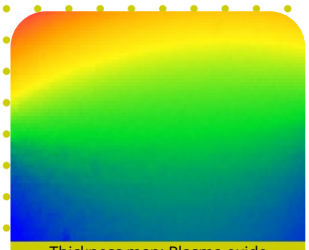
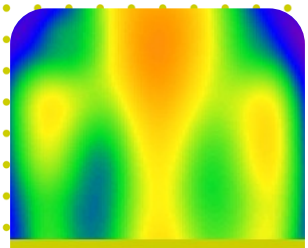
ACCURION
solutions for science

NANOFILM_RSE

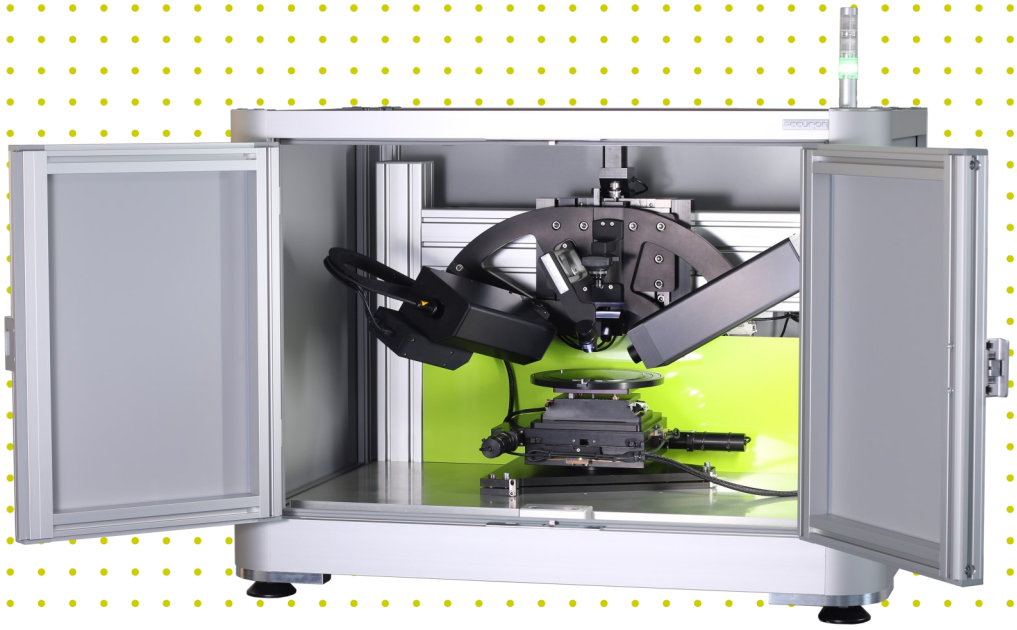
REFERENCED SPECTROSCOPIC ELLIPSOMETRY: FAST INSPECTION OF THIN FILMS AND SURFACES

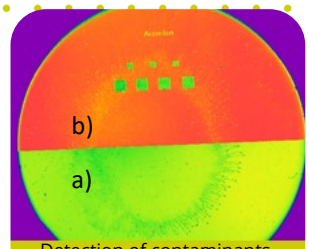


Thickness map: Plasma oxide
SiO_2 | Si



Wafer Inspection
Si_3N_4 (~1200 nm) | Si

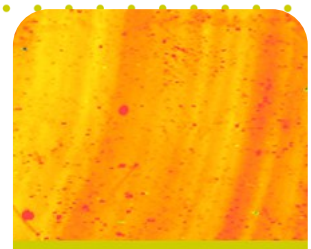




Detection of contaminants
(a) **SnO (~9 nm)** | Si (b) Si

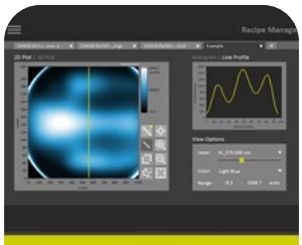
"Single shot"
spectroscopic
measurements

Data rate of
200 spectra / second

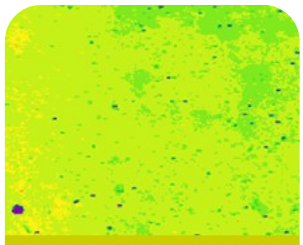


Thickness (Interlayer)
Graphene | **SiO_2** | Si

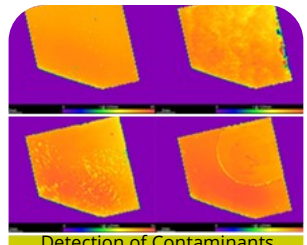
Live fitting of layer thickness
Easy and fast!



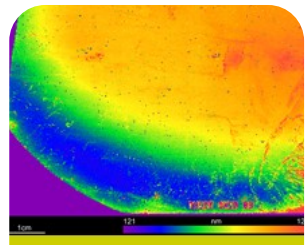
Intuitive and easy to use
Software Package



Thickness (Ultrathin layer)
Graphene | SiO_2 | Si



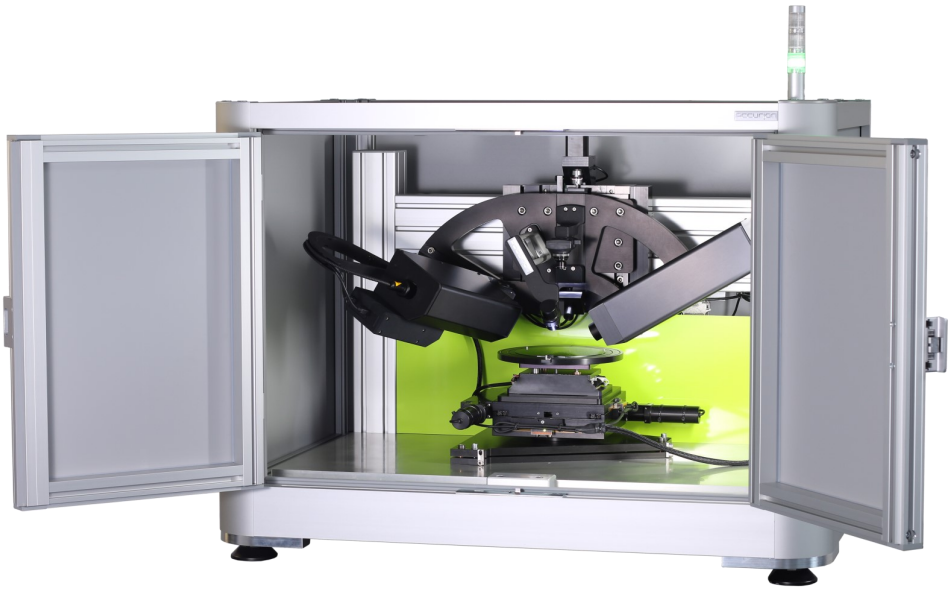
Detection of Contaminants
Impurities from Isopropanol



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. This way the ellipsometric difference between sample and reference can be measured. Due to the orientation of the reference none of the optical components needs to be moved or modulated during measurement and the full high resolution spectrum can be obtained in a single-shot measurement. This way 200 spectra per second are acquired. The synchronized x-y stage enables acquisition of large field film thickness maps within a few minutes.



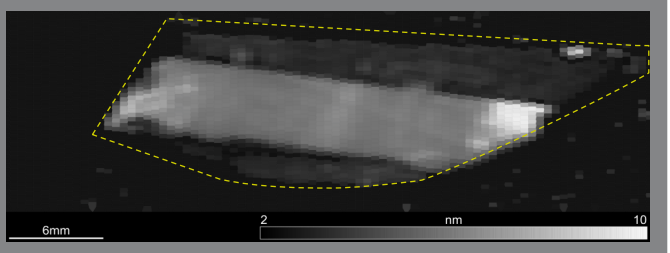
Supported by:

Federal Ministry
for Economic Affairs
and Energy

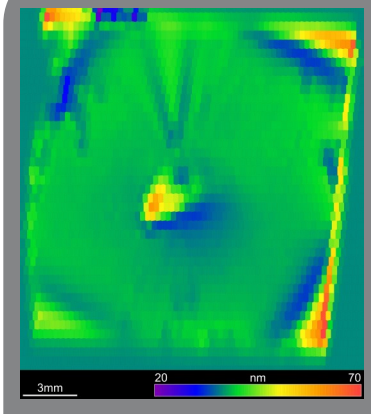
on the basis of a decision
by the German Bundestag

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.



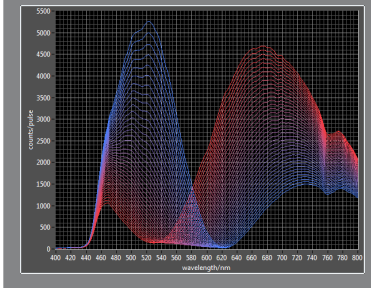
Residues of a physisorbing plastic foil

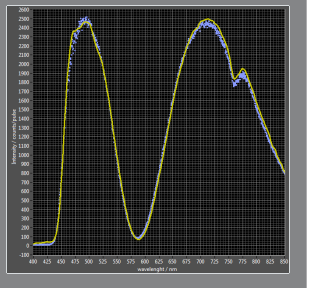


The silicon substrate was coated with polystyrene in a spin-coating-process. The film thickness map was acquired within 1:50 min with the nanofilm_RSE.

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).

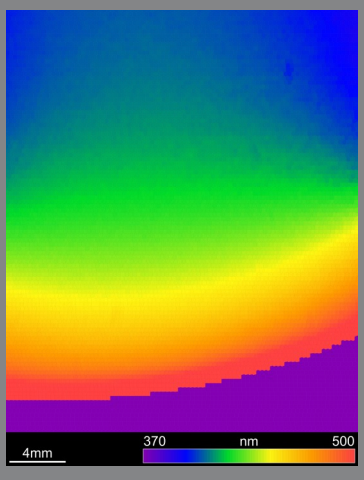
In the lower right a typical fit of the optical model is shown. The blue points show the spectral raw data, the green curve the fit. Live-fitting is possible due to a LUT-implementation.

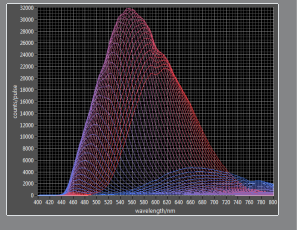




Spin-coated polystyrene on silicon

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.



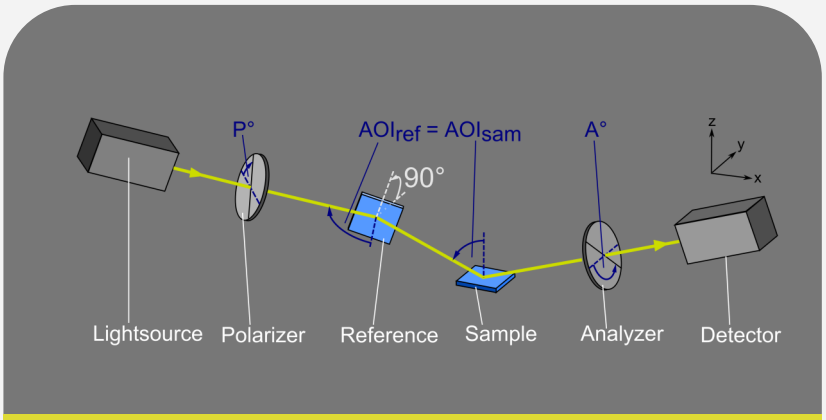


Film-thickness-map of a SiO_2-coated 4"-wafer

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.



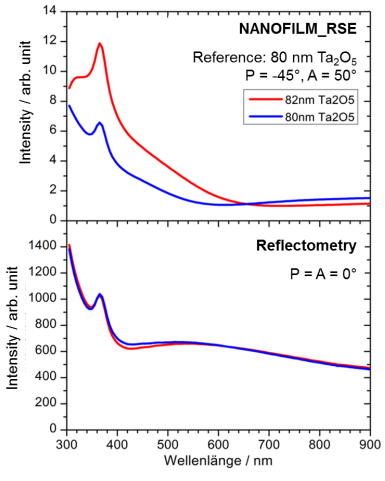
Pathway of light of a Referenced Spectroscopic Ellipsometer

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.

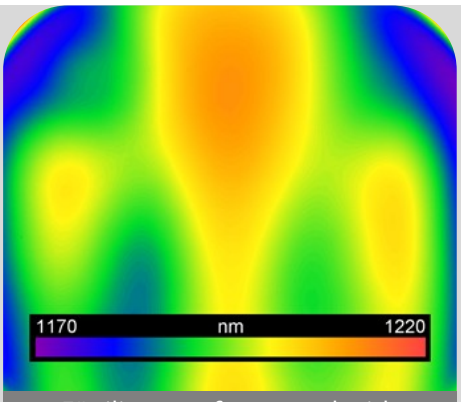


Comparison Referenced Spectroscopic Ellipsometry and Reflectometry

Wafer Inspection

Fast determination of thickness distribution

Live data processing for evaluation of film thicknesses

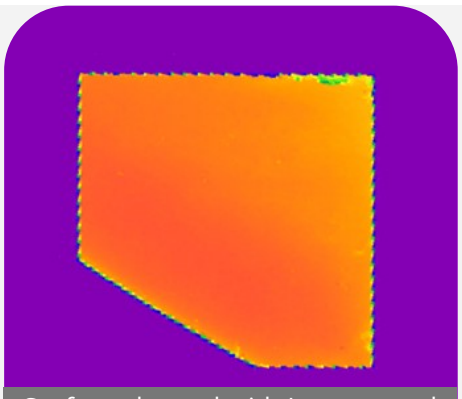


5“ silicon wafer coated with nominally 1200 nm Si_3N_4

Detection of Contaminants

High sensitivity

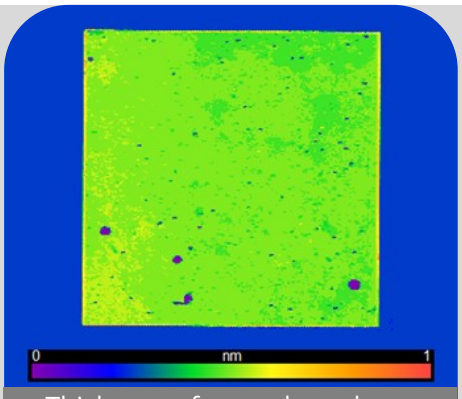
Referenced technique



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

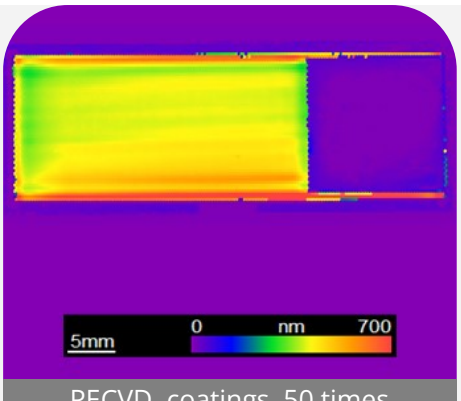


Thickness of a graphene layer

Air | Graphene | SiO_2 | Si

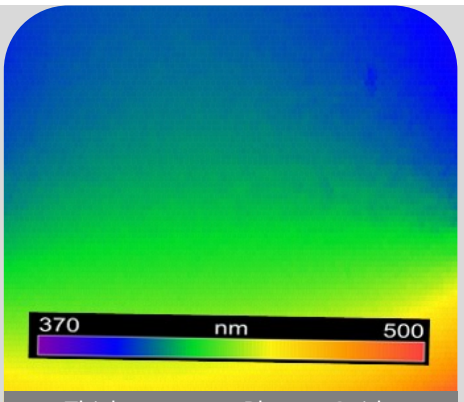
Thin Layers on Transparent Substrates

Thickness and homogeneity of coatings on transparent substrates like glass



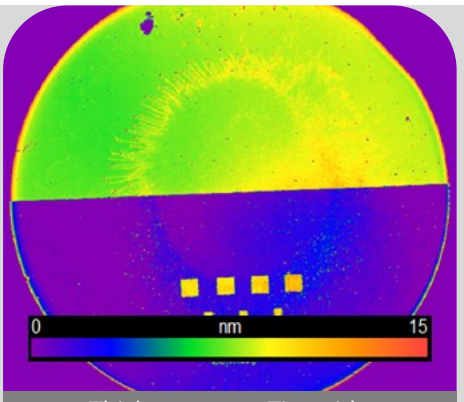
PECVD coatings, 50 times

Air | SiO_x | BK7- glass



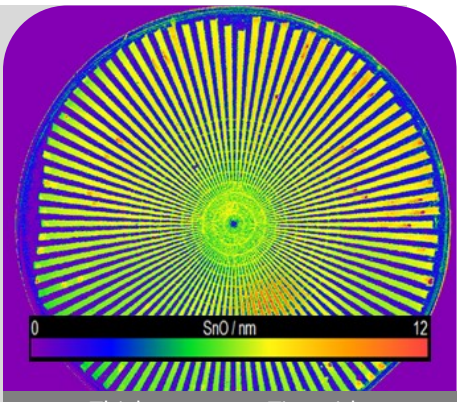
Thickness map: Plasma Oxide

Air | SiO_2 |Si



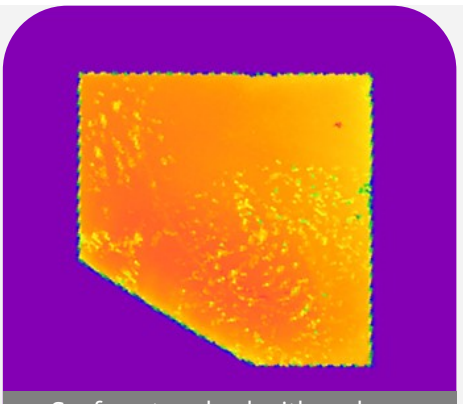
Thickness map: Tin oxide

Air | SnO| Si

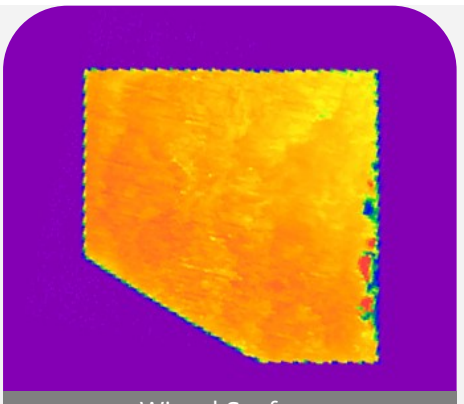


Thickness map: Tin oxide

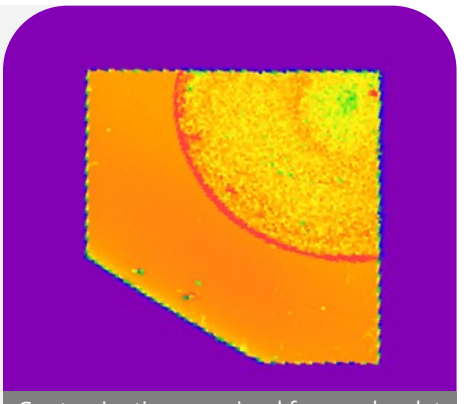
Air | SnO| Si



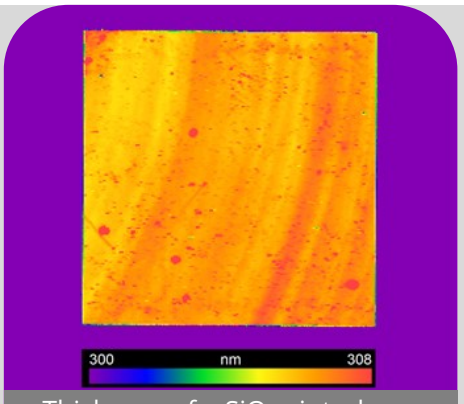
Surface touched with a glove



Wiped Surface

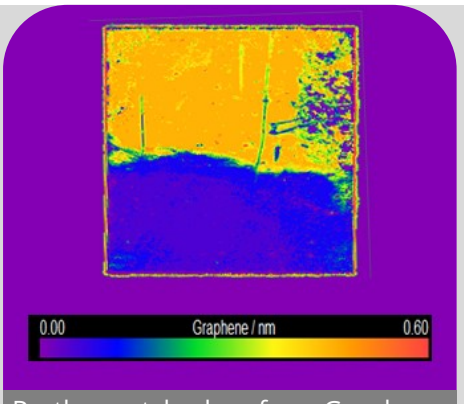


Contamination remained from a droplet of isopropanol, stored in a PE– bottle



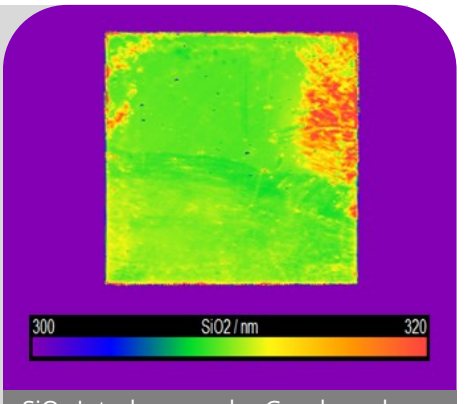
Thickness of a SiO_2 - interlayer

Air | Graphene | SiO_2 | Si



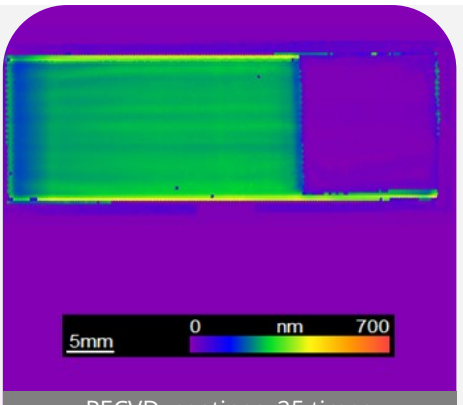
Partly scratched surface, Graphene

Air | Graphene | SiO_2 | Si



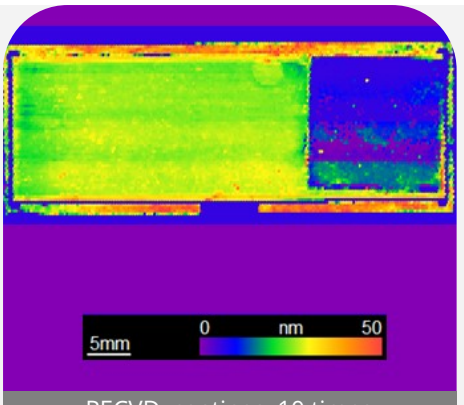
SiO_2-Interlayer under Graphene layer

Air | Graphene | SiO_2 | Si



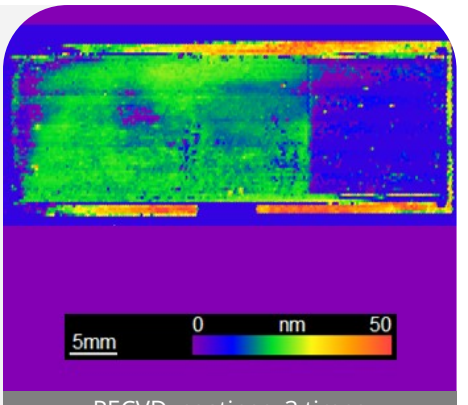
PECVD coatings, 25 times

Air | SiO_x | BK7- glass



PECVD coatings, 10 times

Air | SiO_x | BK7 - glass

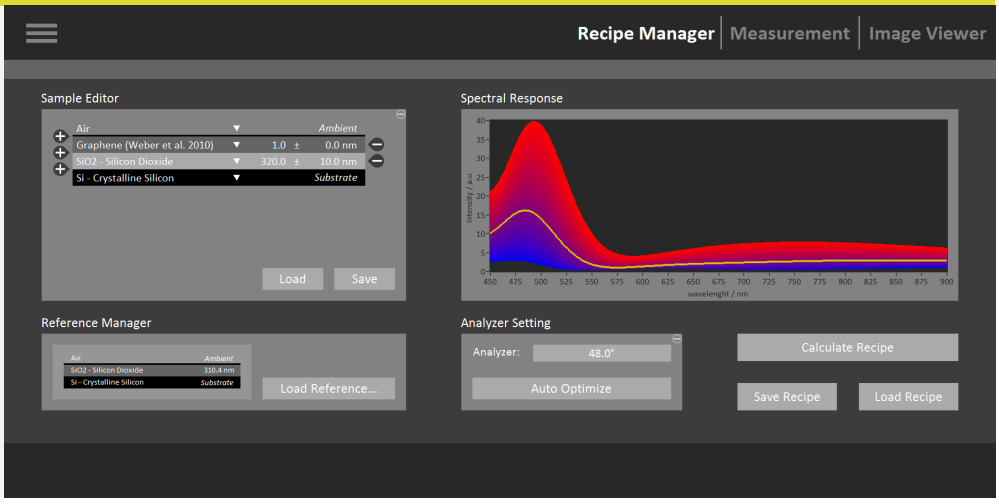


PECVD coatings, 3 times

Air | SiO_x | BK7- glass

RECIPE MANAGER

- ✓ Intuitive layer stack creation
- ✓ Auto-optimization of device settings
- ✓ Reference manager
- ✓ Recipe generation
- ✓ Simulation of system re-sponse
- ✓ Save, load and modify recipes



MEASUREMENT

- ✓ Display of overview-camera and live data
- ✓ Region of Interest (ROI)-Editor
- ✓ Click and drive motor control
- ✓ Automatic sample alignment
- ✓ Save and load measurement routines
- ✓ Multi ROI measurement
- ✓ Multi ROI generation from CAD-File
- ✓ Kinetics measurement (thickness vs. time)
- ✓ Rotating Analyzer mode

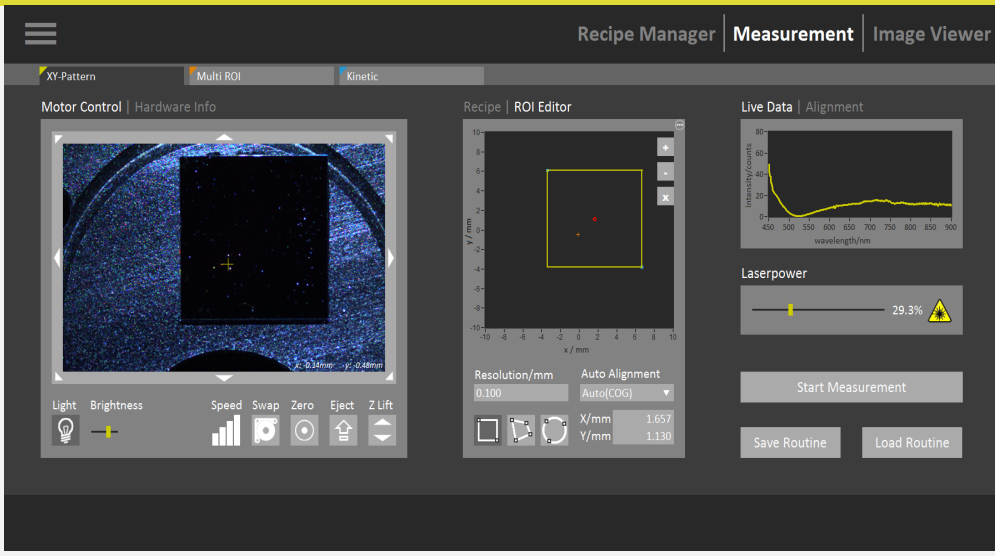
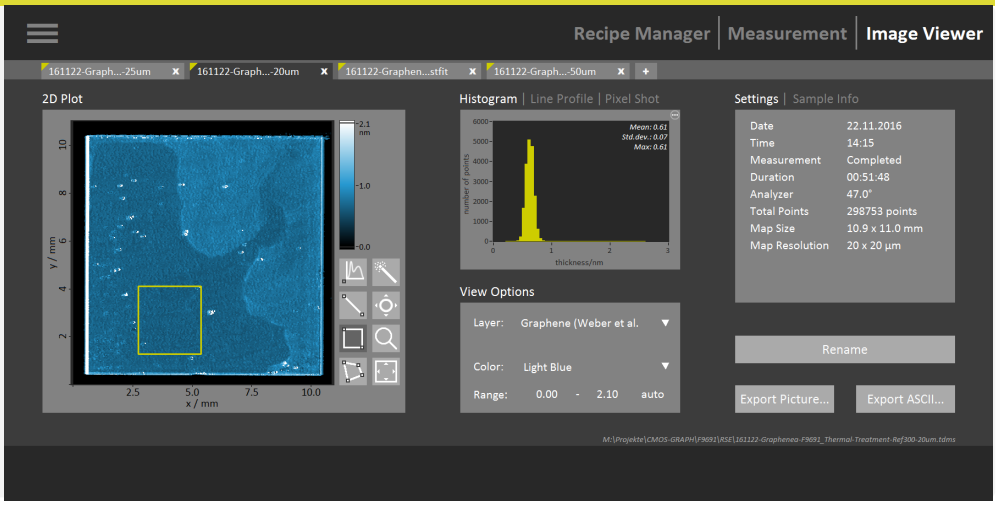


IMAGE VIEWER

- ✓ Tab based, compare files easily
- ✓ Easy access to spectral data cube
- ✓ Histogram, line profile
- ✓ Live-evaluation during measurement
- ✓ View recipe information and all measurement settings
- ✓ Export data to ASCII, PNG, JPG and BMP



	SPECIFICATIONS[3]
Instrument Type	Referenced Spectroscopic Ellipsometer
Angle of Incidence	60°
Spectral Range	450-900 nm, 1.2 nm resolution
Data Rate	200 full spectra per second
Spot Size[1]	Up to 25 x 40 µm microspot (standard: 200 x 50 µm microspot)
Film-Thickness Resolution[2]	Typ. 0.01 nm
Film-Thickness Reproducibility[2]	0.01 nm
Roughness Tolerance	Max. 50 nm R_a
Height Tolerance[1]	±50 µm
Working Distance[1]	12.5 mm
Effective Measurement Time	Full 4"-wafer map at 140 µm x 500 µm resolution in 12 min (112.000 spectra), incl. modeling
Light Source	110 mW supercontinuum laser, class 3b, $M^2 = 1.1$
Detector	2048-channel Czerny-Turner spectrometer, 16 bit, 200 Hz
Polarizing Optics	Two high quality Glan-Thompson prisms, motorized
Alignment	Two-axis automatic sample alignment
X-Y-Z-Positioning	Motorized X-Y-Stage with up to 300 mm range, max. 100 mm/s, motorized Z-positioning in instrument head with 40 mm range
Software	Including control and modeling software for easy access to all measurement and model parameters
PC	Ready to use PC running on Microsoft Windows®, pre-installed control and modeling software
Power Supply	100-240 V, 50/60 Hz
Environmental Conditions	Operating temperature range: 15-30 °C Humidity: 20-80% RH

1: Depending on configuration

2: Depending on sample

3: Specifications are subject to change without prior notice.

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