SENTECH Erfolg durch Leistung

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SE 800 DUV
DUV-VIS SENresearch
Spectroscopic Ellipsometer

Spectral range: 190nm ... 1000nm

Product description

- Measurement of refractive Index, absorption and film thickness
- Ultimate solution for high speed combined with high performance
- Measurement of the entire spectral range by one click
- STEP SCAN ANALYZER measuring mode combined with compensators for the whole spectral range and polarizer tracking for most accurate and complete sample analysis
- SpectraRay /3 - comprehensive software for spectroscopic ellipsometry including sophisticated multiple angle, multiple sample, and combined photometric data analysis, programmable customer interface and advanced reporting
- Easy operation for both, experts and beginners
- SENTECH material library and sample applications for efficient modeling

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1. General description

The **SE 800 DUV** is the top of the line of SENTECH's SENresearch spectroscopic ellipsometer family. It is the ideal tool for thin film and material characterization from DUV to VIS.
The **SE 800 DUV** is applying the Step Scan Analyzer (SSA) measurement mode and a high performance multiplex detection, dedicated to fit perfectly SENTECH's goal of fast and accurate measurements of refractive index, absorption and film thickness.

The **SE 800 DUV** is a high performance spectroscopic ellipsometer, based on fast diode array detection in the DUV/VIS spectral range The **SE 800 DUV** is characterized by both fast data acquisition and full spectral resolution.

The DUV concept is designed for low stray light, high DUV sensitivity and best S/N ratio even for low reflecting samples.

The operation of the **SE 800 DUV** is extremely user friendly. The entire ellipsometric spectrum between 190 nm and 1000 nm or a user defined spectral range can be measured by just one click and the results are displayed in a few seconds. The transition between DUV/UV and VIS is seamless due to a sophisticated, automated channel switching concept.

The computer controlled stabilized dual light source comprises a Deuterium lamp for the DUV, a halogen tungsten lamp for the VIS. The detection unit for the DUV-VIS spectral range is based on a DUV enhanced grating spectrograph with a DUV sensitive CCD. The detector head is sealed and TE cooled to ensure a low dark signal.

The use of high grade broadband polarizer prisms with outstanding extinction ratio and acceptance angle guarantees best transmission and polarization in the entire spectral range from 190 nm to 930 nm.

The **SE 800 DUV** ellipsometer setup actually contains the Polarizer – Compensator – Sample – Analyzer (PCSA) set-up assuring the measurement of the degree of polarization and to compensate for depolarization effects caused by non-uniform samples, rough surfaces, limited spectral resolution and focusing angle. Using compensator the ellipsometric angle Δ can be measured in the whole range from 0 – 360 degrees with extreme accuracy and ultimate precision. Additionally the compensator is highly stabilized against changes of the environmental temperature to provide lowest drift and lowest measurement error even at Delta around 0 deg.

The **SE 800 DUV** data acquisition can be tuned for highest measurement accuracy for each individual application. The polarizer position is computer controlled and can be set to dedicated values according to the optical response of the sample (polarizer tracking).

Precise sample alignment is vital for highly accurate ellipsometric measurements. The **SE 800 DUV** features the Auto Collimating Telescope (ACT) for the tilt and an optical microscope for the focus of the sample.

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Smooth operation of the instrument is guaranteed by SENTECH's controller concept. While the software runs on a state of the art PC under Windows 7 the complete hardware is separately controlled by its own embedded microcontroller.

SENTECH's proprietary ellipsometer software **SpectraRay/3** comprises two modes of operation: recipe mode and interactive mode. The recipe mode allows for easy execution of repetitive applications. In interactive mode, ellipsometric measurements are enhanced by an interactive, guiding graphical user interface. The operation of **SpectraRay/3** is very intuitive and satisfies the demands for ease of use and multiple user operation.

SpectraRay/3 includes data acquisition, modeling, fitting, and extended reporting of ellipsometric, reflection, and transmission data. It supports variable angle, multi-experiment, and combined photometric measurements. **SpectraRay/3** contains a huge library of materials data based on SENTECH measurements and literature data as well. The large number of dispersion models allows modeling of nearly any type of material.
The scripting capability makes it very flexible to automate routine measurements, to tailor it for dedicated applications and to control third party hardware like sensors, heaters or a cryostat.

The **SE 800 DUV** comprises the mechanical setup with a manual goniometer for multiple angle measurements, the optical components, the optical fibers, an electronic rack, a desktop PC with Windows 7, and the SENTECH **SpectraRay /3** software. Light sources and detector are coupled to the ellipsometer arms by optical fibers.

2. Technical Specifications

2.1 General:

Spectral range: 190 nm to 1000 nm UV-VIS-NIR

Spectral resolution: DUV-VIS: Better than 0.8 nm per pixel

Max. sample size: 6", optional 8" and 300 mm,
                      Maximum substrate thickness 7 mm
                      larger and /or thicker samples on request

Substrate: Opaque or transparent

Layers: Software allows for an unlimited number of layers to be analyzed.
                      The practical number of layers that can be measured depends on the
                      sample. More than five layers is possible for almost all samples.

2.2 Optical, electrical and mechanical components:

Ellipsometer operation   **Combined PSA and PCSA setup:**

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principle:	P: polarizer
	C: compensator
	S: sample
	A: Step Scan Analyzer

Light source:	Deuterium Tungsten-Halogen combined lamp
	Lifetime: More than 1000 hours
Polarizer/ analyzer:	High grade broadband MgF2 Rochon prisms,
	Computer controlled Analyzer (SSA) and polarizer (polarizer tracking)
Extinction rate	10^{-5}
Angular precision:	better than 0.01° SENTECH uses Step Scan Analyzer / Polarizer mode which results in an effective angular precision of better than 0.01°
Compensator	Highly stabilized
	The use of compensator enables the user to measure the ellipsometric angle Δ in the whole range from 0° to 360° with extreme precision.
Measurement spot:	Manually variable beam diameter from 4 mm to 1 mm
	Optional micro spot 200 µm
	Smaller spot size on request
Spectral discrimination:	The detection is based on the step scan measurement mode where no parts are moving during data acquisition: The reflected light is analyzed at discrete angle positions with an optical multichannel analyzer, consisting of a grating and high performance CCD array detector.
Spectral resolution	4 nm FWHM at 100 µm slit width
Sample stage:	Fixed samples stage with 150 mm samples platform, height and tilt adjustable
	Optional mapping stage:
	50 mm x 50 mm, manual or motorized, 150 mm x 150 mm motorized, 200 mm x 200 mm motorized, 300 mm r, ϑ stage, motorized. Other stages on request
	Vacuum chuck
Sample holder for	Fast exchange with standard sample stage via quick lock
Transmission	90deg measurement position of ellipsometer arms, sample is clamped to the holder

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measurements	Minimal sample size 10 mm
	Other configurations on request
Goniometer:	Mechanical Goniometer, variable from 40° to 90°, set in 5° steps, accuracy better than 0.02 °
	Optional: Computer controlled goniometer, variable angle from 40° to 90°, Min. step width 0.002°, accuracy better than 0.01°
	Extended angle range from 20° to 90 °on request.
Sample alignment:	Auto Collimating Telescope (ACT) and optical microscope for sample alignment (focus and tilt)
	Optional:
	CCD camera to show the measuring area and the alignment procedure at the computer monitor
Measurement time	Typical time for full ψ / Δ spectra of a sample is less than 10 seconds
Controller:	Modular unit with bench top ellipsometer optics and goniometer. Separate rack contains light source, ellipsometer controller with electronic boards and microcontroller unit, spectrophotometer
Computer:	State of the art desktop PC, monitor, keyboard, mouse,
	Windows 7 professional operation software
Output device:	Inkjet printer compatible Software interface to export and import spectroscopic data optional Network card
Power requirements:	Rated voltage:115/230 VAC auto select (100-132 VAC or 207-264 VAC) Rated frequency: 50-60 Hz Rated power: 600 W Other common line voltages available
Environment:	Cleanroom (Class 100) compatible

3. Data acquisition and analysis software: SpectraRay /3

Features:	**SpectraRay/3** operating and analysis software comprises • Interactive and recipe mode of operation

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- Automated system Calibration
- Automatic setting up of optical and mechanical components
- Easy and guided software operation including data acquisition, modeling, fitting and reporting
- Complete experiments can be saved as recipes
- Recipe mode for routine applications
- Mapping module for computer controlled samples stages (description see also mapping options)
- Advanced reporting of measured and fitted spectra, measurement data, user comments, sample information in a Word-like environment

Measurement output:	- Ellipsometric angles ψ; Δ, Fourier coefficients s_1, s_2 vs. energy, wavelength or wavenumber (related to sample position, angle of incidence) of single or multiple angle or time dependent measurements
	- Mueller matrix elements
	- Polarized reflectivity R_p, R_s and transmission
	- Dispersion relation
	- Dielectric function
	- Degree of polarization
	- Graphic representations of measured and calculated ellipsometric spectra
	- Data clipping to selected wavelengths and angles without changing original data
	- Merge function for combining sets of different wavelength ranges
	- Combine function for combining sets of different data in one file
	- Reduction of data as modulo or average
	- Extract angle traces from multiple angle and time dependent data

Modelling, simulation and fit:	**SpectraRay/3** is able to fit any multilayer structure (single film, layer stack, periodical groups of stacks) for ψ, Δ; tan ψ, cos Δ and Fourier coefficients, transmission, reflection etc. This includes anisotropic substrates and layers (separate software license).

- Large material library (more than 200 data sets), user expandable and application adaptable

- Large set of dispersion relations to describe the optical properties of layers and bulk materials: data file (data table), 2D table, Cauchy, Sellmeier, Schott, Drude-Lorentz, Lorentz, Urbach, Leng, Tauc-Lorentz, Cody-Lorentz, Brendel, Hamberg, Sernelius, Forouhi-Bloomer, Afromovitz, Tanguy, spectral combination layer for combining different dielectric models, user defined dispersion formula, dispersion formula for uniaxial and biaxial anisotropic materials, dispersion formula for periodic layer stacks

- Each layer of a model stack can be a homogeneous film, an interface, a

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surface roughness, a homogeneous growing layer, an index gradient (effective medium approximations: Maxwell-Garnett, Bruggemann, Lorentz-Lorenz, Clausius-Mossotti)

- Material gradients can be modeled by one of the following type of functions: linear, exponential, error function like, Gaussian (symmetrical or asymmetrical) like, parabola like.

- Fast regression algorithms for fitting calculated spectra to measured spectra

- Graphical representation of fitted spectra

Fit of composite data:	The fit algorithm does not only allow fitting of ellipsometric data but also transmission and reflection spectra as well. The fit can be based on multiple measurements (Ψ,Δ, R, T) and different samples with same layer material. External data of other instruments can be imported as ASCII data and analysed / fitted
Fit parameters:	Customer defined, depending on the model. There is no fundamental limit for the number of fit parameters or layers in a layer stack. Fit parameters could be e.g.: film thickness, refractive index, extinction coefficient, constituent fractions, incident angle, composition profile, temperature, and time.
Fit statistics:	Fit error and correlation matrix are calculated. Device -, wavelength - and sample alignment errors can be taken into account.
File management functions:	The software is based on Windows 7 and provides full file management functions.
User management:	The software provides full user level management and allows user specific assignment of rights on a function level basis.
Recipe module:	Push button operation of routine applications (recipes), A recipe includes the hardware settings, measurement conditions, model and measured data. A set of standard recipes is delivered with the software. New recipes can be built up by adapting already existing recipes or importing corresponding data from the interactive operation part of **SpectraRay/3** after a new ellipsometric application was solved. A measurement can be directly started after loading a new recipe. All settings can be optimized / set by the user (password based user management available). The measured results (measured and fitted spectra, fit parameters) are shown in the operation window of the module. Recipes can be used in mapping applications as well if computer controlled mapping is available
Customized user interface:	**SpectraRay/3** includes a software package to develop user defined measuring and operation routines based on an easy to use script language.

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4. Optional Items

SE 802	Computer controlled goniometer, precision 0.01°
SE 800-3	Micro spot option, 200 µm spot diameter in the UV/VIS, 100 µm spot on request
SE 800 NIR-FTIR	Spectral extension into NIR, up to 2500 nm
	For the NIR a Fourier Transform Infrared (FTIR) Spectrometer is used. Applying FTIR ellipsometry adds speed, high resolution and a high signal to noise ratio. It provides automatic wavelength calibration as well.
	Spectral resolution: 1 cm^{-1} up to 64 cm^{-1} (0.06 ... 2 nm @800 nm; 0.5 nm ... 18 nm @ 2500 nm)
SE 800 NIR Z	Spectral extension into NIR, up to 1700 nm InGaAs diode array detector Spectral resolution 6 nm at 50 µm slit width
SE 61	Video camera for alignment in lieu of eyepiece, frame grabber, microscopic image
SE PXY	Manual x-y stage with 50 mm travel
SE PSV	Vacuum chuck in lieu of standard sample stage
SE PSD	Rotational element with quick lock in lieu of standard sample stage
SE 800-PST	Sample holder with quick lock for transmission measurements
SE14	Mapping stage, x = 50 mm, y = 50 mm sample stage (including vacuum chuck), 150 mm sample platform extensive mapping software to define scan raster and to display scans in various ways
SE 15	Mapping stage, x = 150 mm, y = 150 mm sample stage (including vacuum chuck), 150 mm sample platform extensive mapping software to define scan raster and to display scans in various ways
SE 16	Mapping stage, x = 200 mm, y = 200 mm sample stage (including vacuum chuck), 200 mm sample platform extensive mapping software to define scan raster and to display scans in various ways
SE 17	Mapping stage, r,ϑ-stage for 300 mm wafers, 150 mm travel length (including vacuum chuck), 300 mm sample platform extensive mapping software to define scan raster and to display scans in various ways
SE AF	Autofocus option in combination with SE 800 mapping option
SE AFT	Auto height and tilt adjustment
SE 800-30	Reflectometer based on FTPadv, spectral range 450-920 nm, 80 µm spot size
SE 20	Liquid cell for in situ measurements, Teflon, one pair of windows liquid at rest
SE CFH26	Liquid cell 26 ml volume heated up to 70°C, incidence angles 50°, 60°, 70°, fluid flow,

	Cells with other parameters on request
SE K20	SENTECH thin film test wafer, nominal 20 nm SiO2 on Si
SE K100	SENTECH thin film test wafer, nominal 100 nm SiO2 on Si
SE K400	SENTECH thin film test wafer, nominal 400 nm SiO2 on Si
SE 51	Second SpectraRay license for work station
SE 5A	SpectraRay/3 license for anisotropic sample analysis