XTRAIA® XD Series

High-resolution XRD epitaxial film characterization

Cutting-edge metrology

Rigaku

Semiconductor Metrology Solutions
rsmd.rigaku.com

HR-XRD metrology tools for blanket and patterned wafers.
XRR, XRD, Rocking curve, RSM, including multilayer thickness and composition analysis

rigaku.com

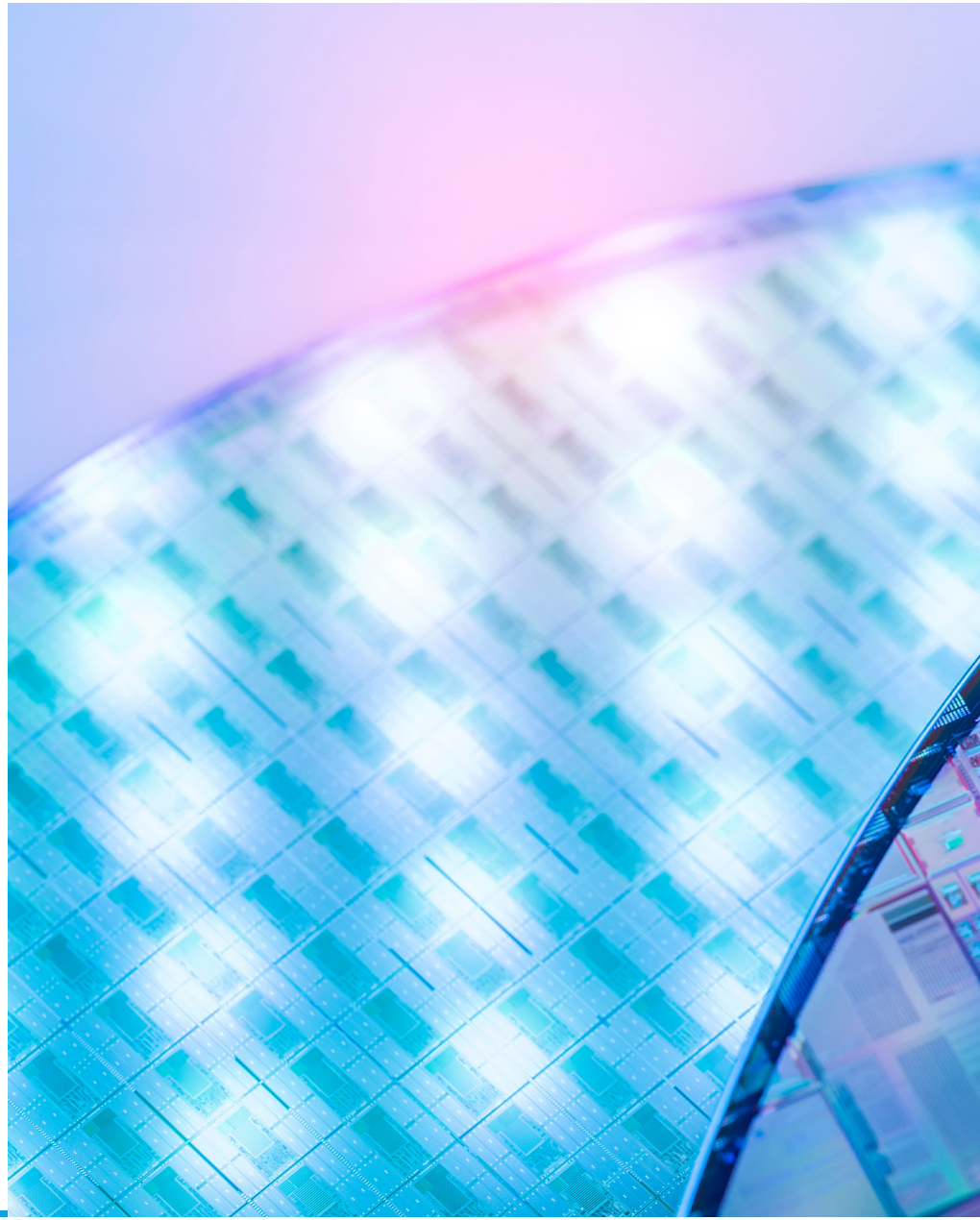
Technological challenges

Non-destructive wafer analysis for multi-layered materials

Epitaxial films

Measurements; thickness, composition, strain, relaxation, and structural quality

Patented Hybrid Micro-spot X-ray Optics



XTRAIA® XD-3200

HR-XRD, XRR, XRD, rocking curve and RSM

For Blanket Epitaxial Thin Films (e.g. Si/SiGe multilayer)

- 9 kW rotating anode X-ray generator (optional 2.2 kW sealed X-ray tube)
- Line focus with mirror and/or 2/4 bounce crystal

Up to
300 mm
Wafers

XTRAIA® XD-3200 technical specifications

System Parameters	Specifications
Metrology Type	HR-XRD High-resolution X-ray Diffraction and XRR X-ray Reflectivity
Wafer Size	200 mm, 300 mm
Wafer Type	Blanket
Wafer Transfer	Loader, EFEM (Dual Port)
X/Y Stage Parameters	X: -150 to 150 mm Y: -150 to 150 mm Z: 0 to 9 mm φ: ±180° x: -5° to 90°
Sample Handling	Double arms for wafer
Automation	GEM300
SW User Interface	Windows10 – Automation, analysis, and recipe software
X-ray Tube Energy	9 kW Rotating Anode or 2.2 kW Cu Sealed Tube
X-ray Optics	Max. 2 monochromators Ge (400)x2,Ge(220)x2,Ge(220)x4
Detector Type	2D (HyPix-3000)
Small Spot Size	-
Pattern Recognition	-
High Intensity	✔
Chi Axis	✔
Goniometer	θs:+85°, θd:+85
Dimensions	1656(W) x 3689(D) x 2289(H) [mm] Main unit (With load ports) 602(W) x 1521(D) x 1080(H)mm Water chiller (With a base pan and power box)
Standards	SEMI S2/S8 Other: CE Compliant

Analysis software

XRR, XRD, Rocking curve, RSM, including multilayer thickness and composition analysis. User-friendly interface.

* Specifications and appearance are subject to change without notice.

* 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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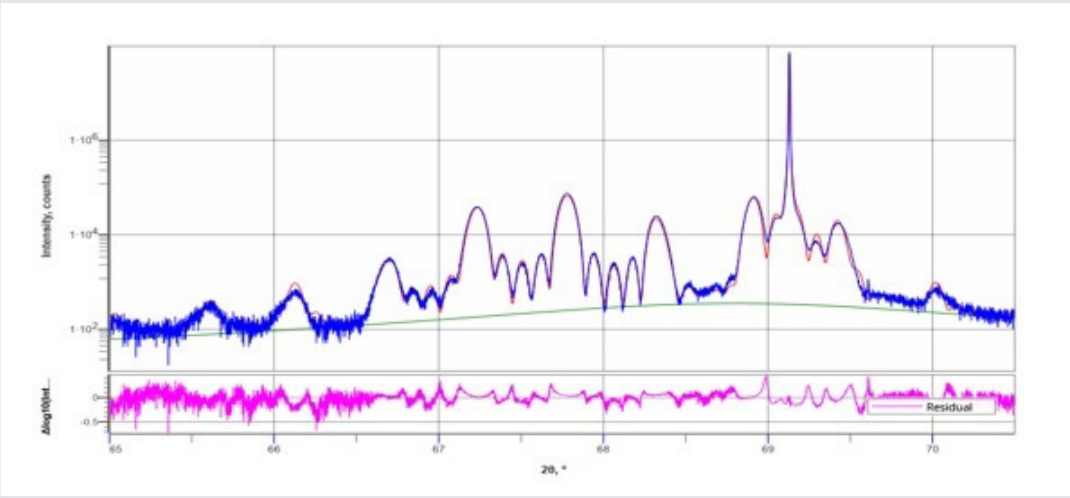
XTRAIA® XD-3200 application

Measurements sample

Measurements and analyses of Si/SiGe multi-layer films using X-ray Optics



Transistor blanket epitaxial film sige, etc.

X-ray Optics

- 9 kW RA Line focus
- 2-bounce monochromator
- Analyzer optional
- 2.2 kW sealed tube optional

Evaluation

- Thickness
- Composition
- Strain

Benefit

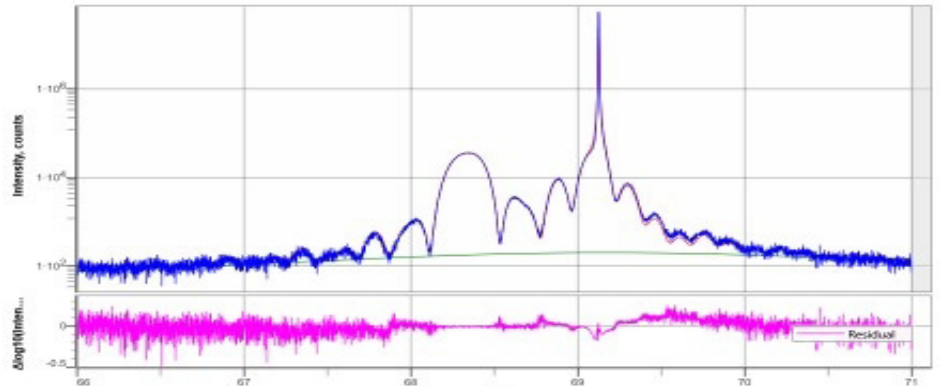
- High resolution and high flux

Layer number	Material	Thickness	Conc(X),cx>
L10	Si	1.652	1.0000
		± 0.5 f it	
L10	Si	16.566	1.0000
		± 0.5 fit	
L9	Si(1-x)Ge(x)	9 .871	0.2805
		± 0.13 f it	± 0.002 fit
L8	Si	10.075	1.0000
		± 0 .11 fit	
L7	Si(1-x)Ge(x)	9.719	0.2833
		± 0.5 fit	± 0.008 f it
L6	Si	9 .716	1.0000
		± 0 .04 f it	
L5	Si(1-x)Ge(x)	9 ,349	0.2846
		± 0.4 fit	± 0.006 f it
L4	Si	9 .852	1.0000
		± 0 .04 f it	
L3	Si(1-x)Ge(x)	8.993	0.2883
		± 0.3 fit	± 0.005 fit
L2	Si	9 .406	1.0000

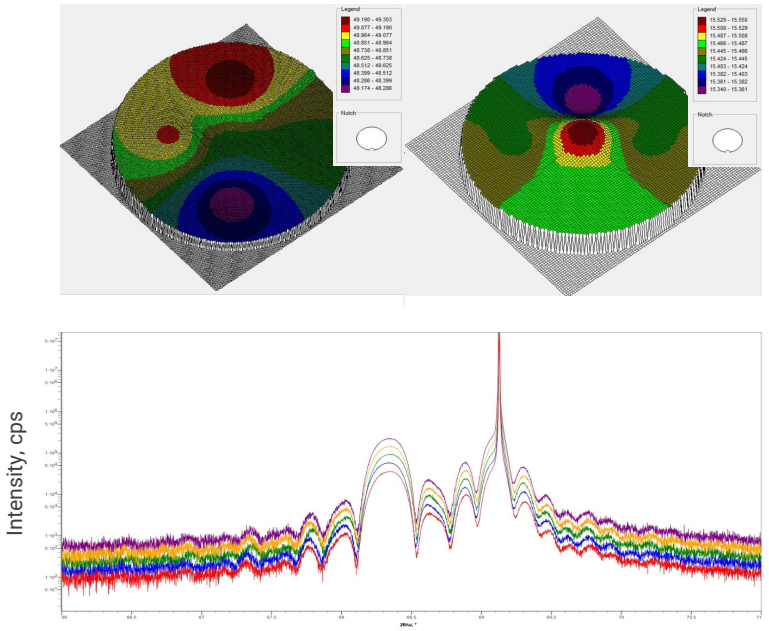
XTRAIA® XD-3200 application

Measurements sample

SiGe Wafer-level Map of thickness and composition



Layer number	Material	Thickness	Conc(X),cx>
L2	Si	23.624	1.0000
		± 0.06 fit	
L1	Si(1-x)Ge(x)	49.057	0.1545
		± 0.04 fit	± 7E-05
Sub	Si	∞	1.0000



WAFER BULK Si

X-ray Optics

- 9 kW RA Line focus
- 2.2 kW sealed tube optional

Evaluation

- Orientation
- Off cut angle

Benefit

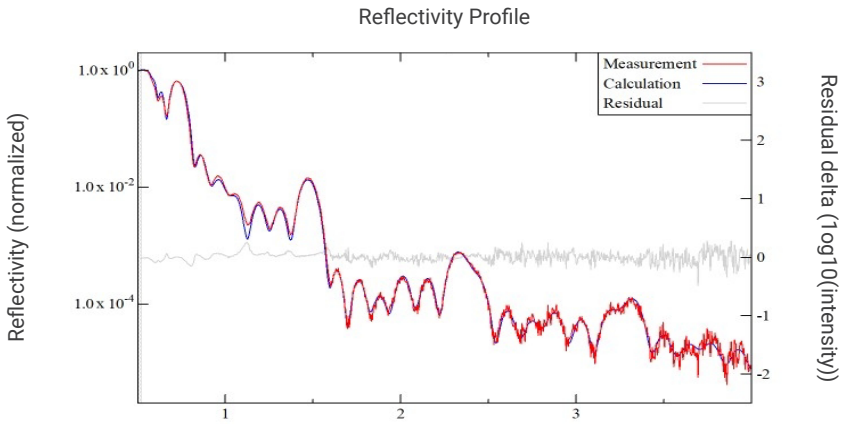
- High throughput by high intensity X-ray source

XTRAIA® XD-3200 application

Measurements sample

Measurements and analyses of GaAs/AlAs multi-layer films using X-ray Optics

Number	Layer Name	Thickness	Density	Roughness
7	GaAs03	2.2833	4.36813	0.712401
6	GaAs	5.68139	5.61965	0.299854
5	AlAs	9.66806	3.77733	0.398427
4	GaAs	9.53777	5.52873	0.436842
3	AlAs	9.61125	3.66873	0.364917
2	GaAs	9.54655	5.50068	0.446075
1	AlAs	9.631 41	3.71251	0.327172
0	GaAs	0.0 [...]	5.32[...]	0.3521 47



Thin film and multi-layer thin film

Blanket polycrystalline / amorphous film Mo/Si

X-ray Optics

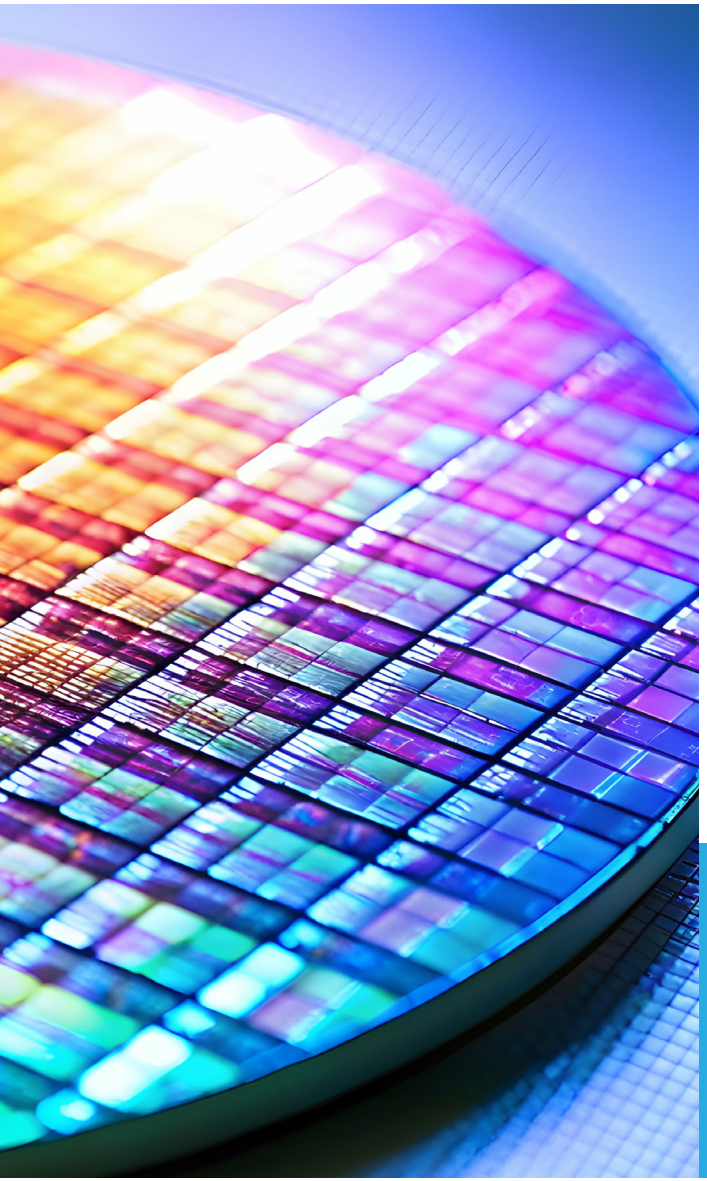
- 9 kW RA Line focus
- 2-bounce monochromator
- Analyzer optional
- 2.2 kW sealed tube optional

Evaluation

- Super lattice structure
- Thickness

Benefit

- High-resolution XRR and high throughput grazing incident diffraction



XTRAIA® XD-3300

HR-XRD, XRR, XRD, rocking curve and RSM

For Blanket/Patterned Epitaxial Thin Films

Dual-beam (Line and 40 µm micro-spot)
Pattern recognition

Up to **300 mm** Wafers

XTRAIA® XD-3300 technical specifications

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Standards	SEMI S2/S8 Other: CE Compliant

HyPix-3000 Detector

This sophisticated X-ray metrology tool makes it practical to perform high-throughput measurements on product and blanket wafers ranging from ultra-thin single-layer films to multi-layer stacks.

Highly capable metrology is enabled by world-class key components include high brilliance source technology, multi-layer optics, and state-of-the-art 2D detectors with ultra-high dynamic range and high sensitivity.

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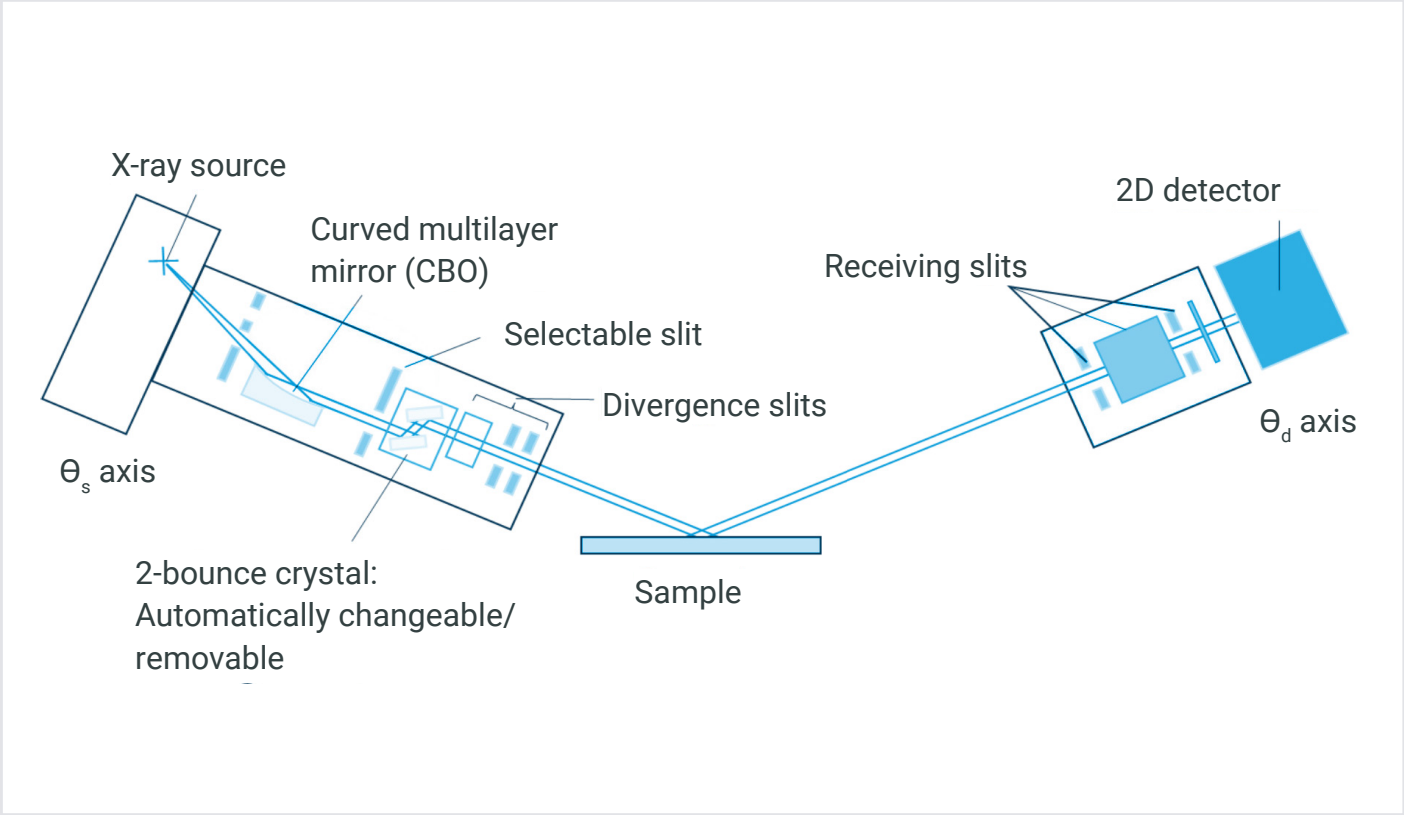
COLORS™ X-ray optics

Exclusive Rigaku technology

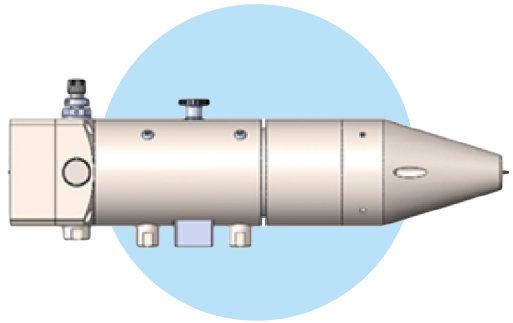


* CBO = Cross Beam Optics

Features

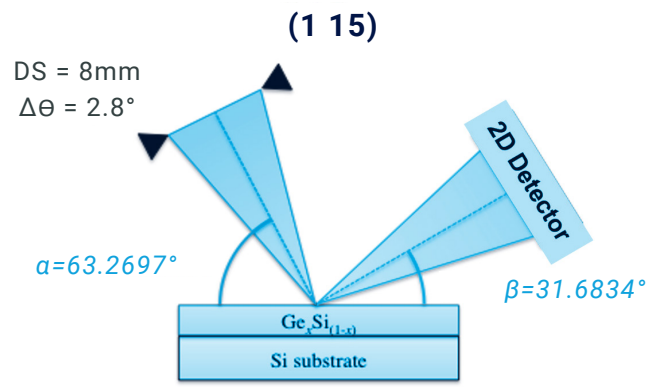
XTRAIA XD-3300 with COLORSTM Hybrid Cu beam module can make HRXRD measurements on blanket and patterned wafers (using both sources) and XRR measurements on blanket wafers (using the line focus rotating anode source only).

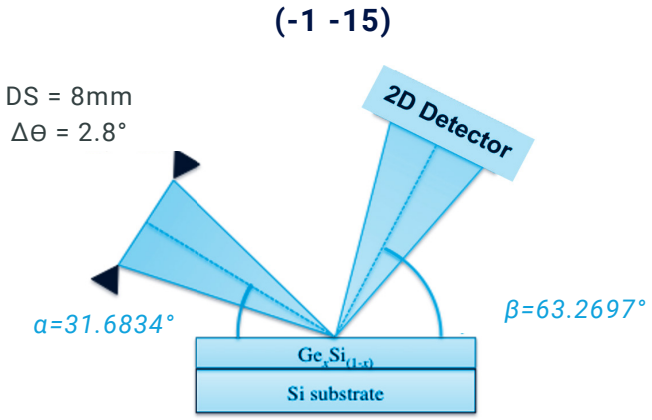
- An automatic crystal monochromator selector (high throughput / high resolution)
- Appropriate for single crystal material, epitaxial thin film, etc.



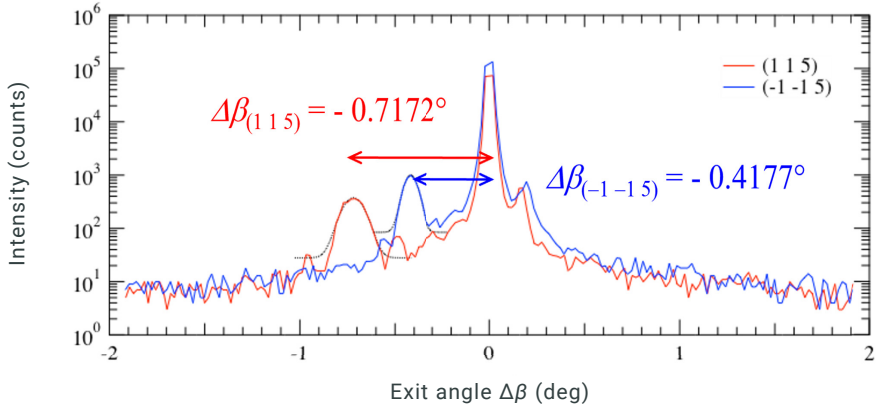
Rocking curve of asymmetric diffraction

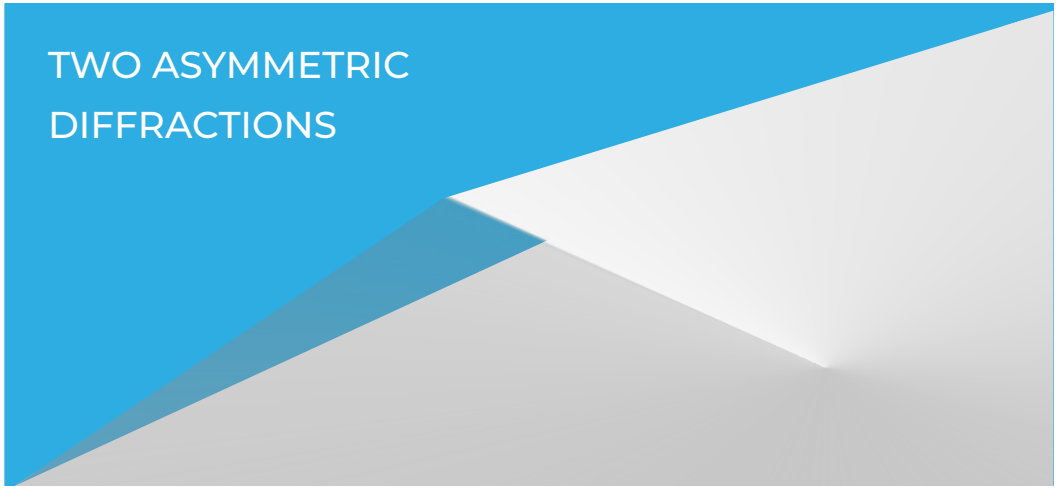
Simultaneous measurement of focusing X-rays using 2D detector



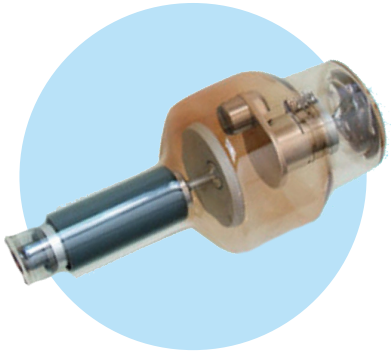


Add Time and Sped detail notes (50 µm)





XTRAIA® XD-3300 features and advantages



Advanced sources and optics

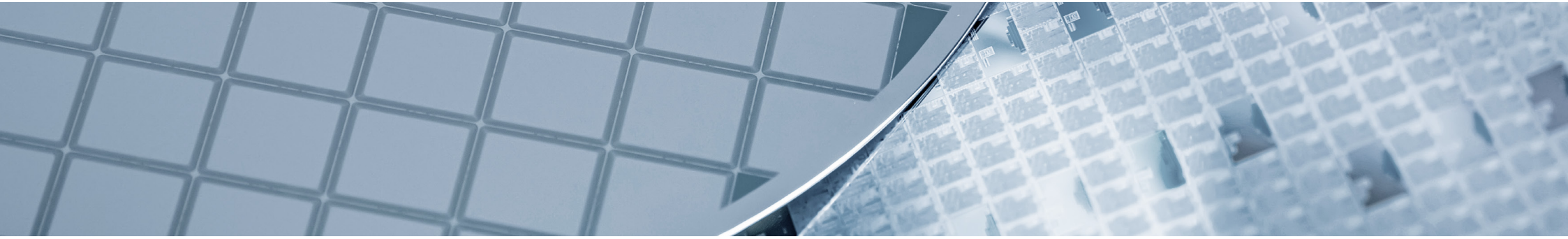
9 kW rotating-anode, line-focus and sealed-tube, micro-spot Cu X-ray sources, pattern recognition, and 2-D detector.

Control and data processing system

Analysis software XRR, RSM, XRD, Rocking curve, RSM including multi-layer thickness and composition analysis. User-friendly interface.

Robotic wafer handling

Automatic wafer handling robot system with 200 mm and 300 mm wafer handling capability and wafer pre-aligner.



Metrology solutions by modular type optics

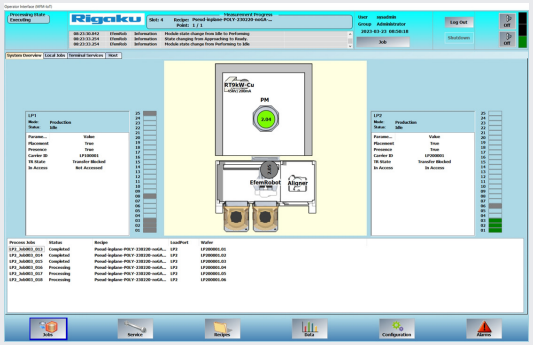
In-line XRD and XRR Metrology Tools with down to 40 µm beam XTRAIA® XD SERIES for 200 mm and 300 mm wafers

- ✔ High resolution X-ray beam
- ✔ 2 dimensional detector
- ✔ Stage and goniometer
- ✔ Analysis software
- ✔ Full automation function

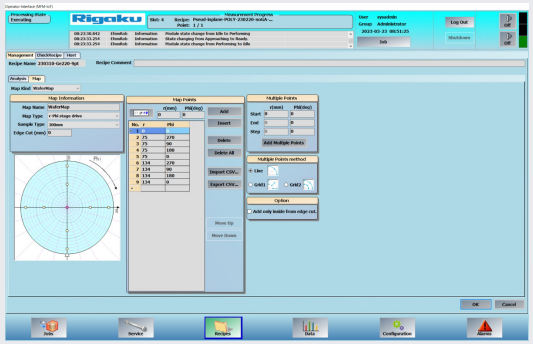
Application	Material	Evaluation Contents	Measurement Method	Remarks
Transistor	SiGe	Thickness, Composition, and Strain	Symmetric and Asymmetric Rocking curve; and RSM	Asymmetric diffraction for rapid evaluation
LED / LD	GaN, GaAs, and InP	Tilt angle, and Twist angle	Out-of-plane XRD	Up to 90o x axis
MEMS, Sensor	PZT and AIN	Crystal orientation	XRD and XRR	Up to 90o x axis
New Memory	GST	Crystallinity	Out-of-plane and Grazing Incidence XRD and XRD-	-
Metal Film	Cu, etc. multi-layer	Crystallinity, Thickness, and Orientation	Out-of-plane and Grazing Incidence XRD, and XRR	Super lattice structure measurements
Multi-layer Film	Mo / Si, etc.	Thickness	XRR and Symmetric Rocking curve	Super lattice structure

Software advantages

Main GUI

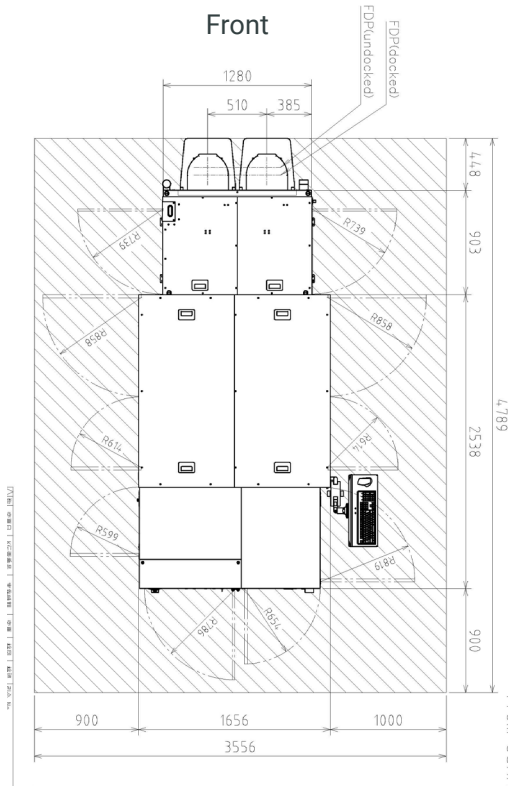


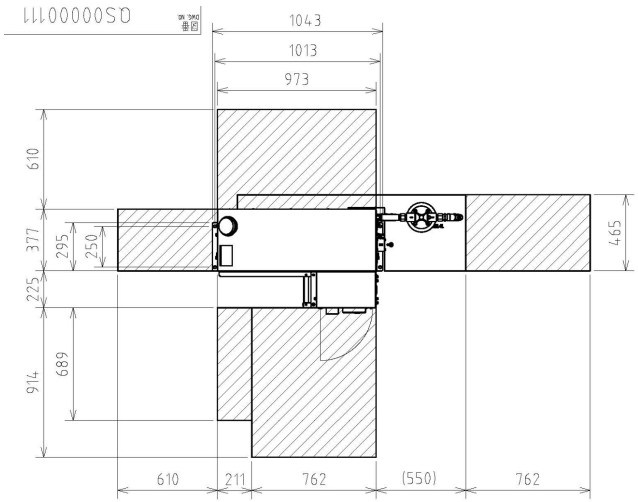
Wafer Map at Recipe setting GUI



- Enhanced performance for characterization and metrology of epitaxial thin films in the compound and silicon semiconductor industries.
- Determining the incident and exit angles of the X-ray beam at intensity maxima in the spectrum, the strain, and hence lattice parameters, of the individual layers.
- XTRAIA XD-SERIES Metrology Tools for accurate analysis of thickness, density, and roughness of the surface and boundary of thin films deposited on a wafer.
- This High-resolution XRD Metrology Solution combines x-ray reflectometry (XRR) for film thickness analysis and x-ray diffraction (XRD) for estimation of the film crystallinity.
- The software to operate this equipment has the function of GEM300 Host Communication, and the automatic operation by the Host Computer of FAB is available. (Optional)
- XRR measurement of the thickness, density, and roughness.
- XRD measurement of crystallinity and preferred orientation.
- Automatic wafer transfer from a cassette to the main module of the equipment.

XTRAIA XD Series floor arrangement





Safety Standards Compliance: SEMI S2 and SEMI S8

Communication Standards Compliance: GEM300 and SECS/GEM

Quality Standards: ISO 9001 and ISO 14001 approved

Requirements

Tool body (including load ports)
1656 (W) x 3689 (D) x 2289 (H) mm
Approx. 2860 kg

Chiller unit
602 (W) x 1521 (D) x 1080 (H) mm
Approx. 170 kg

Power supply
200 - 220 V Phase 3 50/60 Hz 60A

Power supply chiller unit
200-220 V Phase 3 50/60 Hz 30 A

Cooling water for chiller unit
0.3~0.5 MPa 1L/min at 25 degree C

Vacuum#1 ~80 kPa 20 L/min

Vacuum#2 ~80 kPa 20 L/min

CDA 0.55~0.7 MPa

About Rigaku

Founded in 1951 in Tokyo, Japan, Rigaku is an analytical and industrial instrumentation leader. With numerous innovations, the Rigaku group of companies is now a global authority in several fields, including X-ray diffraction (XRD), thin-film analysis (XRF, XRD, and XRR), X-ray fluorescence spectrometry (TXRF, EDXRF, and WDXRF), small-angle X-ray scattering (SAXS), protein and small molecule X-ray crystallography, Raman spectroscopy, X-ray optics, semiconductor metrology (TXRF, XRF, XRD, and XRR), X-ray Topography Imaging, X-ray sources, computed tomography, non-destructive testing, and thermal analysis While X-ray and related technologies are the foundation of Rigaku's business, its true strength lies in its commitment to working with customers. By fostering partnerships and driving innovation, Rigaku powers new perspectives and tailor-made solutions to meet the diverse needs of industry, academia, and government.

With a global presence and over 2,000 employees worldwide, Rigaku values collaboration between users and employees to ensure alignment with customer needs and market trends. Its products and services drive innovation in fields as diverse as semiconductor chip design, drug discovery, and nanotechnology research.

We value our customers, value our people, and value our technology. The company's mission is to contribute to the enhancement of humanity through scientific and technological development.

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