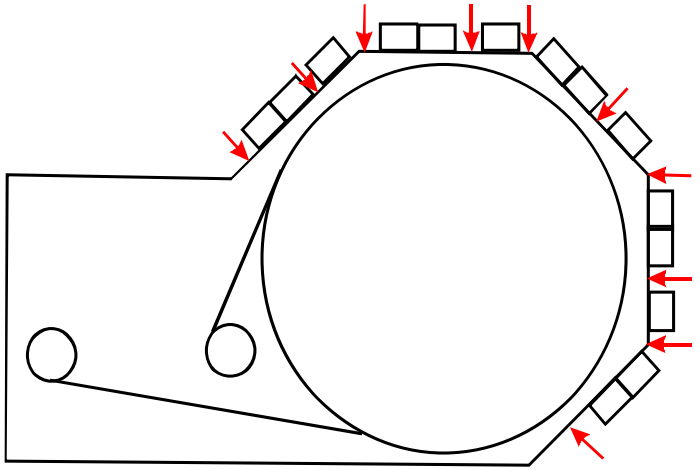


Measurement head through view-port

Organic layers of few nanometers can be resolved.

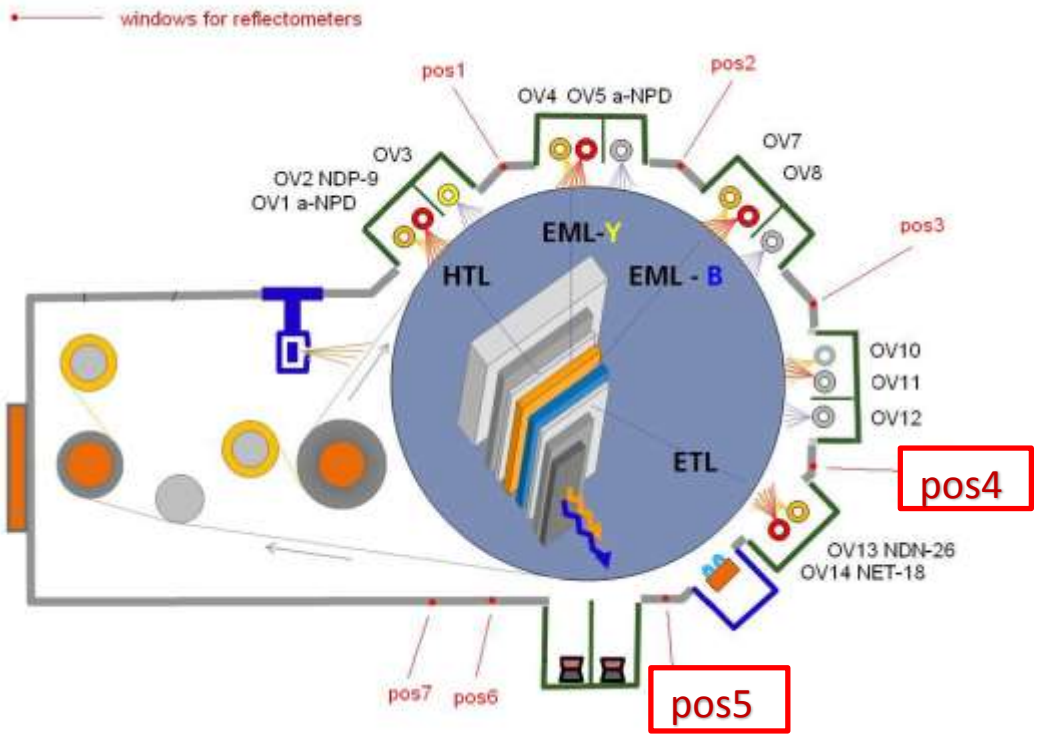
In-line measurement on flexible substrate

Layer	Soll	Foil, in-situ
HTL	60 nm	51 ± 3 nm
EBL	10 nm	5 ± 2 nm
EML	20 nm	20 ± 3 nm
HBL	10 nm	6 ± 2 nm
ETL	30 nm	28 ± 3 nm



Measurement set-up for NET18 on NPD in roll-to-roll process

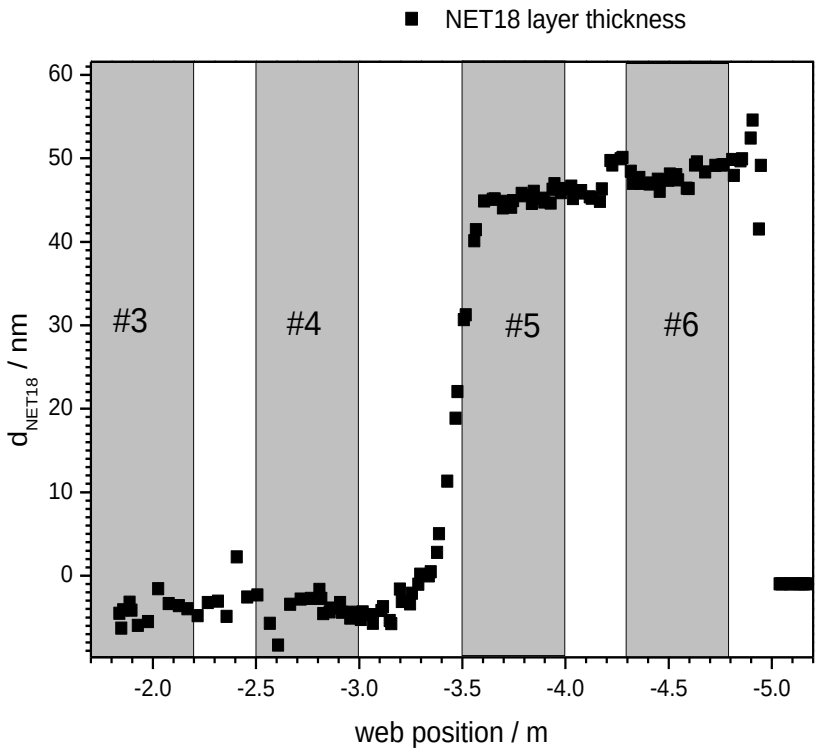
- In-line Measurement at the center of the foil
- Pos4 = NPD
- Pos5 = NPD+NET18



Sequential measurement at pos4 and pos5 resolves double-layer structure.

Layer thickness of NET18 on NPD

- Step #3 and #4 no deposition
- Step #5 to #6 deposition of nominally 50nm NET18
- Drift in thickness can be resolved
- Thickness-resolution down to 10nm



LayTec can measure very thin OLED layers with high accuracy. Feasibility study necessary for new materials.

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LayTec competence in displays

- LayTec offers sophisticated in-line and in-situ optical metrology tools that yield long-term stable results
- Thicknesses of typical anorganic and organic functional layer stacks can be measured in-line and in real-time
- Measurement accuracy comparable to lab equipment
- Access to thickness homogeneity, composition, as well as electronic properties such as conductivity and mobility

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Layer by layer

- 1999 foundation of LayTec
- Optical in-situ & in-line metrology solutions for thin film applications
- World market leader of in-situ metrology for LED and LASER production equipment
- Worldwide more than 1600 metrology systems

All LayTec products are certified quality “Made in Germany”.

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www.laytec.de