



# Metrology Systems and Accessories

Our Mikropack line of metrology products includes fully integrated systems and accessories for thin film measurement, plasma analysis and optical characterization. Systems take advantage of our miniature spectroscopy technology and a range of light sources, sampling devices and software to meet your metrology

needs. Among the applications supported are semiconductor materials analysis, thin film thickness measurements and plasma monitoring.

We offer three primary systems: the NanoCalc-series thin film reflectometer; the Spec-El-series

ellipsometer; and the PlasCalc-series plasma monitoring system. Each system is complemented by accessories and software that provide a level of measurement flexibility often not available with comparable turnkey metrology systems. Replacement parts are also available.

# Thin Film Metrology

## Spectroscopic Reflectometry Systems

NanoCalc systems are versatile and configurable thin film measurement systems utilizing spectroscopic reflectometry to accurately determine optical and non-optical thin film thicknesses for applications in consumer, semiconductor, medical and industrial applications. NanoCalc is part of the Mikropack line of thin film metrology systems. Options are available for measurements ranging from the deep UV to the shortwave NIR.

NanoCalc systems come with a spectrometer, light source and USB interface and require software and a reflection probe, which are available separately. Also available is an extensive range of add-on software, optical fibers and metrology accessories.



### Sample NanoCalc Applications

- Transmission and reflection measurements of anti-reflective & hardness coatings
- Analysis of medical coatings and catheter balloon foils
- Testing of the hardness and wear of coatings
- Measurement of the thickness of thinned silicon wafers
- Determination of photoresist layers for masks
- Analysis of coatings applied for weather or dirt resistance (Lotus Effect)
- Measurement of coatings inside beverage containers
- Air gap measurements
- Analysis of optical disk coatings

### NanoCalc Features

- Resolution to 0.1 nm
- Able to measure stacks of up to 10 layers
- Thickness and refractive index data
- Sophisticated algorithms for defect and roughness tolerance measurements
- Large database to ensure accuracy of a broad range of materials
- Adapters for complex geometries and accessories for thickness mapping

### Specifications

Specification	NANOCALC-VIS	NANOCALC-XR	NANOCALC-DUV	NANOCALC-NIR
Wavelength range:	400-850 nm	250-1050 nm	190-1100 nm	900-1700 nm
Thickness range:	50 nm-20 µm	10 nm-100 µm	1 nm-100 µm	100 nm-250 µm
Optical resolution:	0.1 nm	0.1 nm	0.1 nm	0.1 nm
Repeatability:	0.3 nm	0.3 nm	0.3 nm	1.0 nm
Angle of incidence:	90° or 70°	90° or 70°	90° or 70°	90° or 70°
Number of layers:	Up to 10	Up to 10	Up to 10	Up to 10
Refractive index:	Yes	Yes	Yes	Yes
Test materials:	Transparent or semi-transparent thin film materials	Transparent or semi-transparent thin film materials	Transparent or semi-transparent thin film materials	Transparent or semi-transparent thin film materials
Reference needed:	Yes (bare substrate)	Yes (bare substrate)	Yes (bare substrate)	Yes (bare substrate)
Measurement modes:	Reflection and Transmission	Reflection and Transmission	Reflection and Transmission	Reflection and Transmission
Rough materials capable:	Yes	Yes	Yes	Yes
Measurement speed:	100 ms to 1 s	100 ms to 1 s	100 ms to 1 s	100 ms to 1 s
On-line capable:	Yes	Yes	Yes	Yes
Mechanical tolerance (height):	6.35 mm w/collimation	6.35 mm w/collimation	6.35 mm w/collimation	6.35 mm w/collimation
Spot size:	200 µm or 400 µm standard; 100 µm available upon request	200 µm or 400 µm standard; 100 µm available upon request	200 µm or 400 µm standard; 100 µm available upon request	200 µm or 400 µm standard; 100 µm available upon request
Microspot:	Yes (w/microscope)	Yes (w/microscope)	Yes (w/microscope)	Yes (w/microscope)
CCD color:	Yes (w/microscope)	Yes (w/microscope)	Yes (w/microscope)	Yes (w/microscope)
Mapping option:	150 mm (6") and 300 mm (12") xy-scanning stages	150 mm (6") and 300 mm (12") xy-scanning stages	150 mm (6") and 300 mm (12") xy-scanning stages	150 mm (6") and 300 mm (12") xy-scanning stages
Vacuum capable:	Yes	Yes	Yes	Yes

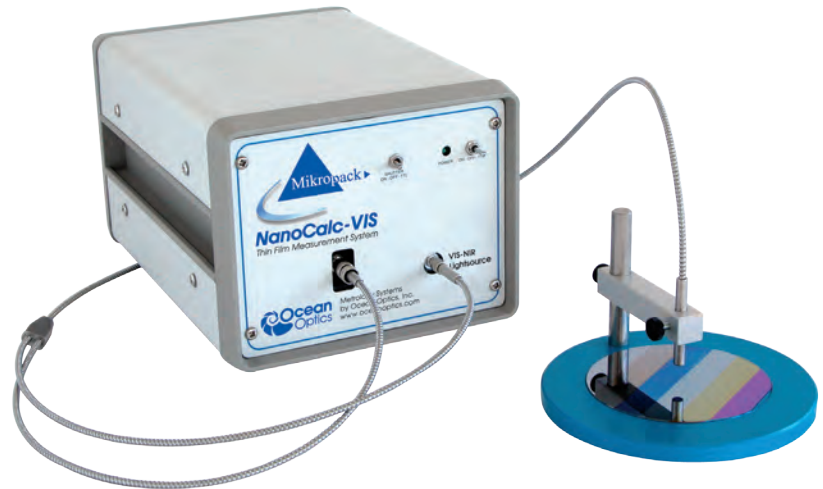
# Thin Film Metrology

## Spectroscopic Reflectometry Systems

With NanoCalc systems, you can select from among four models, several software options, reflection probes and optical fibers and more than a dozen accessories designed to accommodate microscopes, mapping stages and more. Here are your options:

### Selecting Your NanoCalc System

Model	Wavelength Range	Optical Layer Thicknesses
NANOCALC-VIS	400-850 nm	50 nm-20 $\mu$ m
NANOCALC-XR	250-1050 nm	10 nm-100 $\mu$ m
NANOCALC-DUV	190-1100 nm	1 nm-100 $\mu$ m
NANOCALC-NIR	900-1700 nm	100 nm-250 $\mu$ m



### Selecting Your NanoCalc Software

Each NanoCalc system requires the purchase of NANOCALC-1 or NANOCALC-10-N operating software. Add-on modules for functions such as spectrum simulation, mapping and external triggering are also available.



### Standard Operating Software (Required)

Item	Description	Required for
NANOCALC-1	Thin film measurement software for Windows; measurement, simulation and single-layer analysis of up to 4-layer stacks (only one layer can be extracted, the other three have to be fixed)	Any NanoCalc measurement of thin films up to 4 layers
NANOCALC-10-N	Thin film measurement software for Windows; measurement, simulation and analysis of up to 10 layers of 11-layer stacks; refractive index analysis also possible (refractive index for multiple layers requires SCOUT software)	Any NanoCalc measurement of thin films up to 10 layers

### Add-on Software Options

Item	Description	Required for
SCOUT-FULL VERSION	Spectrum simulation program for Windows 95/98/ME/NT/2000/XP. Computes reflectance, transmittance, absorbance or ellipsometry spectra and fits your model to measured spectra by manual, graphical or automatic parameter variation. Scout can be controlled by OLE automation controllers	Spectral simulation; use w/NANOCALC-10-N
NANOCALC-MAPPING	Mapping module software (needs NANOCALC-1 or NANOCALC -10-N) is 3D-mapping module with control of 150 mm and 300 mm mapping stages	Systems using mapping stages
NANOCALC-ONLINE	On-line module software (needs NANOCALC-1 or NANOCALC-10-N) includes external trigger and manual multipoint measurement with data transfer into Excel, plus statistical feature and 1D-Plot; also provides online display of XY-graphs and histograms of layer thickness and removal rate	On-line applications
NANOCALC-MULTIPOINT	Multipoint module software (needs NANOCALC-1 or NANOCALC -10-N) for manual multipoint measurement; provides result list with data transfer into Excel, CSV data, statistical and 1D-graphic; lets you measure on a mouse click, keyboard key or external trigger	Multipoint measurements
NANOCALC-REMOTE	Remote module (needs NANOCALC-1 or NANOCALC -10-N); has active-X functionality to control most NanoCalc functions from any other software; comes with an example program in Visual Basic	Controlling NanoCalc functions w/other software

# Thin Film Metrology

## Spectroscopic Reflectometry Systems

### Selecting Your Reflection Probe or Fiber Assemblies

For all NanoCalc systems you'll need to purchase a bifurcated assembly or reflection probe.

### Bifurcated Assemblies for NanoCalc Systems

Item	Description	Use with NanoCalc Models
NC-2UV-VIS400-2	Bifurcated UV-VIS fiber, 400 $\mu\text{m}$ , 2 m long, 2 x SMA 905 connectors, flexible metal jacketing, common end with stainless steel ferrule 6.35 mm x 50 mm	NANOCALC-VIS NANOCALC-XR
NC-2UVS400-2	Bifurcated DUV fiber, 400 $\mu\text{m}$ , 2 m long, 2 x SMA 905 connectors, flexible metal jacketing, common end with stainless steel ferrule 6.35 mm x 50 mm	NANOCALC-DUV
NC-2VIS-NIR400-2	Bifurcated VIS-NIR fiber, 400 $\mu\text{m}$ , 2 m long, 2 x SMA 905 connectors, flexible metal jacketing, common end with stainless steel ferrule 6.35 mm x 50 mm	NANOCALC-NIR

### Reflection Probes for NanoCalc Systems

Item	Description	Use with NanoCalc Models
NC-7UV-VIS200-2	Reflection probe, 6 illumination, 1 read fiber, 200 $\mu\text{m}$ UV-VIS fibers, 2 m long, flexible metal jacketing, stainless steel ferrule 6.35 mm x 50 mm, 2 x SMA 905 connectors	NANOCALC-VIS NANOCALC-XR
NC-7UV-VIS200-2-SMA	Reflection probe for use w/MFA-PT microscope adapter, 6 illumination, 1 read fiber, 200 $\mu\text{m}$ UV-VIS fibers, 2 m long, with flexible metal jacketing, stainless steel ferrule 6.35 mm x 50 mm, 3 x SMA 905 connectors	NANOCALC-VIS NANOCALC-XR

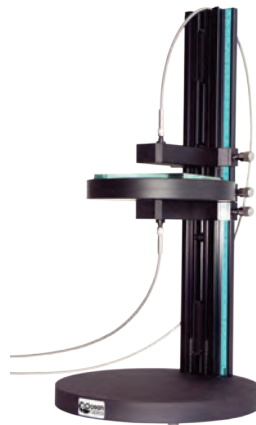
### Additional Accessories

NanoCalc systems are available with accessories for use with microscopes, mapping stages and various mounting configurations. Here are some of our most popular accessories:



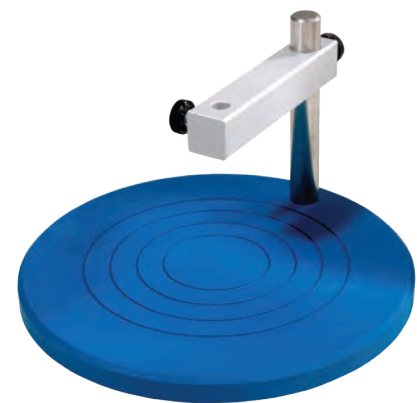
#### Reference Wafers

We offer two Si-SiO<sub>2</sub> reference wafer options for measuring the thickness of thin, transparent films on substrates such as silicon wafers and optical layers. The STEP-WAFER covers UV-VIS wavelengths and the STEP-WAFER-600-1100 covers VIS-NIR wavelengths. Each wafer is a 100 mm diameter, 5-step wafer with calibrated thickness range of 0-500 nm or 600-1100 nm.



#### Reflection-Transmission Stage

The versatile STAGE-RTL-T is a handy tool for reflection and transmission measurements of various substrates (for transmission setups you'll need two extra optical fibers). The STAGE-RTL-T consists of a variable rail, fiber holder, sample holder and light trap and comes with two collimating lenses.



#### Single-point Stage

The STAGE is a Single-point Reflection Stage for measurement of non-transparent samples. It's a good option if you're also using a reference wafer, as the wafer fits nicely on the base plate of the stage.

# Thin Film Metrology

## SpecEI-2000 Ellipsometry System



The SpecEI-2000 is a benchtop thin film measurement system utilizing spectroscopic ellipsometry to measure multilayer, semi-transparent samples such as flat wafers or glass plates. The SpecEI-2000 is affordable, compact (52 cm x 33 cm x 24 cm) and convenient, with easy placement of the sample and one-button operation. SpecEI is part of the Mikropack line of thin film metrology systems. Models are available for 300-1000 nm (SPECCEL-2000-UV-VIS-NIR) and 400-1000 nm (SPECCEL-2000-VIS-NIR). SpecEI systems include an integrated spectrometer, broadband light source and controller; software is available separately.

### SpecEI Features

- Film thickness accuracy to 1.0 nm
- Resolution to 0.1 nm
- Multi-layer stack measurements up to 25 layers
- Single film thickness up to 10  $\mu\text{m}$
- Spectral ranges from 300-1000 nm
- Standard spot size 0.4 mm x 1.2 mm
- Ideal for flat, semi-transparent samples such as wafers, glass, films and foils
- 3D mapping, reference wafers, accessories and other options available
- Accompanying software allows generation and recall of measurement recipes for one-step, repetitive measurements accessories for thickness mapping

### Software for SpecEI-2000 Systems

Powerful SpecEI software offers a range of modeling possibilities such as Cauchy, OJL, Tauc-Lorentz, Drude, EMA and different types of oscillators. The software also stores specific measurement routines, reducing the tedium of repetitive measurements and easing integration.

### Standard Operating Software (required)

SPECEL-ELLICALC	User-friendly 32-bit Windows software for ex situ direct measurement of thickness and n & k coefficients; recipe structure and administrator/user capabilities
SCOUT-FULL VERSION	Scout software. Spectrum simulation program for Windows XP/7. Compute reflectance, transmittance, absorbance or ellipsometry spectra and fits your model to measured spectra by manual, graphical or automatic parameter variation. Scout can be controlled by OLE automation controllers

### Add-on Software Option

SPECEL-MAPPING	Mapping module software (must be used with SPECEL-ELLICALC software). Complete mapping module with software control of 150 mm and 300 mm mapping stages; includes XYZ controls and 3D-graphics
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### Accessories for SpecEI-2000 Systems

We offer reference wafers and mapping stages for use with SpecEI systems. Mapping stages must be purchased at time of SpecEI system order. Replacement parts are also available.

MAPPING-6-INCH-SE	150 mm x 150 mm XY-scanning stage; fully automatic w/vacuum chuck, 2 motors with encoders, integrated 2-axis CNC controller, RS-232 interface; portal structure
MAPPING-12-INCH-SE	300 mm x 300 mm XYZ-scanning stage; fully automatic w/vacuum chuck, 3 motors with encoders, integrated 3-axis CNC controller, RS-232 interface; portal structure
STEP-WAFER	Reference Si-SiO <sub>2</sub> -step-wafer, 5 steps from 0-500 nm, calibrated, 100 mm diameter
STEP-WAFER-600-1100	Reference Si-SiO <sub>2</sub> -step-wafer, 5 steps 600-1100 nm, calibrated, 100 mm diameter

### Specifications

System Performance	
Thickness range:	1 nm-10 $\mu\text{m}$
Resolution:	0.1 nm
n & k analyzer:	Values calculated for complete spectral range
Mathematical models:	Extensive range of options includes constant refractive index, harmonic oscillator and imported dielectric functions
Measurement speed:	7-13 seconds
Repeatability:	70 nm for SiO <sub>2</sub> on Si, $\cos(\Delta) \pm 0.0003$ , $\tan(\Psi) \pm 0.0002$
Sample size:	Desktop up to 150 mm diameter; mapping up to 300 mm diameter
Sample thickness:	5 mm (maximum)
Optical	
Wavelength range:	(UV-NIR) 300-1000 nm or (VIS-NIR) 400-1000 nm
Optical resolution:	1.0 nm
Beam diameter:	400-1200 $\mu\text{m}$
Angle:	70°
Computer	
Software:	Windows XP software; also, recipe structure, administrator-user compatible
Hardware:	IBM compatible PC with Windows XP/7

# Thin Film Metrology

## PlasCalc-2000 Plasma Monitoring and Control System



The PlasCalc-2000 system provides real-time, in situ analysis of the optical emission spectra acquired during plasma processes. The system has all the tools necessary for monitoring and controlling a running process, with sophisticated algorithms for data acquisition and signal treatment. Wavelength, recipe and formula editors allow quick creation of efficient recipe functions for data handling and easy combination of many recipes to build comprehensive strategies for system response during monitoring. PlasCalc-2000 (item PLASCALC-2000-UV-VIS-NIR) is part of the Mikropack line of thin film metrology systems.

The PlasCalc-2000 is 257 mm x 152 mm x 263 mm and includes a spectrometer (200-1100 nm) with 16-bit D/A converter and 12 VDC power supply. Operating the system requires PlasCalc software and 400  $\mu\text{m}$  optical fibers, which are available separately.

### Sample Plasma Monitoring Applications

- Plasma etching
- Plasma chamber health control
- Planarization of blanket polysilicon
- Application of protection coatings
- Abnormal process phenomena
- Process optimization
- Surface cleaning processes

Spectroscopic	
Spectral range:	200-1100 nm
Optical resolution:	1.0 nm (FWHM)
Fiber optic connector:	SMA 905
Electronics	
Power supply:	12 VDC, 1.25 A
Power requirements:	90-240 VAC, 50/60 Hz
D/A converter:	14 bit I/O
Digital I/O:	8x TTL
Analog output/voltage sign:	4x [0-10V]
Computer	
Software:	PlasCalc software (basic operating software); also, SpecLine atomic emission line analysis software (add-on package)
Hardware:	IBM compatible PC with Windows XP/7

### Software for PlasCalc-2000-UV-VIS-NIR System

#### Standard Operating Software (required)

**PLASCALC-SOFTWARE** Real-time and in-situ access to the optical emission spectra of your plasma process. Monitoring and control window in dual-screen technique. Full access to all functions via easy menu-oriented software interface. Multiple plasma species can be picked by a mouseclick, mathematically calculated, subtracted and monitored in real time and in situ. Capabilities: four digital inputs/outputs, 4 analog output channels; display messages with tone signal can be set up for end point, start, stop and limit.

#### Add-on Software Option

**SPECLINE** Software for spectroscopy, astrophysics, plasma science or plasma processing. This tool supports and makes it easy to evaluate spectral data, e.g. finding specific lines in spectra, identifying unknown peaks, identifying atomic lines and molecular bands or comparing data from different different measurements in spectra data. Almost instantly peaks of lines and bands will be found using several powerful filter functions. Extensive database for atoms and molecules included (only for Windows XP/7).



The Mikropack name for our line of thin film metrology systems has its origins in a partnership that first blossomed more than a decade ago. Mikropack was a German photonics company that became an Ocean Optics distributor in 1996 and was known for its metrology systems and spectroscopic accessories. When Mikropack became part of Ocean Optics several years later, we retained the Mikropack name for our metrology systems and accessories. Today, Mikropack systems are developed and supported by our thin film metrology team in Ostfildern, Germany.

# Thin Film Metrology

## Additional Accessories and Replacement Parts



### Additional Accessories & Parts

NanoCalc Accessories	
MFA-PT	Microscope fiber adapter for phototube outlet and SMA 905-terminated optical fibers
MFA-C-Mount	Microscope fiber adapter for C-mount outlet and 6.35 mm ferrule-terminated optical fibers (standard NanoCalc bifurcated fibers)
NC-CMOUNT-ADP	Universal microscope fiber adapter for C-mount outlet and 6.35 mm ferrule-terminated optical fibers; suitable for all common microscopes including beam splitter and multiple objectives for exact images at camera and fiber outlet
NC-MIK-VIS	Microscope for use with NANOCALC-VIS; covers 400-850 nm and includes light source, video microscope for 20 $\mu\text{m}$ spot size with 10x magnification, CCD-USB camera, manual xy-sample-stage
CSH	Probe holder for curved samples; used with reflection probes with cylindrical 6.35 mm ferrule and rubber ring as contact element
COL-UV-6.35	UV/VIS/NIR collimating lens with connector for 6.35 mm ferrule
MAPPING-6-INCH	XY-scanning-stage with 6" (152.4 mm) vacuum chuck, 150 mm x150 mm travel range, RS-232, 90-240VAC (needs software NANOCALC-MAPPING)
MAPPING-12-INCH	XY- scanning-stage with 12" (304.8 mm) vacuum chuck, for sample diameter of up to 300 mm, RS-232, 90-240VAC (needs software NANOCALC-MAPPING)

NanoCalc & SpecEl Spare Parts	
RB-VIS-NIR	Replacement bulb for NANOCALC-VIS; 1,500-hour lifetime (red & black wires)
RB-VIS-NIR-LL	Replacement bulb for NANOCALC-VIS; 10,000-hour lifetime (yellow & black wires)
RB-UV-VIS-NIR-2	Replacement high power bulb for NANOCALC-VIS & NANOCALC-XR; 1000-hour lifetime (yellow wires)
RB-UV-VIS-NIR	Replacement bulb for NANOCALC-VIS; 1,000-hour lifetime (white or blue wires)
SPECEL-2000-BM	SPECEL-2000-VIS-NIR replacement light source module complete with bulb, housing, optics and shutter, for plug and play replacement on customer side
SPECEL-2000-BM-UV	SPECEL-2000-UV-VIS-NIR replacement light source module complete with bulb, housing, optics and shutter, for plug and play replacement on customer side

### Other Accessories

STAGE	Single point reflection measurement for non-transparent samples
STAGE-RTL-T	Reflection and transmission stage with variable rail, fiber holder, sample holder and light trap, 2x collimating lenses for different substrate materials (order for transmission setup, 2x fibers extra).
COL-UV-6	Collimating lens UV-VIS-NIR, fused silica Suprasil, 200-2000 nm, 6 mm diameter, 10 mm focal length, 200 °C, SMA 905, 3/8-24 thread
STEP-WAFER	Reference Si-SiO <sub>2</sub> -step-wafer , 5 steps from 0-500 nm, calibrated, 100 mm diameter
STEP-WAFER-600-1100	Reference Si-SiO <sub>2</sub> -step-wafer, 5 steps 600-1100 nm, calibrated, 100 mm diameter