

X-ray Fluorescence Spectrometer
for Thin Film Evaluation

3650

WAFER/DISK ANALYZER



Supporting Process Control of Metal Film Composition, and Element Concentration

The model 3650 X-ray Fluorescence Spectrometer for thin film evaluation continues Rigaku's history of XRF wafer analyzers that has mirrored the history of thin film device development.

This latest XRF metrology tool contributes significantly to the process control of metal film thickness, film composition, and element concentration with new functions and a low-COO design.

AutoCal function

- Built-in cassette for daily control samples.
- Fully automatic daily qualification of the tool is possible.

5-position aperture

- Selectable size of measurement area from 5~40 mm diameter.

Available new type of Boron detector (AD-Boron)

- 5 times higher sensitivity than Rigaku's previous model*.

Space-saving and low-COO (Cost of Ownership) design

- Realized miniaturization and energy saving of sub-units.
Power consumption was reduced by about 23 % of the previous model*.
- Oil-free transformer adopted.

* Previous model : WAFER/DISK ANALYZER 3640

X-ray Fluorescence Spectrometer
for Thin Film Evaluation

3650

WAFER/DISK ANALYZER

- ▶ For 6" wafer
- ▶ C-to-C
- ▶ Distribution measurement

PSG, Metal film

1983

3613

- ▶ For 8" wafer
- ▶ FP method
- ▶ Mapping function

BPSG,
Memory disk

1986

3620

Metal Film Thickness, Concentration.

WAFER/DISK ANALYZER 3650 with cassette-to-cassette robot



WAFER/DISK ANALYZER 3650

- ▶ High-sensitivity Boron goniometer
- ▶ WSi₆ goniometer
- ▶ New FP method

Thin film BPSG,
Multi-layered wiring film,
WSi₆, Electrode film, SAW

1992
3630

- ▶ Wafer measurement direction setting program
- ▶ XYθ stage
- ▶ New X-ray tube
- ▶ Compact size
- ▶ New C-to-C

Ferrodielectric film, FRAM,
SiC, BUMP, MEMS,
Thin film BPSG, SiOF

1996
WAFER/DISK ANALYZER
3640

- ▶ For 300 mm wafer

High-k film,
Ferrodielectric film,
Thin film BPSG

1998
Wafer X 300

- ▶ AutoCal function
- ▶ 5-position aperture
- ▶ Space-saving and low-COO design

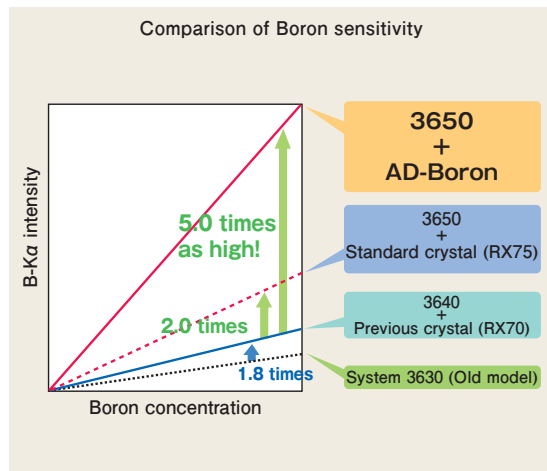
SiC, BUMP, MEMS

2011
WAFER/DISK ANALYZER
3650

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

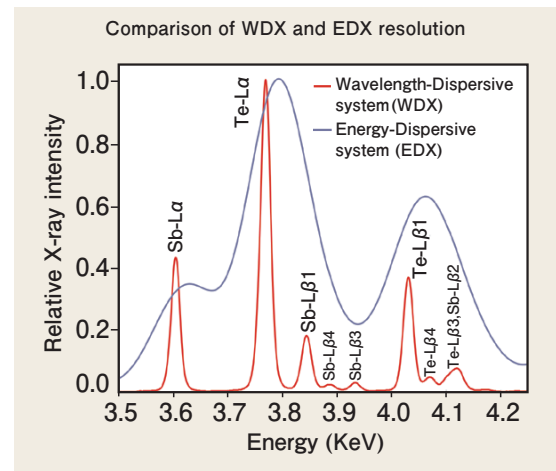
New type of Boron detector

High-sensitivity Boron detector, AD-Boron, is available as an option. Its sensitivity is 5 times that of the one used in the early model 3640 (with RX70 analyzer crystal), and it improves the precision (CV%) by a factor of 2 or more.



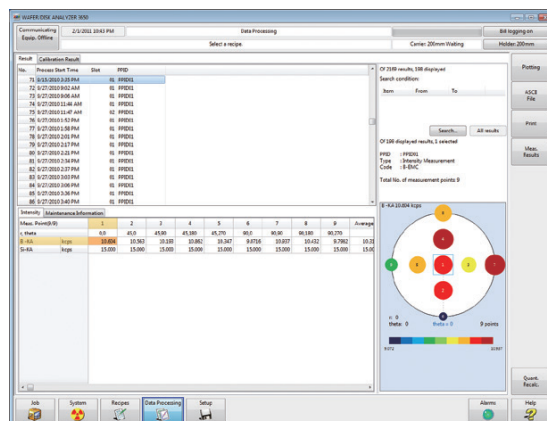
High-resolution optics

The energy resolution of a wavelength-dispersive system is especially useful when element peaks are closely spaced, as with ferroelectrics, etc. Accurate analysis is ensured, especially for Al measurements on Silicon substrates and for GST film measurements, as spectra overlapping is eliminated.



Full lineup of software Complies with SEMI E95

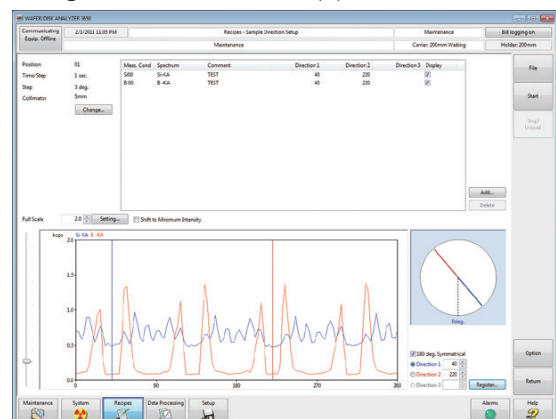
Broad improvement of software functions include an automatic grade display of mapping analysis results (Bubble chart), virtually unlimited saving of analysis results, increase in the number of characters in an analysis recipe name (up to 80), control of folder for analysis recipes (process program), etc.



XY θ stage driving mechanism removing diffraction peak influence

Most metal films require analysis of elements above Ti, and proper analysis must be unaffected by diffraction peaks from the Si wafer. An XY θ stage driving mechanism unique to Rigaku with a patented design enables accurate analysis and distribution measurements in plane without diffraction interference from the Si wafer. The diffraction avoidance function is enhanced on the 3650.

Setting of measurement direction (θ)

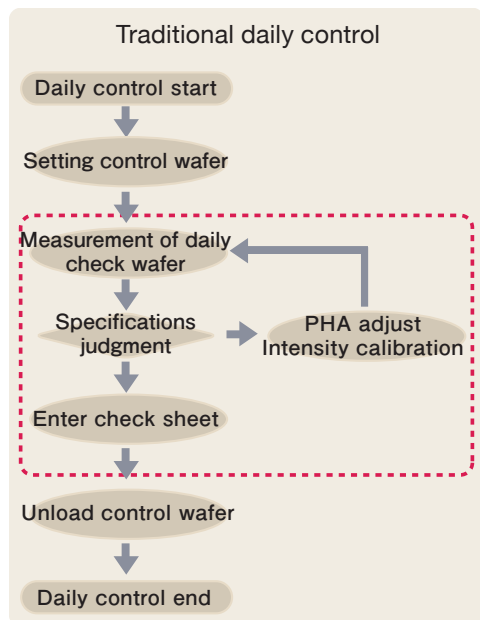


Possible to set the direction (θ) with no influence of diffraction peak while looking at monitor.

Reliable Analysis with High Analytical Performance and Accuracy

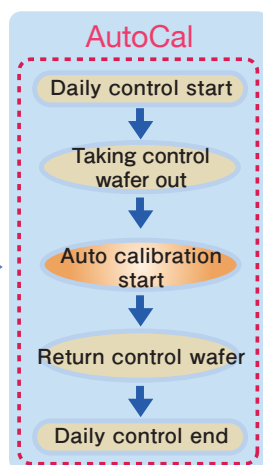
AutoCal function

● Full automation realized

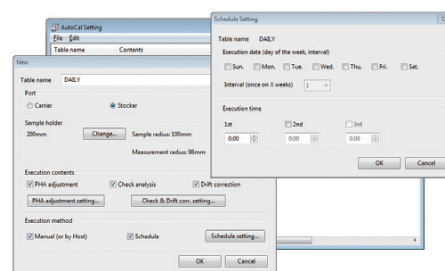


Full automation

Daily check, judgment, intensity calibration can be made by fully automated operation at designated time and day.

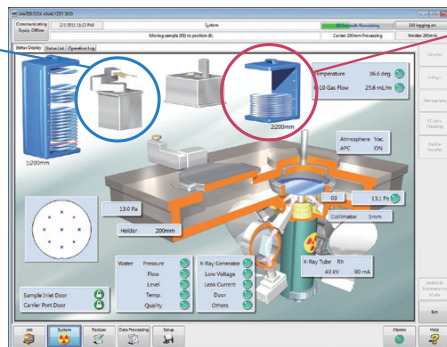


AutoCal setting screen



● Auto transportation robotic arm

Full automation is available by host communication combined with the AutoCal function.



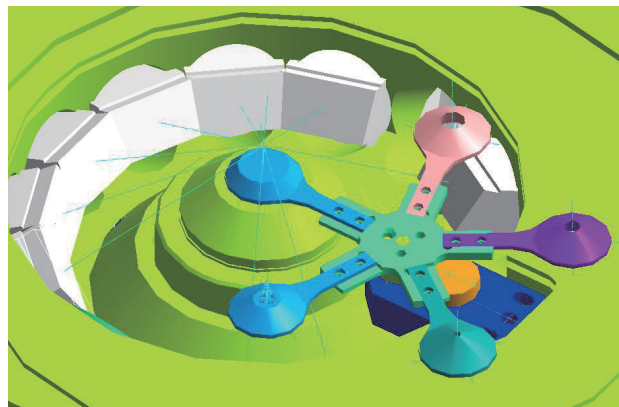
● Built-in stocker for qualification wafers

Customer qualification wafers stored in a built-in cassette in the optional C-to-C wafer autoloader enable fully-automated daily tool qualification.

5-position aperture

Regardless of element of interest, either by scanning-type channel or fixed-type channel, the beam size can be selected from 5~40 mm diameter by the aperture changer.

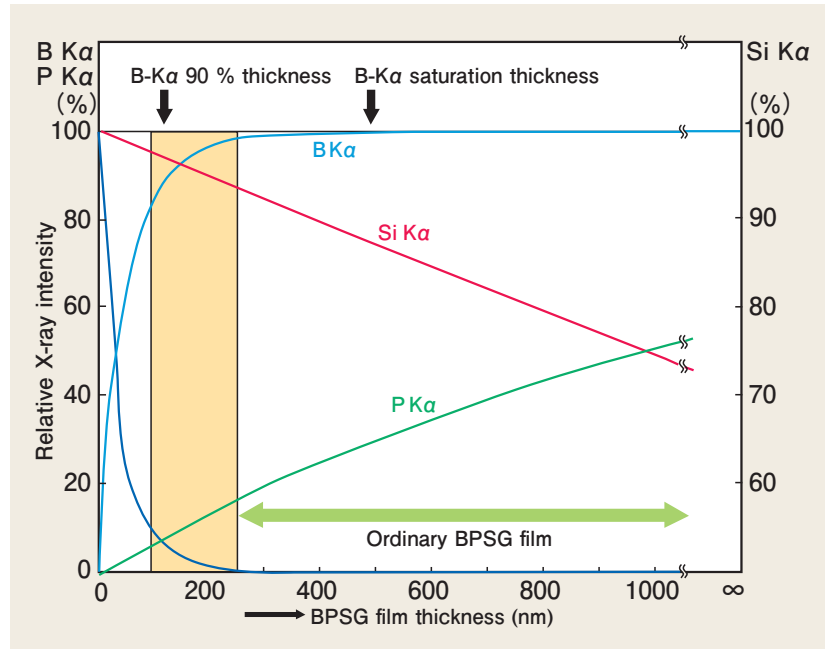
※ 1 position is used for X-ray shutter.



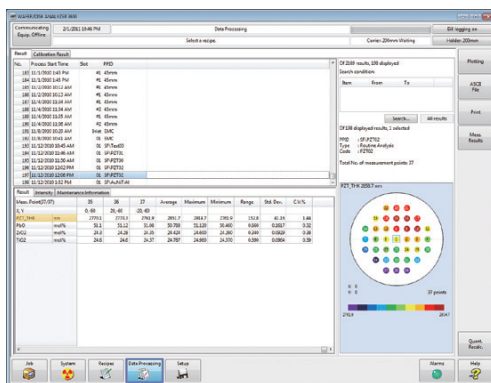
A Flexible Technique for Wide Variety of Applications

BPSG film

For analysis of thin film BPSG in the range 100 nm ~ 250 nm, an optional thin film attachment can provide useful background correction.



Ferroelectric thin film

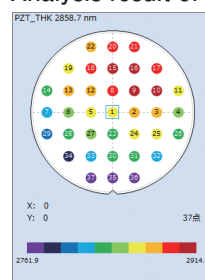


Distribution analysis result of PZT film, 37 sites

	PZT film thickness nm	PbO mol%	ZrO ₂ mol%	TiO ₂ mol%
Average	2852	50.79	24.42	24.79
Max.	2915	51.12	24.60	24.96
Min.	2762	50.46	24.26	24.57
Range	153	0.66	0.34	0.39
S.D.	41.2	0.161	0.093	0.096
R.S.D.(%)	1.44	0.32	0.38	0.39

Measurement spot : 10 mm diameter

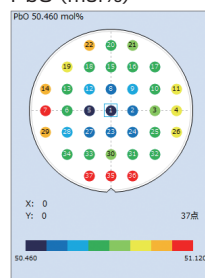
Analysis result of PZT film thickness (Magnified)



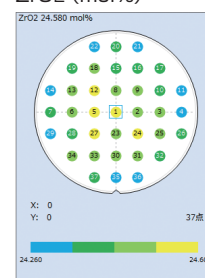
The thickness distribution can be described as a concentric circle centered in the first quadrant of the wafer (X=20, Y=40).

Composition analysis result (Magnified)

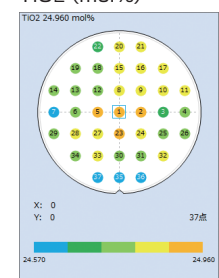
PbO (mol%)



ZrO₂ (mol%)



TiO₂ (mol%)

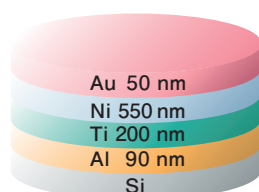


Clicking each component in the analysis result inspection screen changes the grade display (Bubble chart) at the lower right corner of the screen. The PbO component is distributed like a concentric circle of which the central part has lower concentration.

Multi-layered metal film

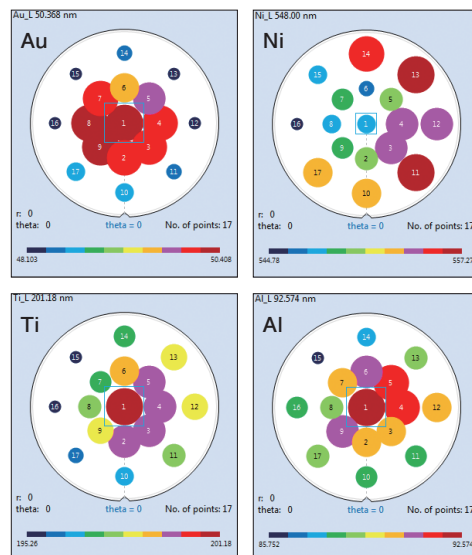
Multi-layered film analysis can be made. Parameters of up to 20 layers and 40 components can be analyzed by a Fundamental Parameter (FP) method unique to Rigaku.

Analysis example of multi-layered film Au / Ni / Ti / Al



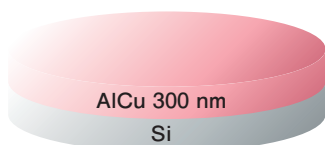
- Simultaneous thickness analysis of 4 layers of backside electrodes Au, Ni, Ti, Al.
- Thickness analysis of the bottom layer Al can be made because of wavelength dispersive system. (* 1)

(* 1) A high-sensitivity type of Al-K α goniometer (with a PET crystal) was used for Al film thickness analysis.



Thickness/Composition analysis of SAW/BAW filter

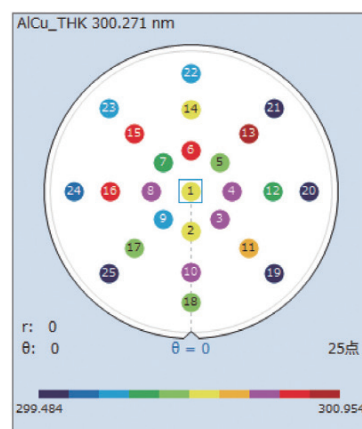
AlCu films, AlN and ScAlN films for SAW/BAW filters are well analyzed with high precision due to the high Al sensitivity and resolution capability from Si peak.



Distribution analysis result of AlCu film, 25 sites

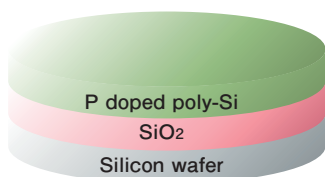
	AlCu film thickness nm
Average	300.3
Max.	301.0
Min.	299.5
Range	1.5
S.D.	0.43
R.S.D.(%)	0.14

Measurement spot: 10 mm diameter
Measurement time: 60 sec



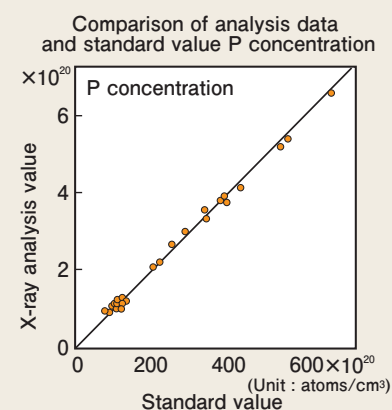
P-doped Poly-Silicon

P concentration of P-doped Poly-Si can be analyzed. There are also analysis possibilities for dopants like As, N, B, etc.



n	P	
	mass%	10 ²⁰ atoms/cc
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

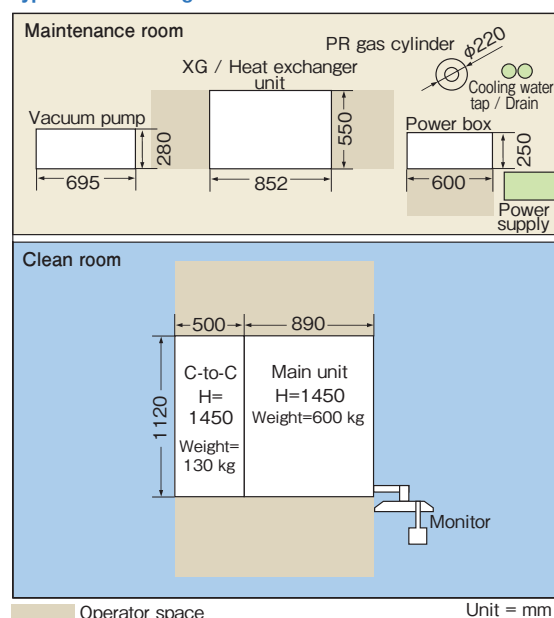
Measurement spot : 40 mm dia.



Specifications

Sample size	8" maximum
Simultaneous analysis elements	20 elements maximum, Fix type (4Be ~ 92U), Heavy element scan type (22Ti ~ 92U)
Aperture	Selectable 4 kinds out of 5, 10, 15, 20, 40 mm diameter
X-ray tube	Rh target, Maximum rating 4 kW
Detector	S-PC, SC, F-PC (PR gas required for F-PC)
Sample stage	XYθ stage
Analysis spot designation	r, θ designation, r : 1 mm step, θ : 1° Step Mouse and Keyboard in put are available
Sample spin mechanism	6 rpm (Available only for wafer center analysis) Available up to 8" wafer
C-to-C (optional)	Orientation flat / V-notch alignment available
Vacuum pump	Dry pump
Stabilizing system	Temperature stabilizer, Automatic vacuum control system
Data processing system	Personal computer, Windows 10
	Software : Film thickness/Concentration simultaneous analysis software
	Fundamental Parameter software for thin film analysis
	Mapping software (optional)
On-line analysis program (optional)	Complies with GEM
Safety standard	Complies with SEMI S2-0310, CE Marking (optional)
Others	SMIF, Through-the-wall, etc. configurations are possible upon request and agreement

Typical floor arrangement



Installation requirement

Model name	WAFER/DISK ANALYZER 3650
Power	200 VAC 3-phase, 50/60 Hz, 50 A
Earth grounding	Grounding resistance 30 Ω or less (Dedicated line)
Cooling water	Tap water or clean industrial water For main unit : 0.29 ~ 0.49 MPa, 10L/min or more (Temperature 30 °C or lower) For dry pump : According to dry pump's specifications
Environment	Room temperature : 20~25 °C (Daily fluctuation within +/-2 °C of average) Humidity : 75 RH% or less Vibration : 200 gal or less (Not to be felt by human body)
N ₂ gas (UPN)	For main unit : 0.3~0.7 MPa, 5 L/min For dry pump : According to dry pump's specifications
PR gas	0.15 MPa, 25 mL/min (For F-PC)
Vacuum	-80 kPa or less, 10 L/min (For C-to-C)
Others	Ventilation for dry pump

(Note : Pressure at gauge)

Compliance with
safety standards



SEMI S2/S8

Compliance with
communication standards

SECS/GEM

ISO 9001/ISO 14001 certified

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

* Company names and product names in this catalog are trademarks of the companies and/or registered trademarks.

Specifications and appearance are subject to change without notice.

Rigaku Corporation and its Global Subsidiaries

e-mail: info@rigaku.com **www.Rigaku.com**