Specifications

|	
Wafer size	300 mm, 200 mm (200 mm using wafer adapter)
Simultaneous analysis elements	20 elements maximum, Fixed-type (4Be ～ 92U), Heavy element scan-type (22Ti ～ 92U)
Aperture	3-position with auto-changer (Standard: 10 mm dia., 20 mm dia., 40 mm dia.) (Optional: 5 mm dia., 15 mm dia.)
X-ray tube	Rh target, Maximum rating 4kW
Detector	S-PC, SC, F-PC (PR gas required)
Wafer stage	$r\theta\phi Z$ stage
Analysis spot designation	r,θ designation, r: 1 mm step, θ 1deg. step X-Y designation 1 mm step
Sample spin mechanism	4 rpm (Available only for wafer center analysis)
Carrier	300 mm FOUP (25 wafer)
Vacuum pump	Dry pump
Stabilizing system	Temperature stabilizer, Automatic vacuum control system
EFEM	FFU with ULPA filter
Data processing system	Personal computer, Windows Software: Film thickness/Concentration simultaneous analysis software Fundamental Parameters software for thin film analysis
Compliant with on-line communication standards	SECS/GEM300 (Optional)
Compliant with safety standards	SEMI S2, S8, S14, S22, CE Marking (Optional)
Others	Through-the-wall, *etc*. can be accommodated upon request

Installation Requirements

| Model name	WaferX 310
Power	3phase, AC200 V, 50/60 Hz, 50 A
Earth grounding	Grounding resistance 30 Ωor less (Dedicated line)
Cooling water	Tap water or clean industrial water For main unit: 0.29 ～ 0.49 MPa, 10 L/min. or more (Temperature 5 ～ 30 ℃) For dry pump: According to dry pump's specifications
Environment	Room temperature : 20～25 ℃ (Daily fluctuation within ±2 ℃ of average) Humidity : 75% RH or less Vibration, dust, and other conditions are according to standards for electronic measurement equipment
N2 gas (UPN)	For main unit: 0.3 ～ 0.7 MPa, 30 L/min. For dry pump: According to dry pump's specifications
PR gas	0.15 MPa, 25 mL/min. (For F-PC)
Compressed air	0.52 ～ 0.7 MPa, 5 mL/min.
Vacuum	-80 kPa or less, 10 mL/min. (For wafer transfer robot)
Others	Ventilation for dry pump

(Note : Pressure at gauge)

Rigaku
Leading With Innovation

X-ray Fluorescence Spectrometer for Thin Film Evaluation

WaferX310

Typical Floor Arrangement (Same floor)

Maintenance space

Unit: mm
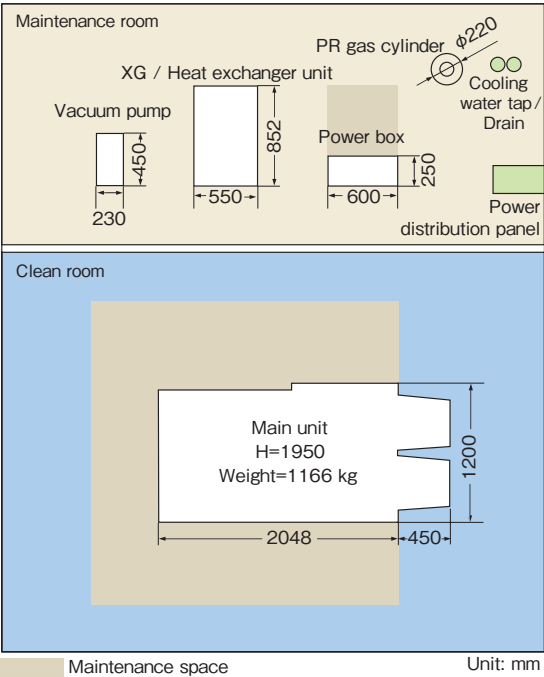
Typical Floor Arrangement (Two floors)

Unit: mm
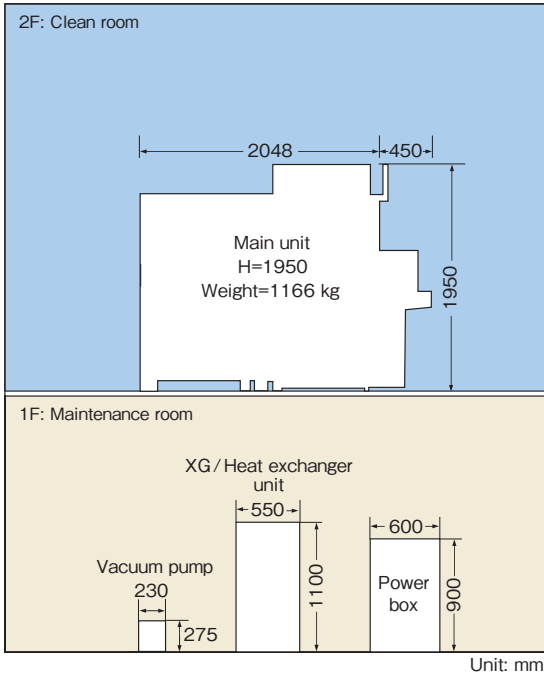
| Compliance with safety standards | CE | SEMI S2/S8 | Compliance with communication standards | GEM300 | SECS/GEM |

ISO 9001/ISO 14001 approved

＊Figures of performance in this catalog are results from tests by Rigaku Corporation and are not guaranteed to be reproduced under other test conditions.
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Rigaku Corporation and its Global Subsidiaries

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CES203B/160610E

Compliant with Advanced Semiconductor Process 300 mm Fab
De facto Standard Model for Thickness and Composition Metrology

World Leader in Analytical X-ray Metrology Tools and Solutions for the Semiconductor Industry

X-ray Fluorescence Spectrometer for Thin Film Evaluation

WaferX310

High-precision Analysis of Film Thickness, Composition, and Element Concentration (for Insulating Interlayer Films, High-k Films, Metal Multilayer Stacks, etc.)

Rigaku has decades of experience providing X-ray Fluorescence Spectrometers for thin film evaluation with more than 600 installations worldwide in semiconductor fabs. This latest WaferX 310 contributes significantly to the high quality of semiconductor processes from device development to fab QC.

300 mm Thin Film Wafer Measurement
Applicable to a Wide Range of Film Thicknesses and Types, from Ultra-thin to Micron-thick

AutoCal Function
- Built-in wafer stocker for daily control samples.
- Fully automatic daily qualification of the tool is possible.

Compliant with On-line Communication Standards (GEM300)
- Compliant with 300 mm fab CIM/FA.

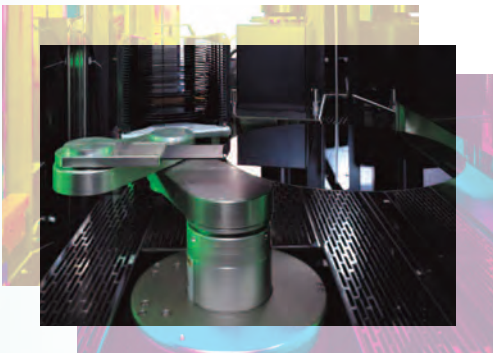### Available High-sensitivity Boron Detector (AD-Boron)
- 5 times higher sensitivity than Rigaku's earlier B detector.

300 mm Wafer Mapping Capability
- Automatic wafer mapping measurements are possible.

Space Saving and Low COO (Cost of Ownership) Design
- Power consumption is reduced by ~21 % from the previous model (WaferX 300).
- Oil-free transformer adopted.
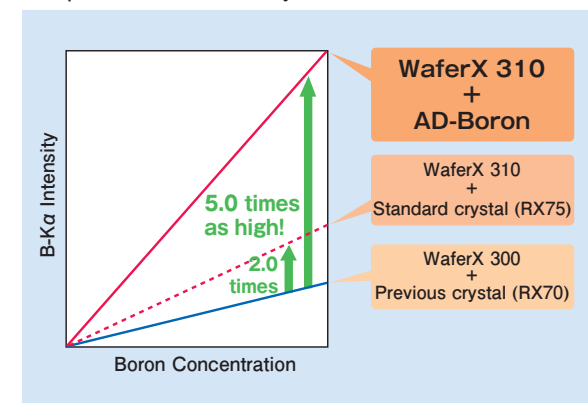
Various Applications

Isolation films	: BPSG, PSG, AsSG, Si_3N_4, SiOF, SiON, *etc.*
High-*k* and ferro-dielectric films	: PZT, BST, SBT, Ta_2O_5, HfSiOx, HfO_2, *etc.*
Metal films	: Al-Cu-Si, W, Ti, TiW, Co, TiN, TaN, MgO, *etc.*
Electrode films	: doped poly-Si (dopant: B, N, P, As), WSix, Pt, *etc.*
Others	: doped films (As, P), trapped inert gas (Ne, Ar, Kr), C, *etc.*

Supporting Sub-micron Technology, Contributing to High-precision Analysis

High-sensitivity Boron Detector

A high-sensitivity Boron detector, AD-Boron, is available as an option. It offers 5 times the sensitivity of Rigaku's earlier model (with RX70 analyzing crystal) and 2 times improvement in analytical precision.
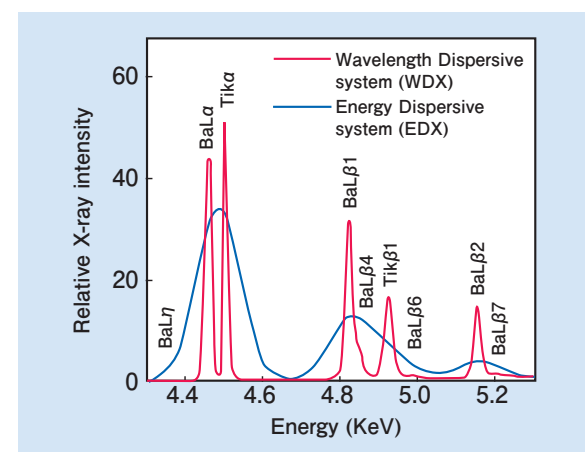
Comparison of B Sensitivity

WaferX 310 + AD-Boron

WaferX 310 + Standard crystal (RX75)

WaferX 300 + Previous crystal (RX70)

5.0 times as high!

2.0 times

B-Kα Intensity

Boron Concentration

High-resolution Optics

The energy resolution of a wavelength-dispersive system is especially useful when element peaks are closely spaced, as with ferro-dielectrics, *etc*. Accurate analysis is ensured when spectral overlapping is eliminated, especially for Al measurement on silicon substrates and for BST film measurements.
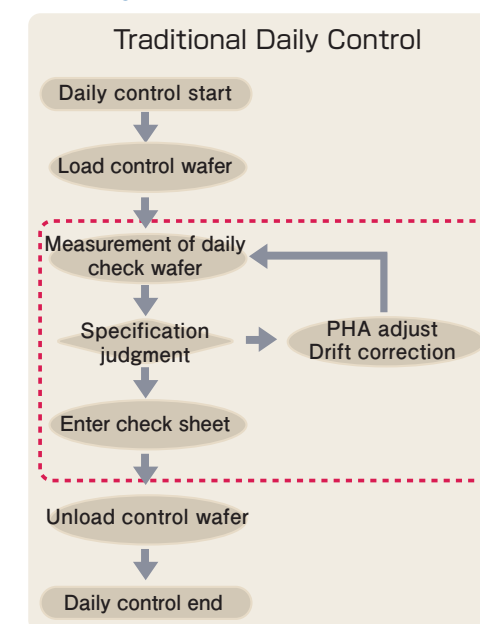
Comparison of WDX and EDX resolution powers

— Wavelength Dispersive system (WDX)
— Energy Dispersive system (EDX)

Relative X-ray intensity

Energy (KeV)

Full Lineup of Software

Broad software improvements include an automatic graded display of mapping analysis results (bubble chart), virtually unlimited saving of analysis results, increased number of characters in an analysis recipe name (up to 80), control of folder for analysis recipe (process program), *etc*.

Diffraction Avoidance

Most metal films require analysis of elements above Ti, and proper analysis must be unaffected by diffraction peaks from the Si wafer. Rigaku's unique, patented stage driving mechanism enables accurate analysis and distribution measurement in plane without diffraction influence from the Si wafer. The diffraction avoidance function is enhanced on the WaferX 310.

Measurement direction setting

It is possible to set the measurement direction to avoid diffraction influence while viewing the monitor.

Reliable Analysis with High Analytical Performance and Accuracy

AutoCal Function

● **Fully Automated**

Traditional Daily Control

Daily control start
Load control wafer
Measurement of daily check wafer
Specification judgment → PHA adjust Drift correction
Enter check sheet
Unload control wafer
Daily control end

AutoCal

Daily control start
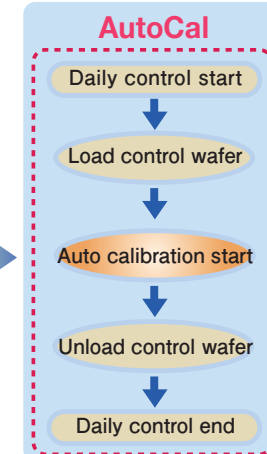Load control wafer
Auto calibration start
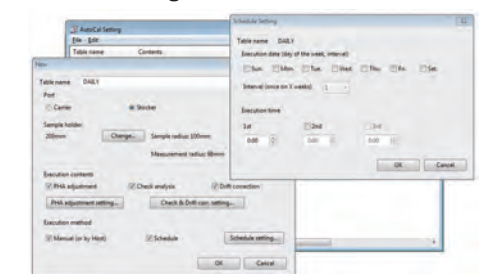Unload control wafer
Daily control end

Full Automation

Daily check, judgment, and drift correction can be made by fully automated operation at designated times and days. The combination of GEM300 and AutoCal can realize full automation.
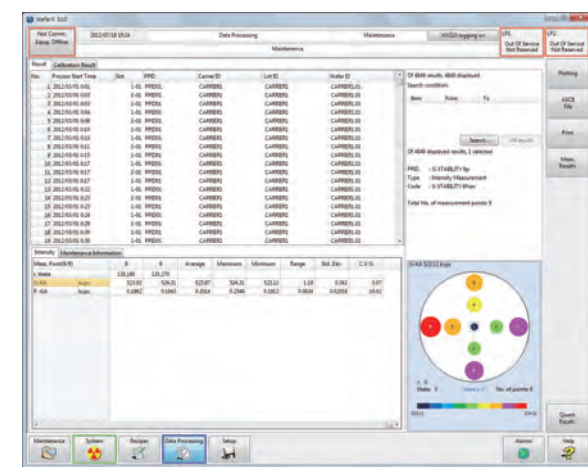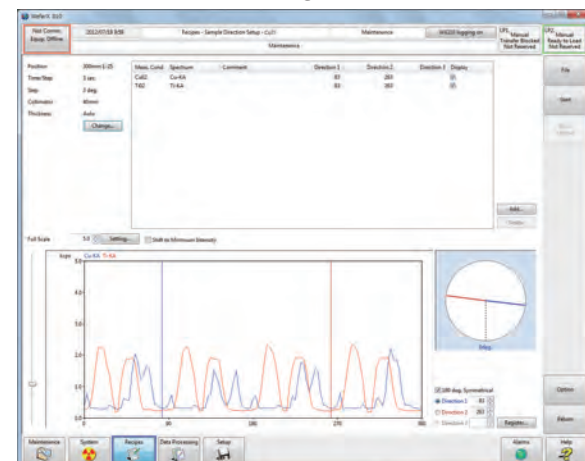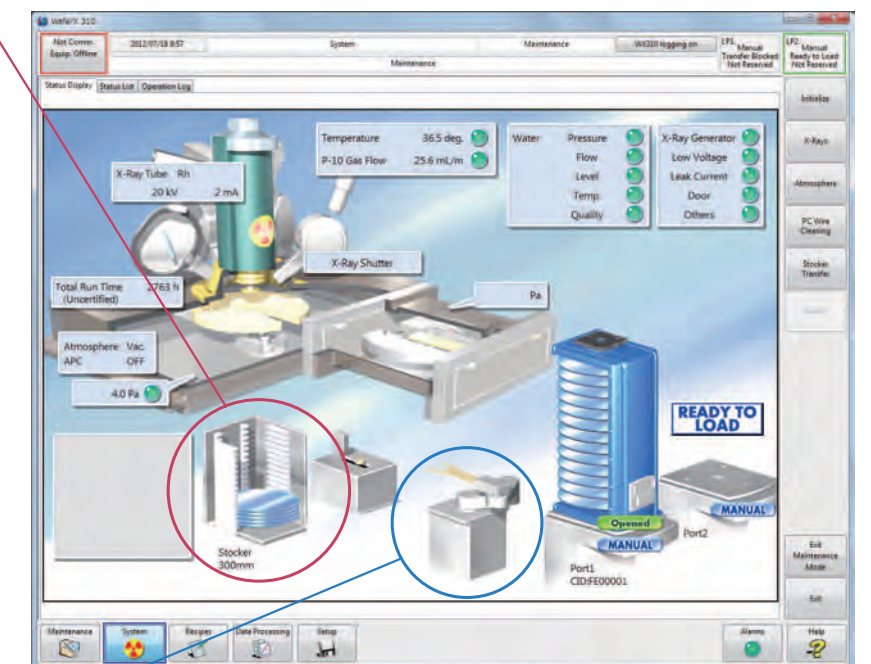
AutoCal setting screen

Instrument Display Function

Operation status of the tool is clear at a glance.

● **Built-in Wafer Stocker for Daily Control Samples**

Customer daily control samples can be stored in a built-in wafer stocker to enable fully-automated daily tool qualification.


● **Robotic Wafer Handling**

A Flexible Technique for a Wide Variety of Applications

BPSG Film

BPSG film thickness / composition can be characterized by XRF without the bonding influences and interferences that affect FT-IR analysis. It is also possible to enter film thickness measurement results from other measurement techniques, e.g. ellipsometry.
For analysis of BPSG films in the range of 100 nm ~ 250 nm, an optional thin film attachment can provide useful background correction.
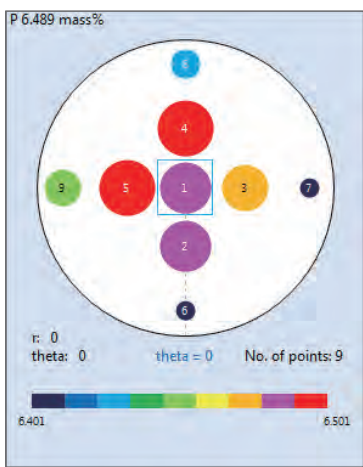

B concentration analysis results

P concentration analysis results
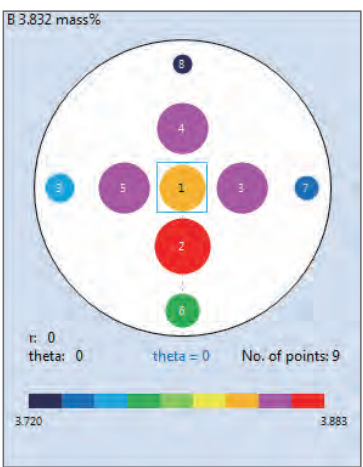
10-times repeated measurement results (precision)

	B
Average (nm)	3.83
S.D.	0.014
R.S.D.(%)	0.38

Thickness : Manual entry (610 nm)
Measurement spot : 40 mm dia.
Measurement time : 100 sec.

10-times repeated measurement results (precision)

|	P
Average (nm)	6.49
S.D.	0.0035
R.S.D.(%)	0.05

Thickness : Manual entry (610 nm)
Measurement spot : 40 mm dia.
Measurement time : 100 sec.

High-k Metal Gate Film

For the Al_2O_3 film, the R.S.D. (%) of the mapping measurement and the 10-times repeated measurement show almost the same value, indicating a very uniform film thickness distribution. In contrast, for the HfO_2 film, significant thickness differences are clearly shown in the mapping measurement results. The distribution tendency shows the center is thick, and the edge is thin.
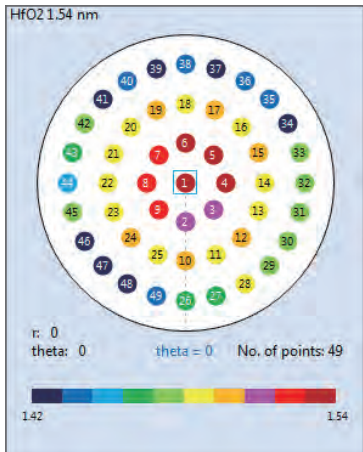
High-k film thickness analysis results

Al_2O_3
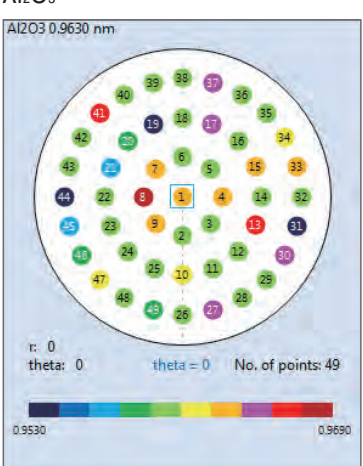
HfO_2

10-times repeated measurement results (precision)

	Al_2O_3
Average (nm)	0.963
S.D.	0.0040
R.S.D.(%)	0.42

Al_2O_3 analysis :
Using PET-type Al-Kα Goniometer
Measurement spot : 40 mm dia.
Measurement time : 60 sec.

10-times repeated measurement results (precision)

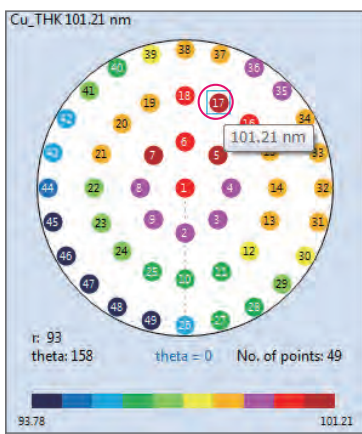|	HfO_2
Average (nm)	1.54
S.D.	0.0050
R.S.D.(%)	0.32

HfO_2 analysis :
Using PET-type Hf-Mα Goniometer
Measurement spot : 40 mm dia.
Measurement time : 60 sec.

Cu/Ta Film Stack

Multi-layered films of up to 20 layers and 40 components can be analyzed by Rigaku's unique Fundamental Parameters (FP) method.
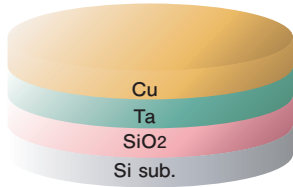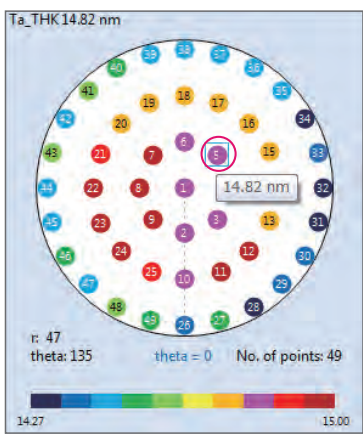

Cu film thickness analysis results

Ta film thickness analysis results

Analysis results can be viewed by clicking the measurement point on the global bubble chart.

CoFeB, MgO (MRAM)

Important MRAM films, like CoFeB and MgO, can be analyzed.
The thickness and composition of CoFeB films can be measured.
The wavelength-dispersive X-ray optical system provides high energy resolution, enabling Mg-Kα and Si-Kα (from the Si substrate) to be easily separated and making high-precision MgO thickness analysis possible.
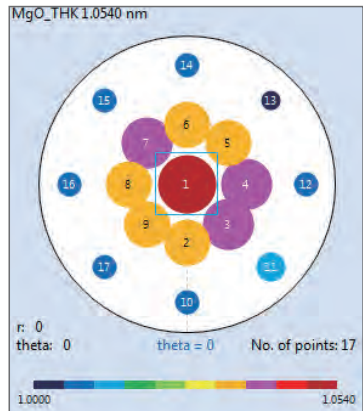
CoFeB thickness analysis results

MgO thickness analysis results
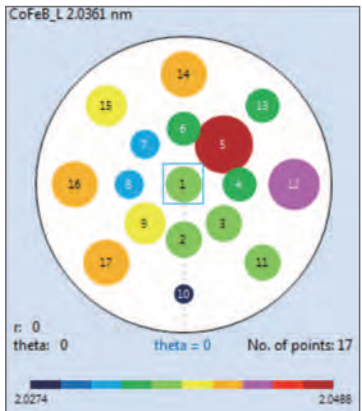
10-times repeated measurement results

	CoFeB(nm)	Co(at%)	Fe(at%)	B(at%)
Average	2.038	19.60	58.57	21.83
S.D.	0.0030	0.112	0.118	0.128
R.S.D.(%)	0.15	0.59	0.20	0.59

Measurement spot : 40 mm dia.   Measurement time : 60 sec.

10-times repeated measurement results

	MgO
Average (nm)	1.050
S.D.	0.0062
R.S.D.(%)	0.59

Measurement spot :
40 mm dia.
Measurement time : 60 sec.

P-doped Poly-Silicon

P concentration of P-doped poly-Si can be analyzed. There are also analysis possibilities for dopants like As, N, B, etc.
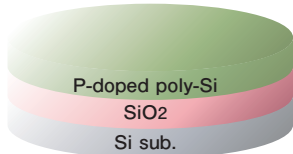
10-times repeated measurement results (precision)

n	P mass%	P 10^{20}atoms/cm^3
1	0.861	3.90
2	0.863	3.90
3	0.862	3.90
4	0.860	3.89
5	0.865	3.91
6	0.862	3.90
7	0.862	3.90
8	0.862	3.90
9	0.861	3.90
10	0.862	3.90
Average	0.862	3.90
Max.	0.865	3.91
Min.	0.860	3.89
Range	0.005	0.02
S.D.	0.0013	0.006
R.S.D.(%)	0.15	0.15

Measurement spot : 40 mm dia.

Comparison of analysis data and standard value for P concentration