

ONYX 3000

IN-LINE NON-DESTRUCTIVE WAFER INSPECTION AND METROLOGY

Hybrid configuration | automated x-ray analysis, 3D scanning, and 2D microscope for film thickness and composition measurements on blanket and patterned wafers



To learn more about the ONYX 3000 and request a sales consultation.

Scan the QR code



Rigaku Semiconductor Metrology Division
X-RAY METROLOGY IN YOUR TOOLBOX
ED-XRF | WD-XRF | XRR | HR-XRD | CD-SAXS | TXRF

Rigaku Corporation and its Global Subsidiaries

© 2022 | Rigaku Corporation and its Global Subsidiaries. All rights reserved.

Global Sales, Service, and Customer Support
rsmd.rigaku.com | rsmd@rigaku.com

1-888-362-2324

SYSTEMS PARAMETERS

Metrology Type	Micro-spot ED-XRF and 2D-3D Optical inspection
Wafer Size	Up to 300 mm
Wafer Type	Blanket and patterned wafers
Overall Position Accuracy	< 1 μm (Stage resolution 0.1 μm)
Sample Handling	Magazine robot
Automation	Full wafer capability with single or dual automatic loader
Navigation	Precise stage complemented with an image recognition algorithm. Sub-micron fast navigation to single feature center.
SW User Interface	Auto calibration. Ease-of-use recipe creation and maintenance. Fundamental parameters optional
Beam Orientation	Vertical incidence micro-spot μXRF
X-ray Tube Energy	Up to 50 kV, 50 W
X-ray Optics	Polycapillary / COLORS™ (monochromatic x-ray optics)
Micro XRF Beam Spot Size	10-50 μm spot sizes adjustable
Detector Type	Silicon drift detector (SDD) optional: light element detector (C,N,O,F,S)
Detector Resolution	123 \pm 5 eV with a large solid angle
Digital Pulse Processor	High efficiency of more than 1 million photons/sec.

3D Scanner

Vertical resolution 100 nm	Lateral resolution 1 μm
--------------------------------------	---------------------------------------------------------

2D Microscope

Pixel count 5 Megapixel	Sensor CCD Color	Lateral resolution 0.5 μm
-----------------------------------	----------------------------	-----------------------------------------------------------

Sub-micron navigation with high-resolution pattern recognition

2D Microscope magnification

2x 5x5 mm FOV, 2.17 μm pixel size	10x 1x1 mm FOV, 0.435 μm pixel size
-----------------------------------------------------	-------------------------------------------------------

Configurable for 300 mm and smaller wafers

150 mm	200 mm	300 mm	LOAD OPTIONS
--------	--------	--------	---------------------

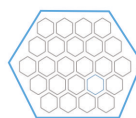
Layer-by-layer wafer inspection with qualitative and quantitative results

XRF measures elemental composition and film thickness

2D Microscope used for pattern recognition, CD calculation.

3D Scanner height measurement, area scan, wafer surface roughness and bumps co-planarity

X-RAY OPTICS OPTIONS



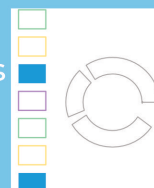
POLYCAPILLARY x-ray optics

Provide polychromatic and enhanced performance of XRF analysis to identify a wide range of elements efficiently

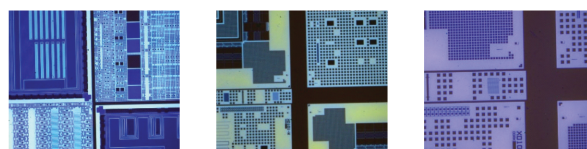
MONOCHROMATIC COLORS™-t x-ray optics

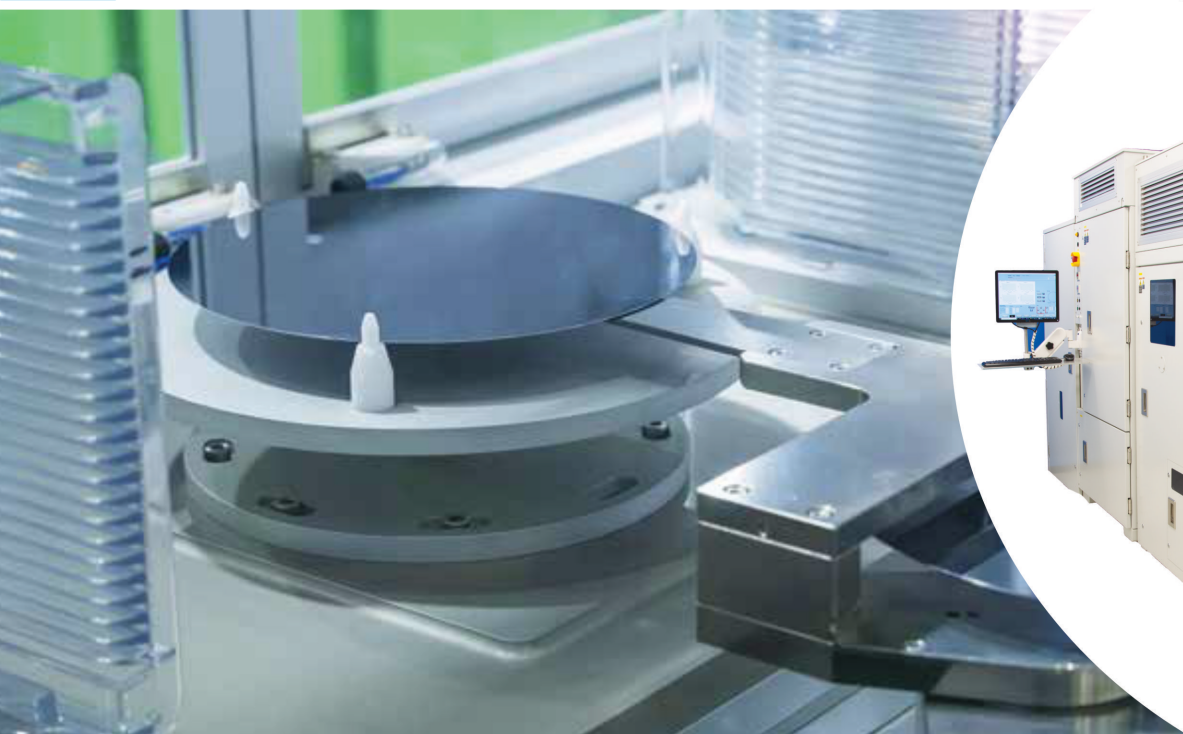
Enables measurements in low background spectrum enabling effective analysis of low signals.

- High brightness excitation
- Small spots for a wide range of thin film applications.
- Ideal configuration for bumps and copper pillars inspection



Accurate navigation and Image processing





ONYX 3000

In-line non-destructive wafer inspection and metrology

Hybrid ED-XRF and optical metrology for in-line, non-destructive wafer inspection and measurement of film thickness, composition, and defect identification/sizing on blanket and patterned wafers

Combining advanced X-ray and optical techniques, the ONYX 3000 offers a unique wafer metrology approach in many areas from FEOL through WLP, leading to in-line solutions for these processes. This sophisticated hybrid metrology tool enables high-throughput, in-line measurements on a blanket and product wafers ranging from ultra-thin single-layer films to multi-layer stacks.

The optical feature with 2D microscope and 3D scanner enables defect detection, sizing, and characterization of BEOL structures through image analysis (of critical dimensions, height, roughness, etc. of metal stacks, solder bumps, pillars, etc.) complemented by elemental composition and thickness measurements by ED-XRF analysis.

Hybrid configuration | automated x-ray analysis, 3D scanning, and 2D microscope for film stack, bumps and composition measurements on blanket and patterned wafers

Rigaku Corporation and its Global Subsidiaries
rsmd.rigaku.com rsmd@rigaku.com

© 2022 — Rigaku Corporation and its Global Subsidiaries. All rights reserved.

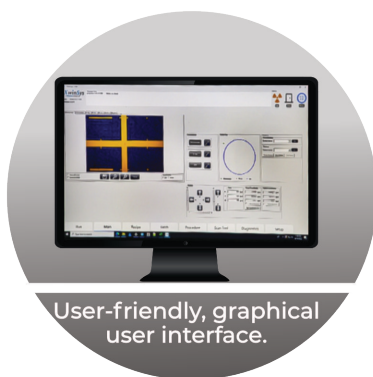
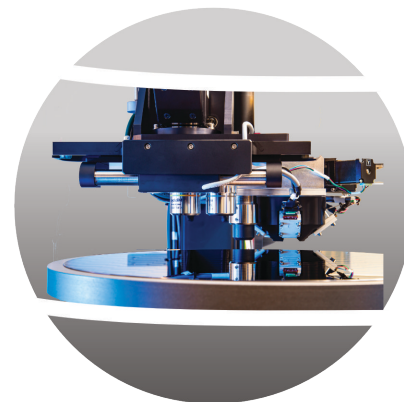


VERSATILE PORT
LOAD OPTIONS

Configurable for 300 mm
and smaller wafers

UNIQUE ADVANTAGES

- Optimal configuration for bumps inspection
- Array of 4 silicon drift detectors (SDD) with large active area and 123 eV FWHM (@5.9 keV) resolution
- Measures light (low-energy) elements (carbon, oxygen, magnesium, aluminum, and phosphorous) using an optional helium atmosphere and special SDD detectors
- Monochromatic or polychromatic x-ray options
- Inspects micro-features through focused vertical X-ray beam (down to 10 μm diameter for polychromatic optics and 20 μm diameter for monochromatic optics)



User-friendly, graphical user interface.

- Advanced motion platform for sub-micron accuracy
- Precise 3D geometrical inspection of features: micro-bumps, pillars, and pads
- Composition analysis associated with FinFET structures
- Fully automated calibration processes, ensuring long-term stability and consistency, and tube aging correction
- In line with SECS/GEM communication protocols

X-RAY OPTICS

The ONYX 3000 is available with micro-spot, polycapillary x-ray optics or monochromatic COLORS-t x-ray optics.

COLORS™-t X-RAY OPTICS AND POLYCAPILLARY X-RAY OPTICS

Rigaku's unique multi-layer mirror technology, the COLORS beam modules are optimized to provide high brightness in small spots for a variety of thin film applications.

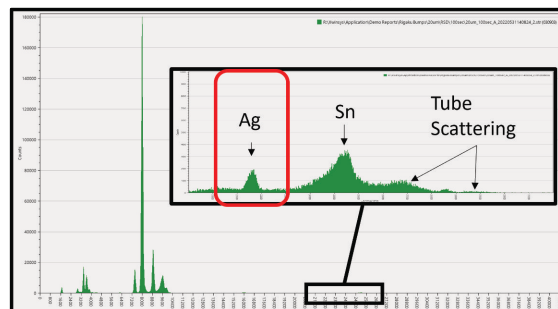
- High-brilliance
- Monochromatic
- Micro-spot x-ray beams

COLORS™-t Characteristics:

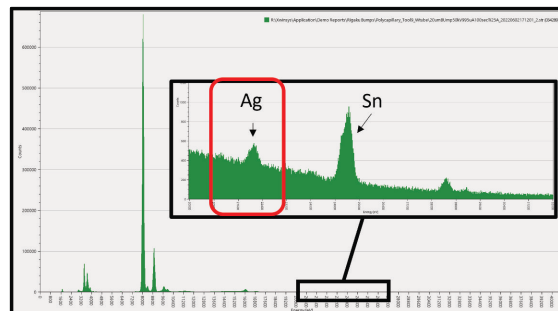
Normal incidence micro X-ray beam module "COLORS™-t 20 μm "

- **Monochromatic:** low background
- **Micro spot:** less than 20 μm FWHM
- **Anodes:** Cu, Au, Mo, W

COLORS™-W
(Spot size ~20 μm @Cr Ka)



Polycapillary
(Spot size ~20 μm @Cr Ka)



3D CONFOCAL SCANNER

Measurements

- Feature Height
- Surface Roughness

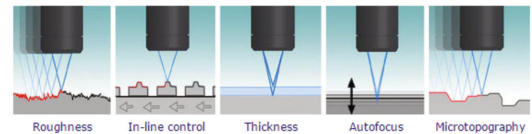
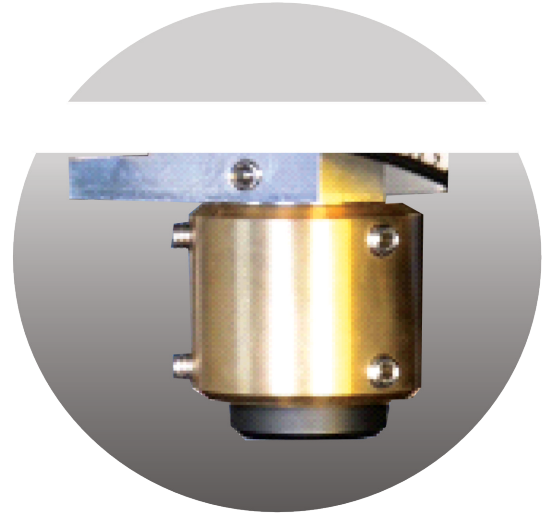
Fast acquisition time (200 msec per point)

High resolution and precision:

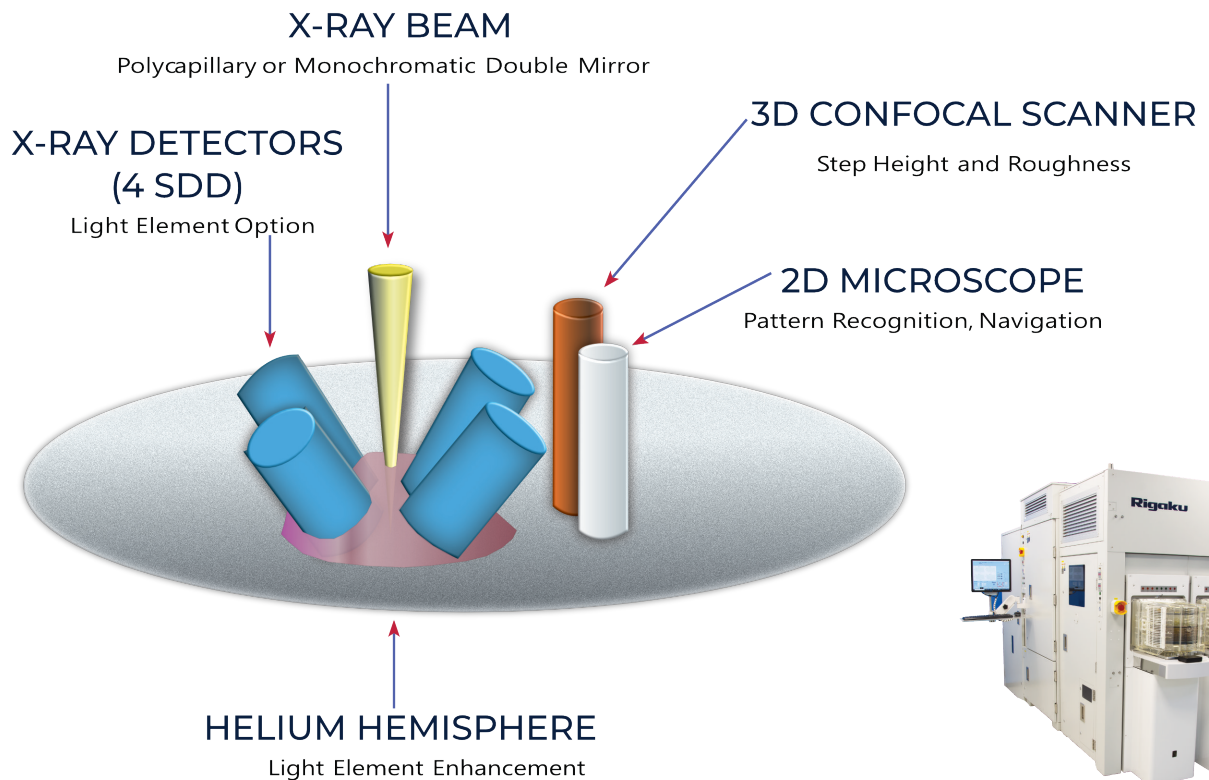
- Vertical resolution: 100 nm
- Lateral resolution: 1 μm

Ability to measure many types of films and surfaces:

- Transparent/opaque, polished/rough
- Semiconductor, metal, glass, ceramic, plastic



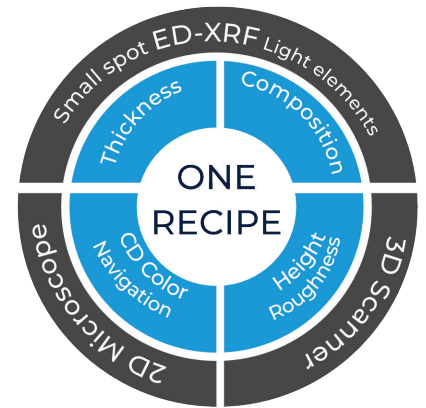
HYBRID METROLOGY | X-RAY/2D/3D OPTICS ENVIRONMENT



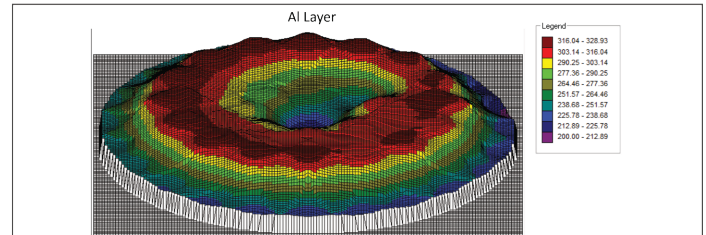
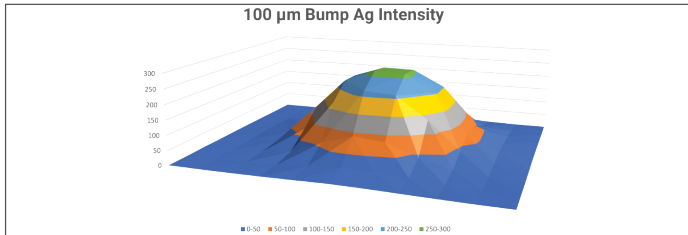


SINGLE RECIPE EXAMPLES

- Set high/low thresholds for pillar height
- Sample pillar heights across wafer with 3D
- Review with ED-XRF on failed pillars
- Discover high variation of e.g. nickel plating
-
- Set high/low gray level thresholds for solder quality
- Sample solder color across wafer with 2D
- Review composition with ED-XRF on failed solder
- Discover high variations of Ag content
-
- Set high/low thresholds for pillar height
- Sample pillar heights across wafer with 3D and pillar diameters with 2D
- Discover photo resist variations out of spec



APPLICATIONS



SINGLE-BUMP METROLOGY

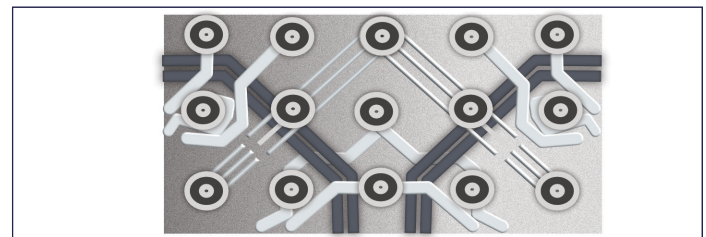
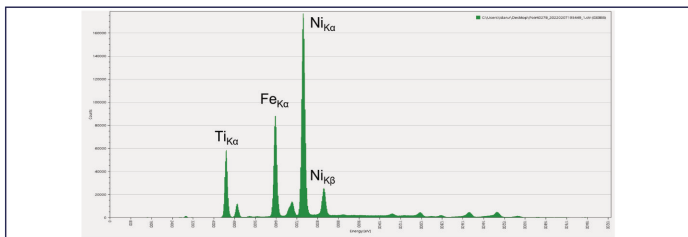
Measure and monitor Ag%, Sn%, AgSn, Ni, and Cu thickness, and total bump height:

- Measure single solder bumps less than 5 µm diameter
- Inspect a range of parameters: across the wafer, wafer-to-wafer, and lot-to-lot
- Measure CD and total height of single bumps using a 2D microscope, 3D scanner

THIN FILMS

Measure and monitor thickness and composition of thin films:

Analyze ultra-thin films transparent or opaque regardless of their physical properties



ALLOY COMPOSITION

Measure and monitor metals and alloy composition:

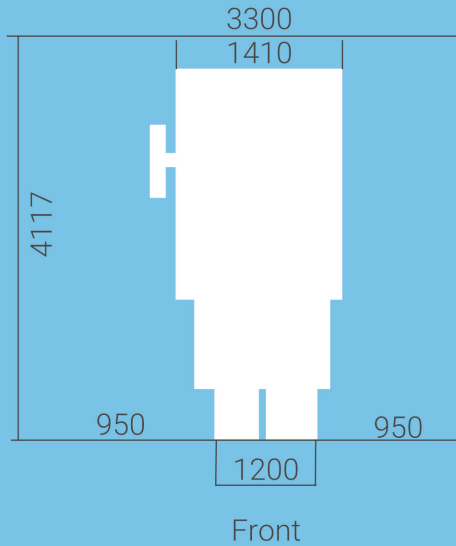
- Analyze metal elements (Ga, Co, Ni, Fe, Pt, Cr, Zn, and Mn)
- Identify alloys (NiFe, CoNi, NiP, NiPt, and CrMn)

UBM/RDL

Conduct metallurgical inspections of under bump metallization (UBM) and redistribution layers (RDL):

- Analyze multi-stack structures and thick monolayers, for layer thickness and composition
- Distinguish separate layers simultaneously

TYPICAL FLOOR ARRANGEMENT



REQUIREMENTS

Tool body (including load ports)

1430 (W) x 3220 (D) x 2125 (H) mm
Approx. 2600 kg

Chiller unit

870 (W) x 377 (D) x 868 (H) mm
Approx. 50 kg

Power Supply

Main unit 208 VAC Phase 3 50/60 Hz 25A

Chiller unit

200-23 VAC Phase 1 50/60 Hz 10 A

Cooling water For chiller unit

0.3~0.5 MPa 1L/min at 25 degree C

Vacuum#1 -90~-70 kPa 80 L/min

Vacuum#2 -90~-70 kPa 80 L/min

CDA 0.48~0.52 MPa

Configurable for 300 mm and smaller wafers

150 mm



200 mm



300 mm

LOAD
OPTIONS

BLANKET AND PATTERNED WAFERS

150 mm

6"

200 mm

8"

300 mm

12"

Setting the Standards
For Semiconductor Metrology

- ✓ Assure product quality
- ✓ High profitability
- ✓ Compelling cost of ownership
- ✓ Productivity metrics



The semiconductor and electronics industries have transformed our lives through advances in communication, automobiles, and general home devices.

At Rigaku we are committed to contribute to the enhancement of humanity through scientific and technological development.

2019



Rigaku Corporation
acquired XwinSys Technologies
Development LTD

X-ray analytical instrument manufacturer Rigaku Corporation and DYG Holdings LTD today announced the closing of the acquisition process by Rigaku, a privately held scientific instrumentation company headquartered in Tokyo, as of July 1st, 2019, to acquire XwinSys Technology Development Ltd, headquartered in Migdal Haemek, Israel. XwinSys is dedicated to designing, manufacturing, and marketing innovative metrology solutions based on enhanced X-ray technology, combined with automated optical 3D and 2D technologies, for semiconductors and related industries.

New industrial solutions will be developed using Rigaku technologies, including in-line x-ray semiconductor metrology with micro-focus mirror optics and XwinSys technologies.

Read the press release at rigaku.com
Scan the QR code



"Rigaku and XwinSys joined efforts to develop new in-line X-ray metrology equipment for semiconductor front-end and back-end processes, MEMS, electronics devices and packaging, and other applications using unique technologies from both companies"

- Dr. Kiyoshi Ogata
Executive Vice President

X-ray Instrument Division and
Semiconductor Metrology Division
Rigaku Corporation



Rigaku Corporation and its Global Subsidiaries

info@rigaku.com rigaku.com

© 2022 — Rigaku Corporation and its Global Subsidiaries. All rights reserved.

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

Global Sales, Service, and Customer Support
rsmd.rigaku.com