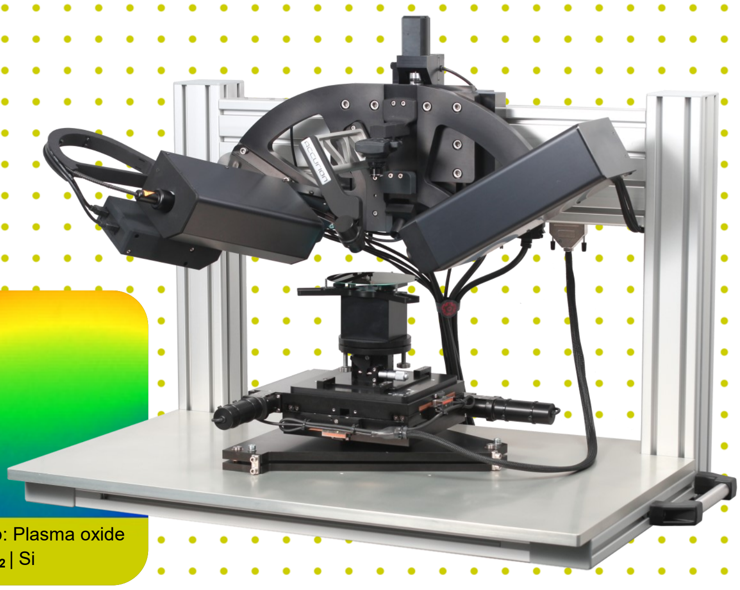
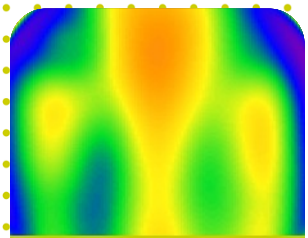
accurion

solutions for science

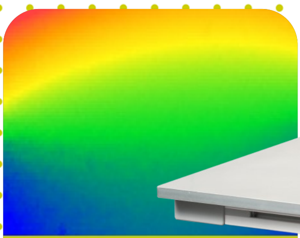
nanofilm_RSE

Referenced Spectroscopic Ellipsometry: Fast Inspection of Nanofilms and Surfaces

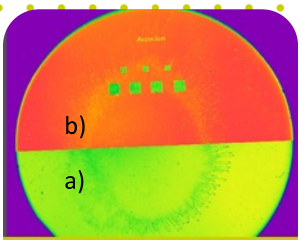




Wafer Inspection
Si_3N_4 (~1200 nm) | Si



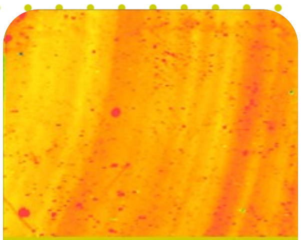
Thickness map: Plasma oxide
SiO_2 | Si



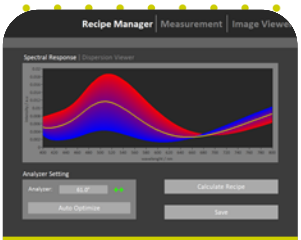
Detection of contaminants
(a) **SnO (~ 9 nm)** | Si (b) Si

"Single shot"
spectroscopic
measurements

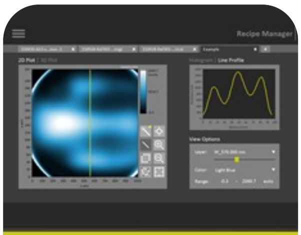
data rate of
100 spectra / second



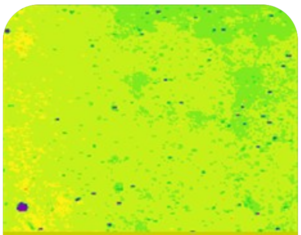
Thickness (Interlayer)
Graphene | **SiO_2** | Si



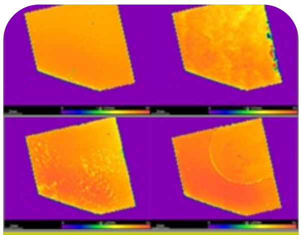
Live fitting of layer thickness



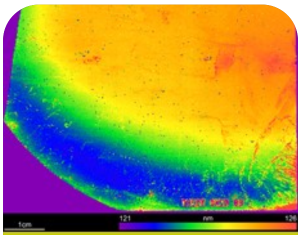
Intuitive and easy to use



Thickness (Ultrathin layer)
Graphene | SiO_2 | Si



Detection of contaminants
Impurities from Isopropanol



SiO_2 film thickness evaluation
SiO_2 (~ 125 nm) | Si

NANOFILM_RSE

The nanofilm_RSE is a special type of ellipsometer, which compares the sample to a reference. In this way, the ellipsometric difference between sample and reference can be measured. Due to the orientation of the reference, none of the optical components need to be moved or modulated during measurement, and the full high resolution spectrum can be obtained in a single-shot measurement. This way 100 spectra per second are acquired. The synchronized x-y stage enables acquisition of large field film thickness maps within a few minutes.

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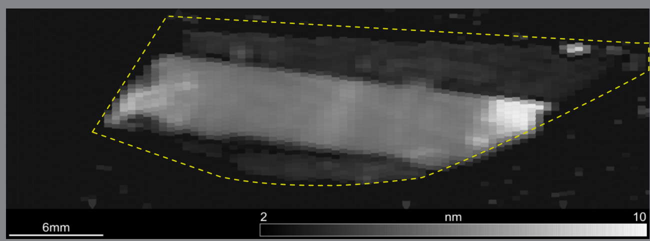
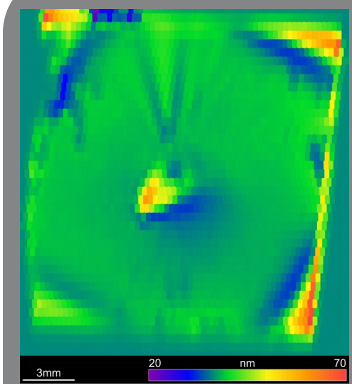
A piece of physisorbing plastic foil as shown on the upper sample was removed from the lower one. The foil should be removable without any residues.

The ellipsometric measurement clearly shows the shape of the removed stripe — obviously some invisible residues remained. Problems in deposition processes may occur due to such contaminations.



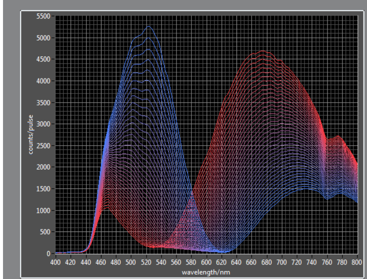
Residues of a physisorbing plastic foil

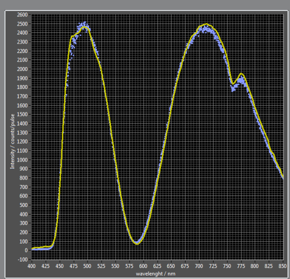


The silicon substrate was coated with polystyrene in a spin-coating-process. The film thickness map was acquired within 1:50 min with the nanofilm_RSE.

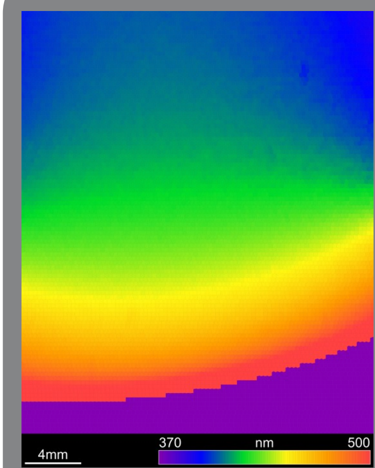
The graph in the lower left shows the spectral variation of the measured signal strength as a function of film thickness (thin to thick from blue to red).

In the lower right a typical fit of the optical model is shown. The blue points show the spectral raw data, the green curve the fit. Live-fitting is possible due to a LUT-implementation.

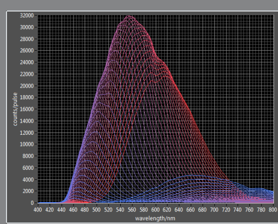




Spin-coated polystyrene on silicon



Film-thickness-variations of a SiO_2-coated 4''-wafer. The mean 400 nm -thickness increases up to 500 nm at the border. The measured field of 25x35mm using 8800 spectra was mapped within 5:40 min. The second picture shows the spectral variation of the signal strength from low (blue) to high (red) film-thickness.

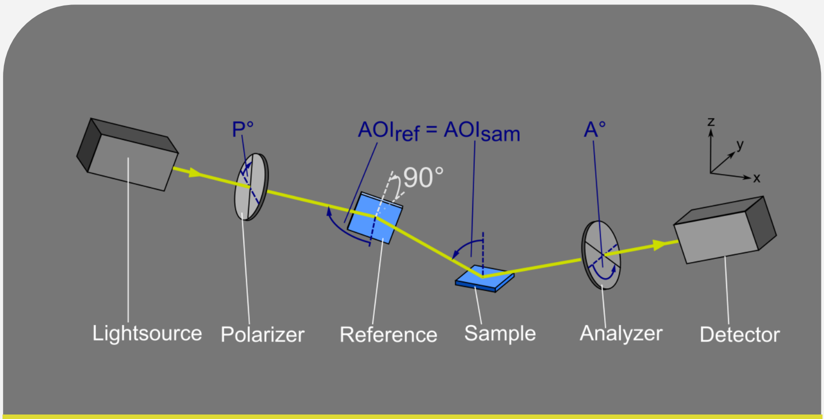


Film-thickness-map of a SiO_2-coated 4''-wafer

How does it work?

Ellipsometry is a very sensitive optical method which has been used for about a hundred years to derive information about surfaces. It makes use of the fact that the polarization state of light may change when the light beam is reflected from a surface. If the surface is covered by a thin film (or a stack of films), the entire optical system of film & substrate influences the change in polarization. It is therefore possible to deduce information about the film properties, especially the film thickness.

As the reference compensated system is an ellipsometer, the measured data needs to be fitted to an optical model to obtain optical parameters like the complex refractive index and/or the film-thickness. To deal with the high data-rate, a look-up-table-fitting was implemented. Prior to the measurement a look-up-table is calculated. The measured data can then be fitted in real-time and in high resolution.



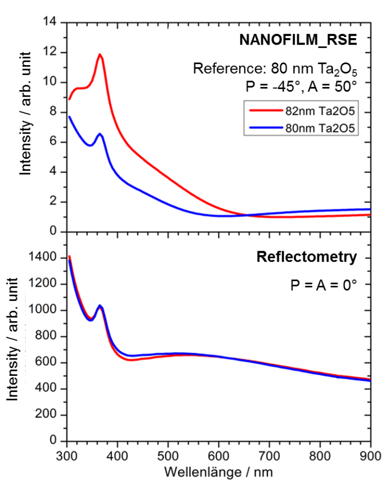
Pathway of light of a Referenced Spectroscopic Ellipsometer

Benefit in comparison to Reflectometry and conventional Ellipsometry

The referenced spectroscopic ellipsometer combines the high sensitivity of an ellipsometer with the measurement speed of a reflectometer.

In comparison to a laser ellipsometer it includes the spectroscopic information between 450 and 900 nm. This is important in the event that more than one parameter of the processed layer is variable like for example thickness and optical density.

Basically referenced methods are more sensitive than absolute methods. Therefore, the RSE method is superior to conventional ellipsometry when very thin layers are in focus. The advantage of increased sensitivity to thin films is even more evident when compared to reflectometry.

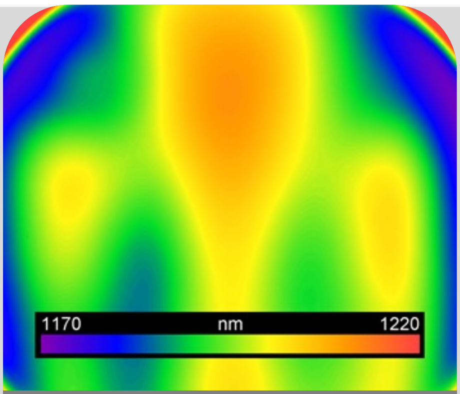


Comparison Referenced Spectroscopic Ellipsometry and Reflectometry

Wafer Inspection

Fast determination of thickness distribution

Live data processing for evalution of film thicknesses

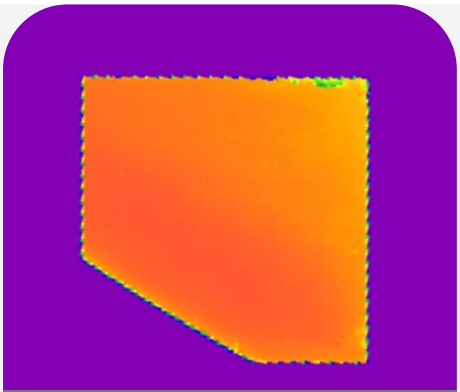


5'' silicon wafer coated with nominally 1200 nm Si_3N_4

Detection of Contaminants

High sensitivity

Referenced technique

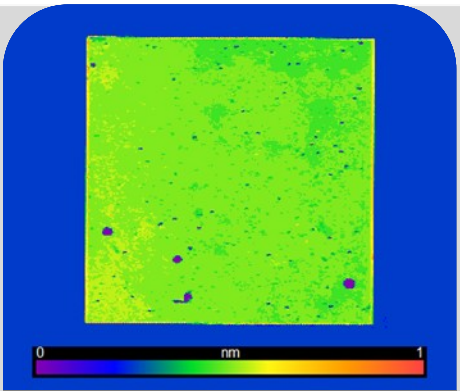


Surface cleaned with Isopropanol

(HPLC-grade)

Thickness of Ultrathin Films and Interlayers

Successful characterization of thinnest layers like monolayers of graphene and independent measurement of interlayers between top layer and substrate

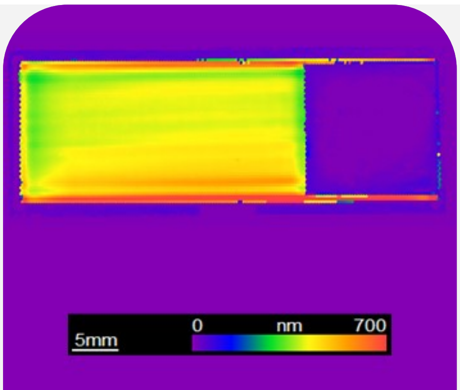


Thickness of a graphene layer

Air | Graphene | SiO_2 | Si

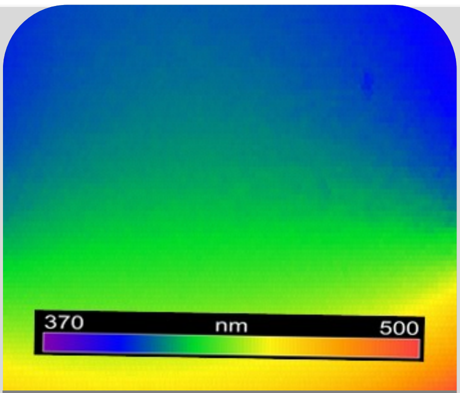
Thin Layers on Transparent Substrates

Thickness and homogeneity of coatings on transparent substrates like glass



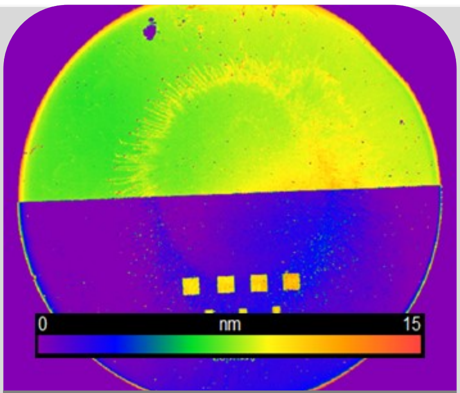
PECVD coatings, 50 times

Air | SiO_x | BK7- glass



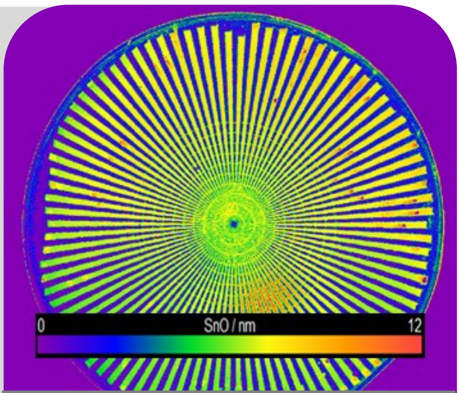
Thickness map: Plasma Oxide

Air | SiO_2 |Si



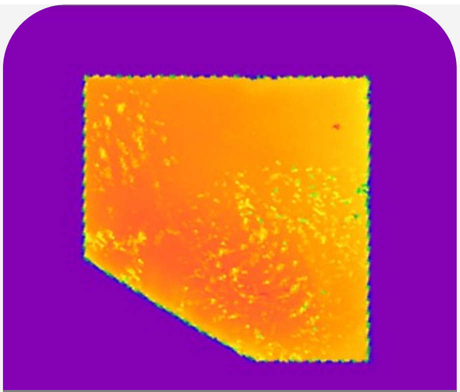
Thickness map: Tin oxide

Air | SnO|Si

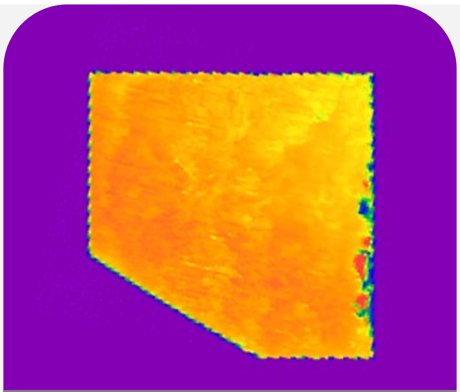


Thickness map: Tin oxide

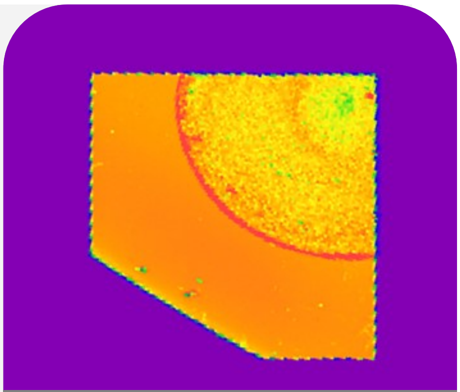
Air | SnO|Si



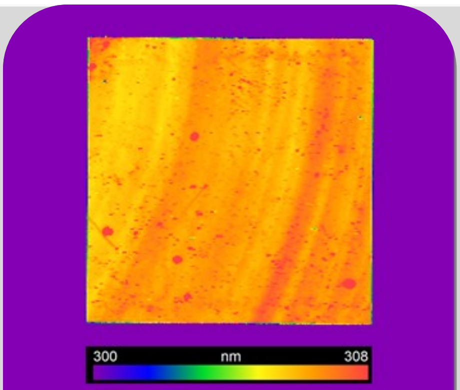
Surface touched with a glove



Wiped Surface

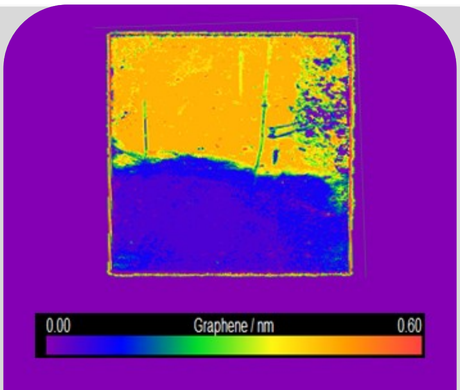


Contamination remained from a droplet of isopropanol, storred in a PE– bottle



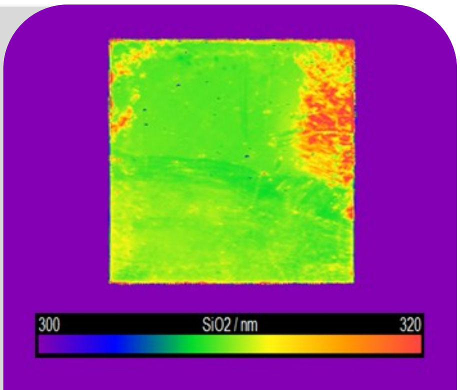
Thickness of a SiO_2 - interlayer

Air | Graphene | SiO_2 | Si



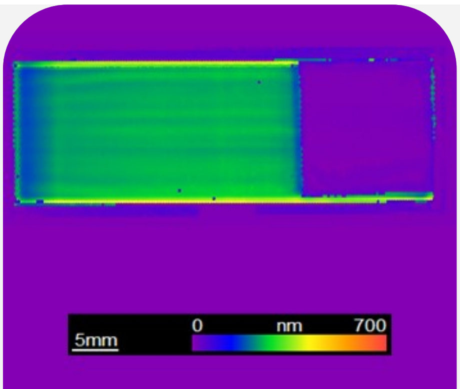
Partly scratched surface, Graphene

Air | Graphene | SiO_2 | Si



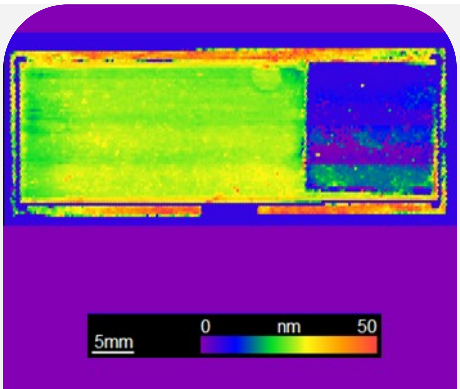
SiO_2-Interlayer under Graphene layer

Air | Graphene | SiO_2 | Si



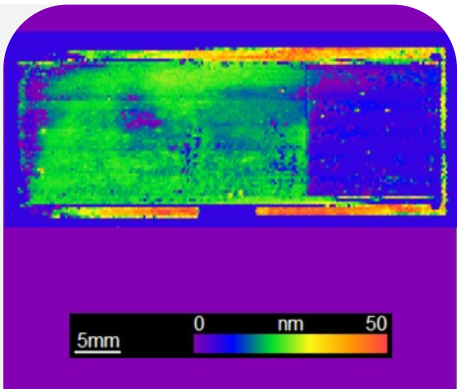
PECVD coatings, 25 times

Air | SiO_x | BK7- glass



PECVD coatings, 10 times

Air | SiO_x | BK7 - glass

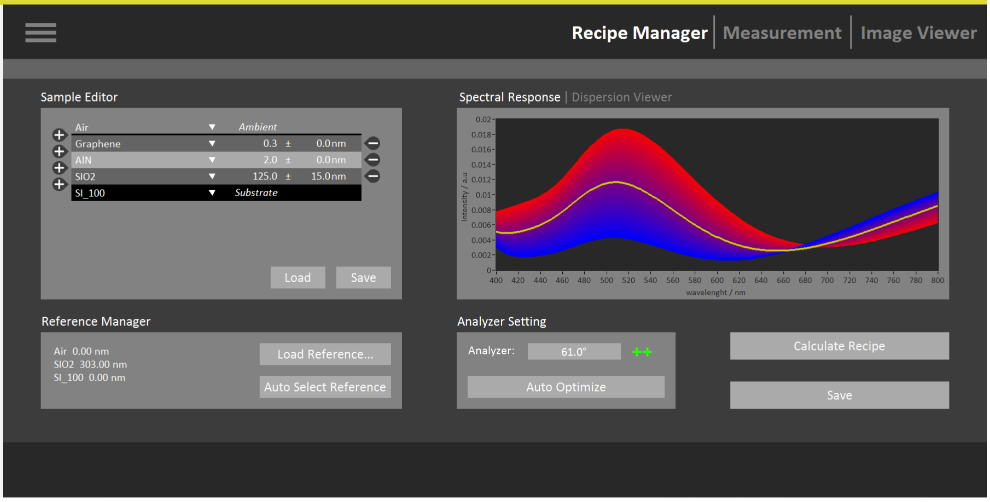


PECVD coatings, 3 times

Air | SiO_x | BK7- glass

RECIPE MANAGER

- ✓ set layer stack
- ✓ measurement task
- ✓ reference manager
- ✓ recipe generation
- ✓ auto-optimization of device settings
- ✓ simulation of system response

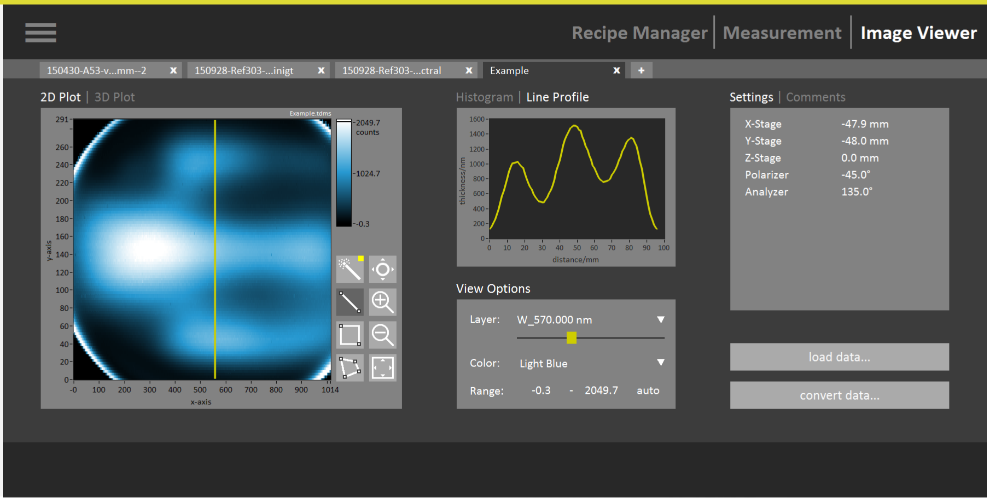


MEASUREMENT

- ✓ live display of overview camera and current spectra
- ✓ ROI-Editor
- ✓ pattern-Editor
- ✓ motor control
- ✓ automatic sample alignment

IMAGE VIEWER

- ✓ result window
- ✓ 2D/3D-View
- ✓ histogram, line profile
- ✓ view options
- ✓ easy access to spectral data cube
- ✓ tab based



	SPECIFICATION
Instrument Type	Referenced Spectroscopic Ellipsometer
Angle of Incidence	Fixed 60° or 70°
Spectral Range	450-900 nm, 1.2 nm resolution
Data Rate	100 full spectra per second, continuous
Spot Size	50x100 µm microspot at AOI=60°
Film-Thickness Resolution	typ. 0.1 nm
Film-Thickness Reproducabilty	typ. < 0.4 % standard deviation
Light Source	110 mW supercontinuum laser, class 3b, $M^2 = 1.1$
Detector	2048-channel Czerny-Turner spectrometer, 16 bit, 100 Hz
Polarizing Optics	Two high quality Glan-Thompson prisms, motorized, 0.001° resolution
Alignment	Two-axis horizontal sample alignment
X-Y-Z-Positioning	Motorized X-Y-Stage with 100 mm range, max. 14 mm/s, motorized Z-positioning in instrument head with 40 mm range
Data Processing	LUT-based data processing for live fitting of film-thicknesses
Software	Including control software for easy access to motorized components, spectrometer and all measurement parameters; including modeling software
PC	Ready to use PC running on Windows 7®, pre-installed control and modelling software,
Power Supply	100-240 V, 50/60 Hz
Environmental Conditions	Operating temperature range: 15-30 °C Humidity: 20-80 %RH

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