REFERENCED SPECTROSCOPIC ELLIPSOMETRY: FAST INSPECTION OF THIN FILMS AND SURFACES

"Single shot" spectroscopic measurements
Data rate of 200 spectra / second

Intuitive and easy to use Software Package

Thickness (Interlayer) Graphene | SiO₂ | Si
Live fitting of layer thickness Easy and fast!

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

Thickness (Ultrathin layer) Graphene | SiO₂ | Si
Detection of Contaminants Impurities from Isopropanol

SiO₂ film thickness evaluation SiO₂ (~ 125 nm) | Si

Thickness map: Plasma oxide SiO₂ | Si
Wafer Inspection Si₃N₄ (~1200 nm) | Si

Detection of Contaminants
(a) SnO (~9 nm) | Si (b) Si
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.

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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.

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.
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.

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.
Wafer Inspection
Fast determination of thickness distribution
Live data processing for evaluation of film thicknesses

Detection of Contaminants
High sensitivity
Referenced technique

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

Thin Layers on Transparent Substrates
Thickness and homogeneity of coatings on transparent substrates like glass
Contamination remained from a droplet of isopropanol, stored in a PE bottle.

Surface touched with a glove.

PECVD coatings, 25 times.

PECVD coatings, 10 times.

PECVD coatings, 3 times.
SPECIFICATIONS AND TECHNICAL DETAILS

SOFTWARE

- 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

RECIPE MANAGER

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

MEASUREMENT

- Intuitive layer stack creation
- Auto-optimization of device settings
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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
<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrument Type</td>
<td>Referenced Spectroscopic Ellipsometer</td>
</tr>
<tr>
<td>Angle of Incidence</td>
<td>60°</td>
</tr>
<tr>
<td>Spectral Range</td>
<td>450-900 nm, 1.2 nm resolution</td>
</tr>
<tr>
<td>Data Rate</td>
<td>200 full spectra per second</td>
</tr>
<tr>
<td>Spot Size</td>
<td>Up to 25 x 40 µm microspot (standard: 200 x 50 µm microspot)</td>
</tr>
<tr>
<td>Film-Thickness Resolution</td>
<td>Typ. 0.01 nm</td>
</tr>
<tr>
<td>Film-Thickness Reproducibility</td>
<td>0.01 nm</td>
</tr>
<tr>
<td>Roughness Tolerance</td>
<td>Max. 50 nm Rₐ</td>
</tr>
<tr>
<td>Height Tolerance</td>
<td>±50 µm</td>
</tr>
<tr>
<td>Working Distance</td>
<td>12.5 mm</td>
</tr>
<tr>
<td>Effective Measurement Time</td>
<td>Full 4”-wafer map at 140 µm x 500 µm resolution in 12 min (112,000 spectra), incl. modeling</td>
</tr>
<tr>
<td>Light Source</td>
<td>110 mW supercontinuum laser, class 3b, M² = 1.1</td>
</tr>
<tr>
<td>Detector</td>
<td>2048-channel Czerny-Turner spectrometer, 16 bit, 200 Hz</td>
</tr>
<tr>
<td>Polarizing Optics</td>
<td>Two high quality Glan-Thompson prisms, motorized</td>
</tr>
<tr>
<td>Alignment</td>
<td>Two-axis automatic sample alignment</td>
</tr>
<tr>
<td>X-Y-Z-Positioning</td>
<td>Motorized X-Y-Stage with up to 300 mm range, max. 100 mm/s, motorized Z-positioning in instrument head with 40 mm range</td>
</tr>
<tr>
<td>Software</td>
<td>Including control and modeling software for easy access to all measurement and model parameters</td>
</tr>
<tr>
<td>PC</td>
<td>Ready to use PC running on Microsoft Windows®, pre-installed control and modeling software</td>
</tr>
<tr>
<td>Power Supply</td>
<td>100-240 V, 50/60 Hz</td>
</tr>
</tbody>
</table>
| 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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