

SENDURO[®]

Automated measurement tool

Up to 200 mm wafer diameter

Product description



SENDURO[®]

1 General description

The **SENDURO**[®] is a new, powerful automated tool for the measurement of single films and layer stacks on transparent or absorbing substrates.

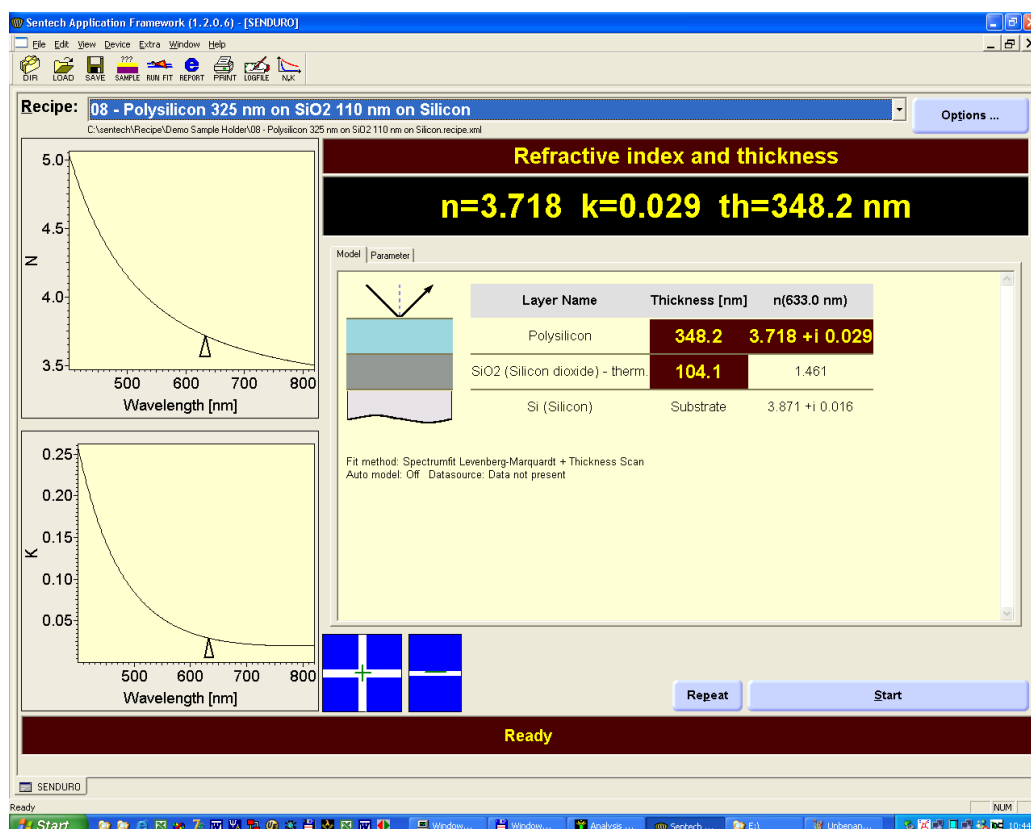
1.1 Highlights and Advantages

Measurement recipes (one-click applications)

Starting with SENTECH's predefined recipe library the user quickly selects the desired measurement task and executes the complete sequence at once:

- automated alignment,
- data acquisition
- sample modeling,
- analysis of single or multi-layer samples by fitting the model to the measured data
- display of results
- reporting of measured data

The predefined recipes cover a wide range of today's thin film objectives. An **AutoModel** feature can even identify the proper application out of a selected range of applications (samples). Furthermore, SENTECH continuously updates the recipe library as new materials and layer types are analyzed and applications become available.



Operator software interface showing a typical measurement result and the alignment status.

Fully automatic sample alignment

A new patented automatic sample alignment liberates the user from the sometimes considered difficult sample alignment in height and tilt to a precision as required by ellipsometry. The auto alignment feature contributes substantially to the precision and repeatability of the measurement. The auto alignment quickly within a second moves the sample into its required position for highly accurate measurement, and a display on the monitor informs the operator of the alignment status. During sample mapping, the auto alignment feature automatically checks for the proper alignment prior to each measurement point.

Measurement on transparent and absorbing substrates

The patented **SENDURO**[®] sample alignment provides accurate height and tilt for absorbing as well as for transparent samples. The **SENDURO**[®] measures all of these different substrates pretty well without any dedicated sample treatment to avoid backside reflections on thin transparent substrates.

High sample throughput rate

The total time to analyze a sample will typically take less than ten seconds; i.e. placing the sample on the sample stage, automatic alignment, data acquisition, calculation, displaying the protocol with results, and finally removing the sample.

Minimized installation effort

The **SENDURO**[®] is completely housed in an attractive shell that protects the ellipsometer optics, the control electronics and the innovative sample stage from dust, damage and mishandling. Only two connections have to be made to start working: power and computer.

1.2 SAMPLES

Sample characteristic

Sample prerequisite	Reflecting transparent or absorbing materials
Sample dimensions	200 mm Ø max or 200 mm x 200 mm max
Sample thickness	10 mm max

Sample stage

150 mm Ø (standard),
sample platform on loading sleigh,
motorized z- and tilt axes for auto alignment
optional:
Vacuum chuck
Mapping options with motorized x-y stage:
50 mm x 50 mm
150 mm x 150 mm
200 mm x 200 mm

Sample alignment

Automated tilt and height alignment,
status display on monitor

Measurement time

Typical time for data acquisition 100 ms pro intensity spectra.
Typical measurement time for (psi, Delta) spectra using
SENTECH's most accurate Step Scan Analyzer operation mode
is between 5 and 10s depending on measurement mode.
The fitting time of data spectra is extremely short.
(Sample: 100 nm SiO₂ / Si with 512 (Ψ,Δ) pairs in about 100 ms).

Measurement area

The sample area used for measuring is 1 mm x 1 mm

Sample parameters

Thickness of each layer of a layer stack (switch-selectable in nm
or Å), Refractive index, extinction coefficient vs. wavelength (290
nm – 850 nm),
Material composition, Roughness, Interface layer.

Recipes library

A large number of predefined recipes are available in the library.
The recipes are assigned to the following topics:

- Semiconductor technology
- Coatings on glass
- Data storage media
- Flat panel applications
- Organic materials
- Dielectric materials
- Metallic films and metals
- Applications in Chemistry and Biology

Predefined recipes can be modified by the user and so easy
adapted to the new requirements of a specific sample.
The library can be extended by user defined applications.

2 Instrumentation

Main item of the automated measurement tool **SENDURO**[®] is a high performance fast and accurate photo diode array detector based spectroscopic ellipsometer in the UV/VIS range featuring fast data acquisition, full spectral resolution and high signal to noise ratio.

The sample alignment is performed by a patented integrated height and tilt sensor together with an automatic sample stage. This removes user dependent alignment uncertainties and speeds up the measurement.

The ellipsometer is based on the most accurate **Step Scan Analyzer** operation mode. The implementation of an achromatic retarder allows to measure the ellipsometric angle delta in the whole data range from 0° to 360° with extreme precision and without any dead spots in delta. Very thin films on absorbing substrates can be measured with extraordinary accuracy.

The high measurement speed makes the **SENDURO**[®] an ideal tool for the analysis of single films and layer stacks on transparent as well as absorbing substrates.

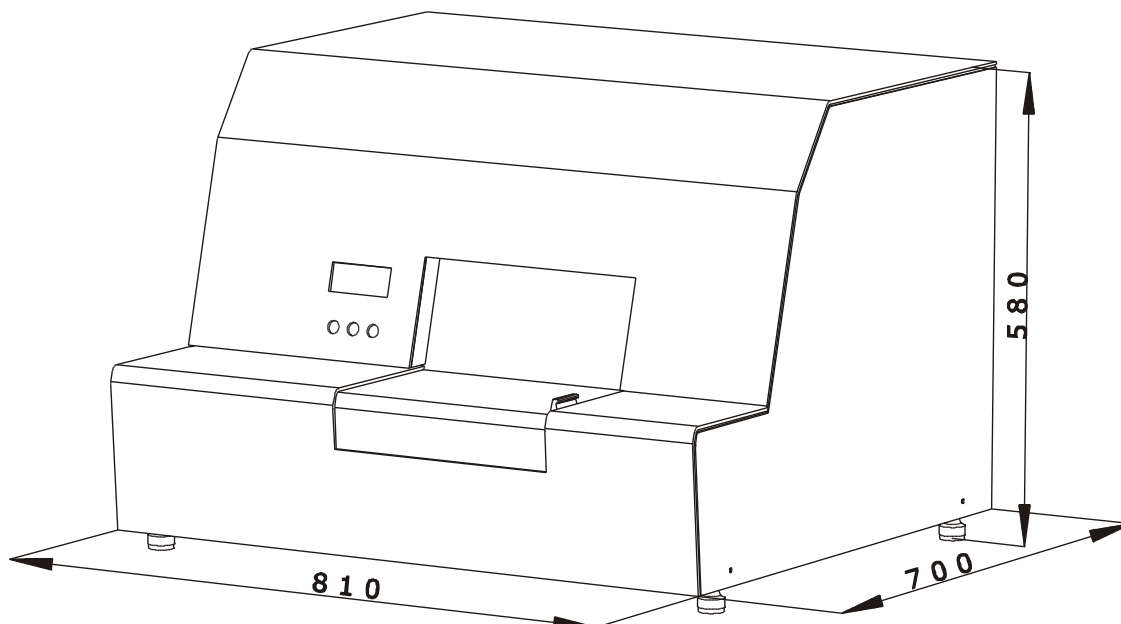
The **SENDURO**[®] comprises the ellipsometer optics, the automatic tilt and height sensor, the sample stage with three motorized axes for height and tilt offset compensation and controller electronics all housed in one compact shell.

The computer with the **SENDURO**[®] software user interface is connected via LAN.

Controller	The unit includes electronic boards, power supplies, light sources, the spectrophotometer, the sample stage and the motorized sample alignment unit. The user PC is connected via a TCP/IP network.
Computer ¹	State of the art table top PC TFT-LCD, mouse, keyboard Ethernet interface
Output device	Inkjet printer compatible software interface to export and import spectroscopic data.
Power	115/230 VAC auto-select (103-132 VAC or 207-264 VAC), Frequency 47-63 Hz
Maintenance	Lampe lifetime control, Typical lifetime >1000h, 2.1.1.1.1.1 Implemented self test reports failures
SENDURO [®] dimensions	Width: 810 mm, height: 580 mm, depth: 700 mm, Weight: 80 kg
Environment	Clean room class 100 compatible

¹ The computer system may change due to the availability of the listed system. The listed features describe the minimum computer equipment.

3 Instrument dimension without computer:



4 Quality and measurement statistics

The spectroscopic ellipsometer setup and the high quality of the used optical and detector components combined with SENTECH's high manufacturing standard guarantee a powerful measurement performance. Terms used are defined in SEMI Standard E10-0299 and SEMI P24-94.

Precision of SENDURO®

(Standard deviation of 30 subsequent ellipsometric measurements of film thickness for typical test samples)

Film thickness:

< 100 Å SiO ₂ on Si:	0.20 Å
100 Å - 1000 Å SiO ₂ on Si:	0.3 Å
> 1,000 Å SiO ₂ on Si:	0.50 Å
> 10,000 Å SiO ₂ on Si:	< 0,03 %

Refractive index:

1,000 Å SiO ₂ on Si:	0.0003
17,000 Å resist on Si:	0.0006

5 SpectraRay/3 software for SENDURO

The **SENDURO**[®] comes with SENTECH's software for spectroscopic ellipsometry **SpectraRay/3**. It comprises the recipe oriented operating module especially developed for a minimum of operator interaction and the interactive operation module for the analysis of new and unknown samples. The recipe module comes with a large library of executable recipes. The operator has only to select the right recipe with a mouse click and hits the measurement button. That is how easy it is to operate the **SENDURO**[®].

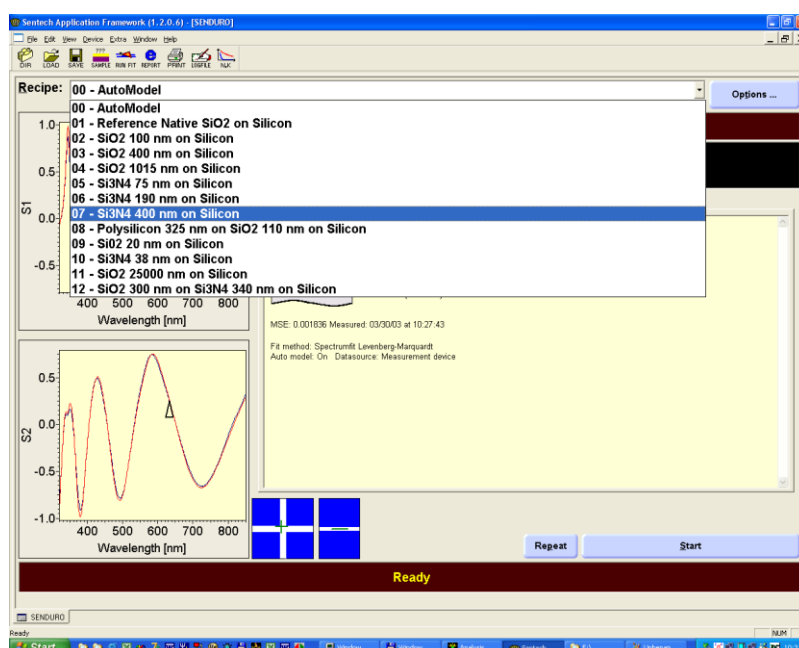
The **SpectraRay/3** software's recipe module offers much more for the advanced user like modification of predefined recipes, or new recipes to be laid out and added to the library. The **SpectraRay/3** software additionally includes a large integrated package of modeling, simulation, and fit programs in order to support the customer for successfully processing even complex measurement tasks. This part of the software is designed for engineers who setup applications for operators and focuses on interactive development of an application (For more information about **SpectraRay/3** see corresponding software description).

Automated sample alignment

A new patented automatic sample alignment liberates the user from the sometimes considered difficult sample alignment in height and tilt to a precision as required by ellipsometry. The automatic sample alignment is fully integrated in the measurement software and allows improving the tilt even during mapping on samples.

Recipes (predefined applications)

A recipe library helps the user to quickly select the desired task and to execute a measurement. SENTECH continuously updates the library as new layer types are analyzed and become available.



Recipe module showing a list of measurement tasks in the recipe library.

The operating and analysis module comprises:

- Predefined recipes
- Application and model editor
- Spectral display in all standard energy (cm^{-1} , eV) or wavelength ($\text{\AA}$, nm) units
- Lifelike monitoring of sample response, online representation of ψ , Δ or S_1 , S_2 ,
- System calibration

Output data:

- Layer thickness in $\text{\AA}$ or nm
- Refractive index, extinction coefficient vs. wavelength (290 to 850 nm)
- Ellipsometric angles (ψ , Δ), ($\tan \psi$, $\cos \Delta$) and Fourier coefficients vs. energy or wavelength (measured and fitted curves)
- Data clipping to selected wavelength and angles without changing original data
- Reporting and protocol function

Modelling, Simulation and Fit:

- Fit of any multilayer structure (single, stack, periodical groups) for ψ , Δ ; $\tan \psi$, $\cos \Delta$ and Fourier coefficients.
- Easy to handle materials library which is user expandable
- Dispersion relations for layers: fixed dielectric constant, file (n,k data table), Cauchy, Sellmeier, Schott, Lorentz, Leng, Tauc-Lorentz, Cody-Lorentz, Hamberg, Sernelius, Forouhi-Bloomer. (Further dispersion relations available in interactive mode of **SpectraRay/3**)
- Effective medium approximations (EMA) by Maxwell-Garnett, Bruggemann, Lorentz-Lorenz, Clausius-Mossotti EMA's to describe composites, surface roughness, or interfaces.
- Fast, regression fitting algorithms for optical models to measured data
- **AutoModel** is a new technology and allows to select the appropriate sample description from a known set of sample structures (in this mode the **SENDURO**[®] can detect the sample structure itself and the user may operate only one recipe for many sample structures)
- Simultaneous graphical display of measured and calculated spectra
- 2D presentation graphics

Fit Parameters

- Customer defined, depending on the model
- There is no fundamental limit for the number of fit parameters or of layers in a layer stack.

File management functions

- The software is based on Windows 7 and provides full file management functions

Statistics

- Fit error, error estimation for any fitting parameters

User management

- the software supports a complete user level management
- many features can be accessed only on configured rights

6 Options

SE 15	mapping option 150 mm x 150 mm motorized stage and software
SE 16	mapping option 200 mm x 200 mm motorized stage and software
SEN FTP	Photometer option for reflectometry based on SENTECH's Film Thickness Probe FTPadv
SEN 220	Microscope and camera option for sample surface inspection