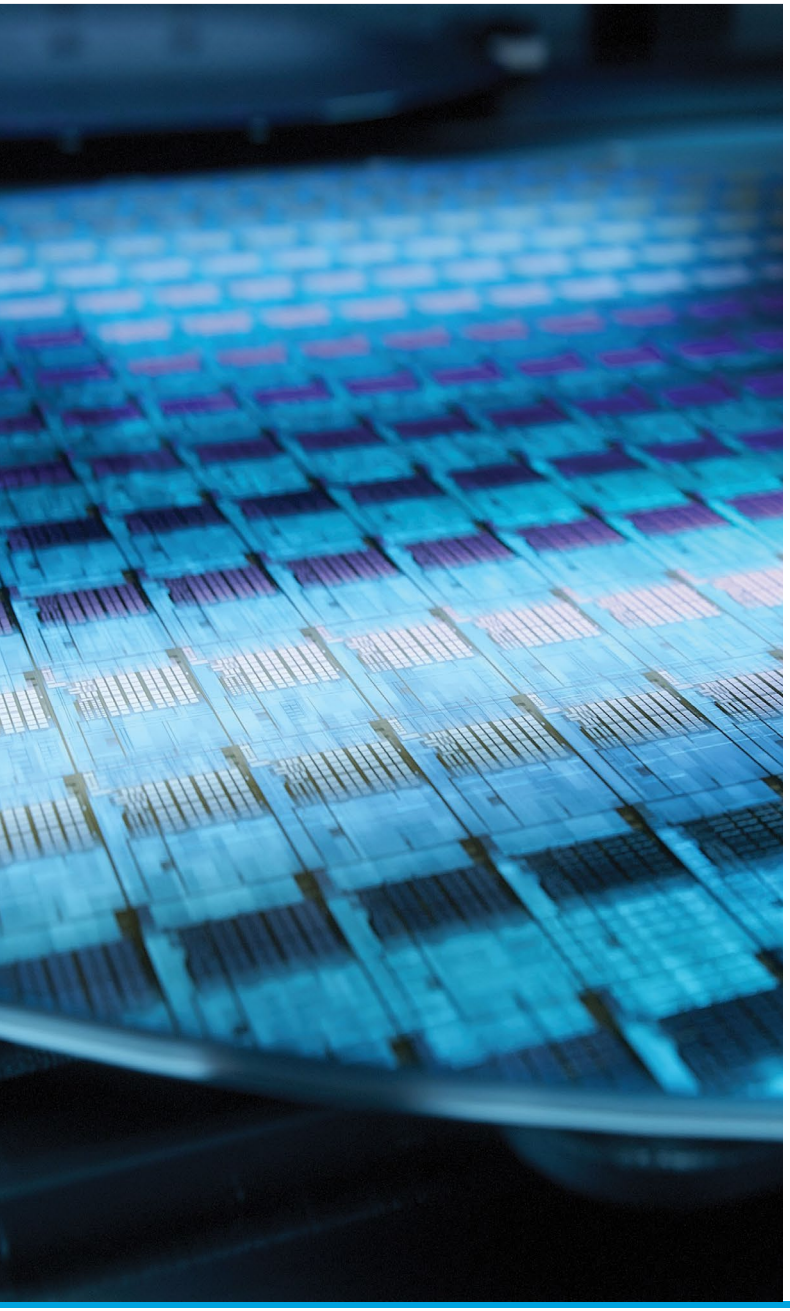
TXRF Series V310/310Fab

Total Reflection X-ray Fluorescence Spectrometer

Rigaku

Semiconductor Metrology Division
rsmd.rigaku.com



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Contributing to the Mass Production Process and Next-generation Devices

Metal Contamination Monitoring at the 10^7 atoms/cm^2 level

By integrating a VPD sample treatment system, unparalleled sensitivity is achieved. Seamless and fully automatic processing from sample preparation to measurement reduces operator burden. Rigaku's advanced X-ray technology and vast application experience help fulfill users' requirements. —The TXRF series contributes to the next generation of process quality control.

TXRF V310

VPD-integrated Total Reflection X-ray Fluorescence Spectrometer

- TXRF analysis tool with the world's first integrated VPD sample treatment system (patented).
- From light elements to heavy elements, analytical needs are fulfilled.

TXRF 310Fab

Total Reflection X-ray Fluorescence Spectrometer

- Suitable for users who put a high value on mapping analysis and who do not require VPD sample preparation. Applicable to 300 mm fabs (automated production lines).

Versatile Functions Contribute to Yield Improvement in the Most Advanced Processes

Features

High-speed Full Wafer Mapping (Sweeping-TXRF)

- High-speed full-wafer mapping.
- Contamination can be mapped at the 5Å~1010 atoms/cm2 level in 35 min (300 mm wafer).

Contamination Monitoring on the Wafer Edge (ZEE-TXRF: Zero Edge Exclusion-TXRF)

- High-sensitivity, non-destructive contamination monitoring out to the wafer edge is possible with 0 mm edge exclusion.
- Metal contamination near the wafer edge is detected without omission.

Wafer Back Side Monitoring (BAC-TXRF: Backside Analysis Capable-TXRF)

- A reversing robot arm enables automatic backside measurement of 300 mm wafers.
- The whole surface of one side and the edge area of the other side of a doubly-polished 300 mm wafer are monitored with a single wafer.
- The combination of Sweeping-TXRF and ZEE-TXRF offers contamination monitoring of the entire wafer surface.

Compliant with On-line Communication Standards (GEM300)

- Compliant with 300 mm fab CIM/FA (Computer Integrated Manufacturing/ Factory Automation).

X-ray Source and Detector

Rotating-anode X-ray Source (TXRF-V310, TXRF 310Fab)

Light elements (Na, Mg, Al), transition metals, and heavy elements are analyzed with high sensitivity using high-power X-rays from a rotating-anode X-ray source.

Liquid Nitrogen-free Detector System

Liquid nitrogen-free SDD (Silicon Drift Detector) offers high resolution and high count rate.

Contamination Analysis Needs

For Ultra-high-sensitivity Analysis

VPD-integrated System — Trace Element Analysis of Na ~ U

- Applicable as an in-line contamination monitor.
- Detection of transition metals at the 1 x 10^7 atoms/cm^2 level is possible (500 sec measurement).

Droplet Search Function is Incorporated

- Dried droplet residue is quickly searched and measured.

To Determine the Distribution of Contaminant Elements

Contamination Distribution Analysis by High-speed Wafer Surface Mapping

- Contamination on a 300 mm wafer surface is measured in 35 min.
- Contamination distribution is seen at a glance by individual element maps and overlapping element view.
- Average contamination is calculated over the entire wafer surface.
- High-precision measurements can be carried out automatically on contaminated spots found by whole wafer surface screening.

For Routine Analysis on Particular Points

Direct TXRF Analysis on Designated Coordinates

- Correct contamination levels are reported at all points on a wafer by avoiding interferences (from diffracted X-rays or escape peaks).
- Detection of transition metals at the 1 x 109 atoms/cm2 level is possible (500 sec measurement).
- Using a high-power rotating-anode X-ray source, three times higher throughput is achieved compared with a sealed-tube X-ray source.
- Light elements (Na, Mg, Al), transition metals, and heavy elements are measured seamlessly without switching between multiple X-ray tubes.

Total Integration and Fully Automated Operation of VPD Sample Treatment and TXRF Measurement

From Na, Mg, Al through U, Ultra-trace Contamination is Detected with High Precision

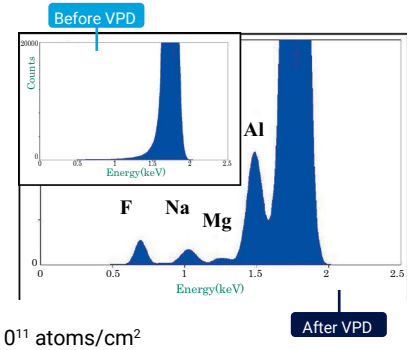
Trace contamination analysis at the 10^7 atoms/cm^2 level is achieved. VPD sample treatment system is completely integrated and fully automated.

Comparison of detection limit (300 mm wafer)

Element	Na	Al	Fe	Ni	Cu
V310	2.0×10^{9}	1.0×10^{9}	1.0×10^{7}	1.0×10^{7}	1.0×10^{7}
310Fab	2.5×10^{11}※	2.5×10^{11}※	1.0×10^{9}	1.0×10^{9}	1.5×10^{9}

Measurement time: 1000 sec Unit: atoms/cm^2 ※In case of particle contamination

Gate oxide example of light element measurement

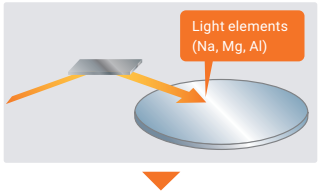


Na: 2.2×10^{11} atoms/cm^2
Mg: 2.4×10^{10} atoms/cm^2
Al: 1.3×10^{11} atoms/cm^2

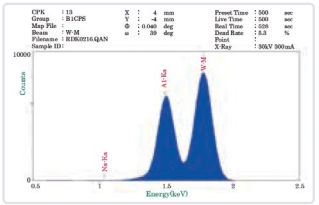
Wide Analyzable Element Range from Na to U with a 1-target, 3-beam Method

With a single X-ray source, 11Na~92U are analyzed thanks to Rigaku's unique 1-target, 3-crystal exchanging mechanism. The crystals are switched automatically through software, quickly and with high precision.

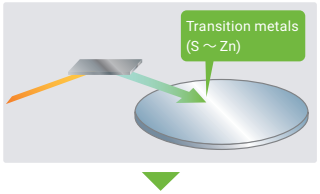
W-Mα line: TXRF 3760



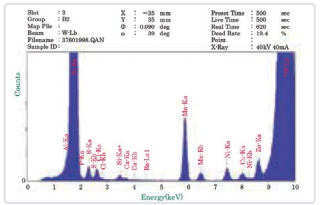
Spectrum chart of Al



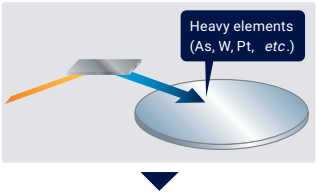
W-Lβ line: TXRF 3760, TXRF 3800e



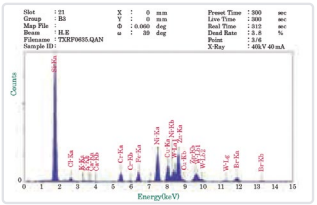
Spectrum chart of transition metals (S ~ Zn)



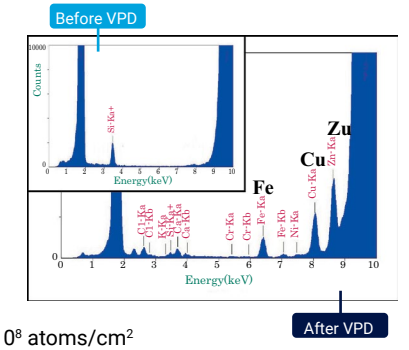
W-H.E.: TXRF 3760, TXRF 3800e



Spectrum chart of heavy element (As, W, Pt, etc.)



Gate oxide example of transition metals measurement

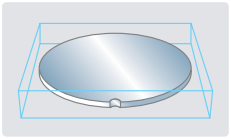


Fe: 6.1×10^{8} atoms/cm^2
Cu: 7.0×10^{8} atoms/cm^2
Zn: 8.6×10^{8} atoms/cm^2

The World's First and Only VPD-integrated TXRF Tool

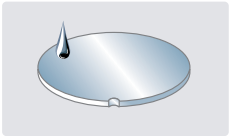
Easy Operation of Integrated VPD Enables Contamination Control in the Most Advanced Production lines

Decomposition

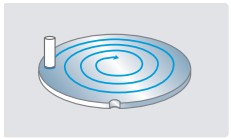


The oxide film on the wafer surface is decomposed using hydrofluoric acid vapor.

Recovery

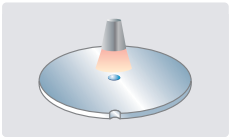


After the oxide film is decomposed, recovery solution is dropped onto the wafer surface.



Contaminants are recovered with the tip of the nozzle holding the droplet.

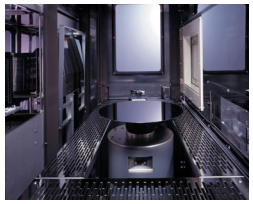
Drying



The recovery solution is placed in the center of the wafer and is heated and dried.

Recovery Solution
Wafer surface scanning solutions TAMAPURE-AA-SSX, TAMAPURE-AA-SSR and TAMAPURE-AA-SSTX are commercially available from Tama Chemicals Co., Ltd.

Recovery Drying Chamber
The shape of the nozzle was designed by Rigaku to provide excellent control of the recovery solution.
After recovery, the nozzle is automatically cleaned for the next operation.



Front End Module
The TXRF measurement and VPD processing can be carried out in parallel to increase throughput.

Compliant with SEMI Safety Standards

- S2 safety guideline
- S8 ergonomics guideline

Droplet Dispensing Function (Option)

- Collection of solution for analysis by ICP-MS, AA, and other techniques (Option).

Up to Two Kinds of Recovery Solution (Option)

- Switching between two kinds of recovery solution (Option).

VPD for Hydrophilic Surface (Option)

- A special nozzle design enables VPD droplet collection from hydrophilic surfaces, such as rough surfaces, organic films, and SiC substrates

Special nozzle

Designed for Easy Maintenance and Safety

- Hydrogen fluoride gas is introduced into the decomposition chamber by bubbling nitrogen gas into the hydrofluoric acid container.
- The decomposition solution bottle and the recovery solution bottle are exchanged by a simple and easy procedure.
- Automatic recovery nozzle cleaning function.
- The hydrogen fluoride concentration in the VPD unit is constantly monitored.
- Various sensors are installed throughout the tool to ensure safe operation.

Partial Recovery (Option)

- Recovery of contamination in any area on a wafer designated by rθcoordinate (Option).
- Recovery of bevel.

Features that Enable High-precision Analysis of VPD Samples

Droplet Search Function

- Quickly locate the position of dried droplet residue.

Sample Position Alignment Function

- Precise measurements on the same coordinate even after unloading and loading a wafer.

X-Y-θStage to Avoid Escape Peak X-ray Interference

- By avoiding diffracted and scattered X-rays from the substrate, trace element analysis is achievable with high precision.

Highly Flexible Decomposition and Recovery Recipes

- Automatic VPD processing is performed with optimized recipes for each type of sample.

High-speed Wafer Surface Contamination Mapping

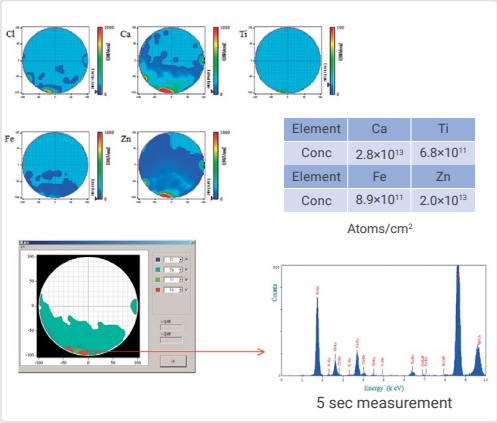
Sweeping-TXRF

A Highly Reliable Rotating-anode X-ray Source and Sweeping-TXRF Software Enable High-speed Contamination Mapping of Trace Elements.

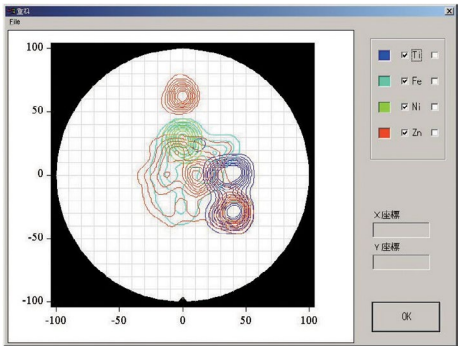
- Screening of the wafer surface to identify contaminated points.
- Contamination can be mapped at the 5 ×10^{10} atoms/cm^2 level in 35 min (300 mm wafer).
- Results from individual contamination points and averaged results from the entire wafer surface can be reported.
- High-precision analysis of contaminated points is performed automatically to output contamination by element and concentration.
- Contamination sources can be easily identified with contaminant element, concentration, and distribution information.

The User is Free to Display Sweeping-TXRF Results in Many Ways

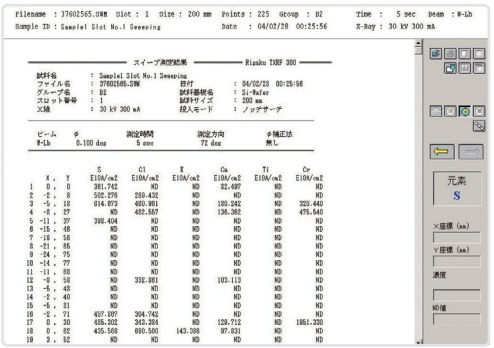
Example of Sweeping-TXRF measurement (5 sec/pt)



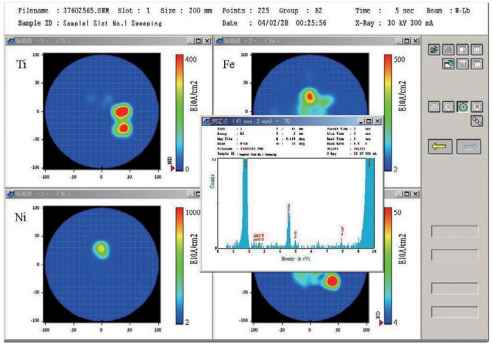
Overlap image of detected elements



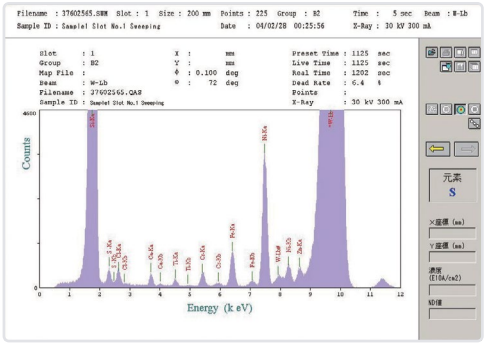
Quantification result of each point



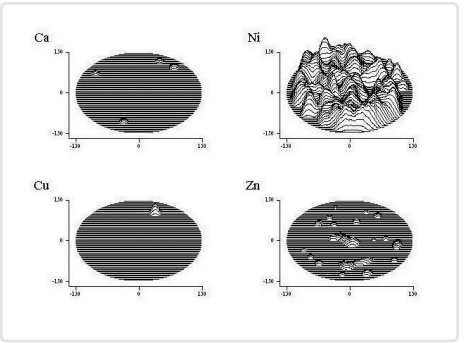
Color contour distribution map and profile of a specific point



Profile of average contamination over the wafer surface



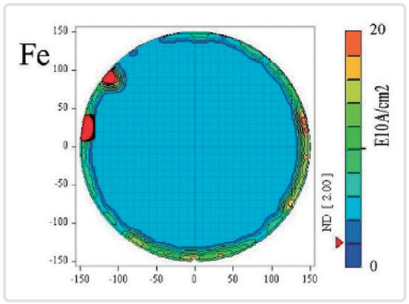
Bird's-eye view of contamination distribution



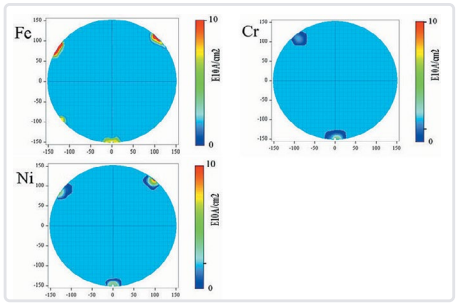
Versatile Functions Set New Standards for Contamination Control in Wafer Processing

ZEE-TXRF

Example of ZEE-TXRF measurement



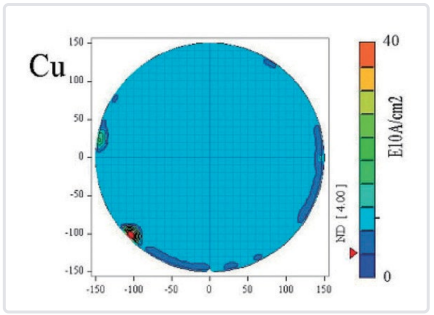
Contamination from edge-grip robot handling



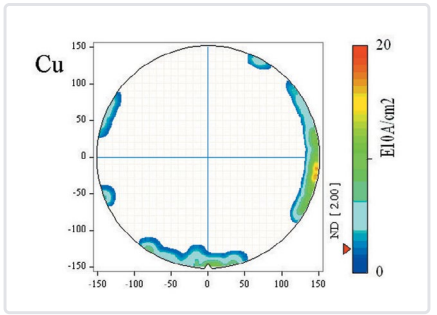
- Zero Edge Exclusion TXRF enables measurement points out to the wafer edge.
- Three beam (W-Mα, W-Lβ, W-H.E.) measurements are possible.
- Optimized X-ray optics enable edge measurements with the same sensitivity as conventional TXRF.

BAC-TXRF

Cu contamination in the edge area of the front side



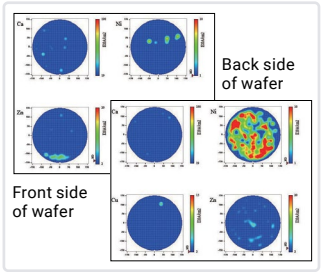
Cu contamination in the edge area of the back side



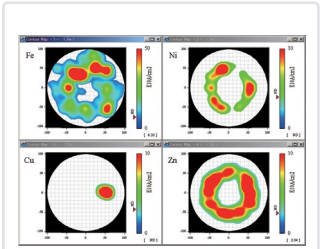
- Mapping of the wafer surface—Automatic contamination measurement at the wafer edge.

Examples of Measurements in Various Processes

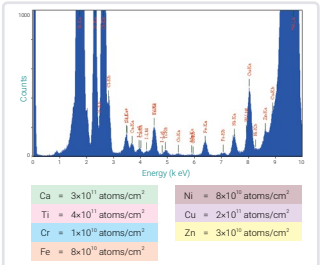
Contamination in the CMP process



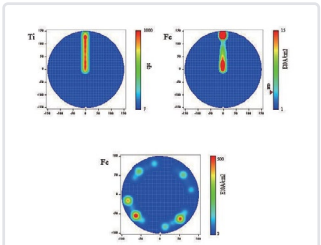
Contamination in wafer production



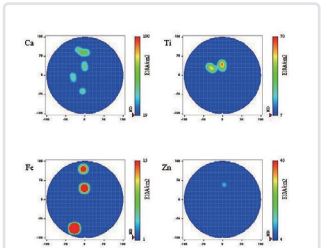
Bevel analysis



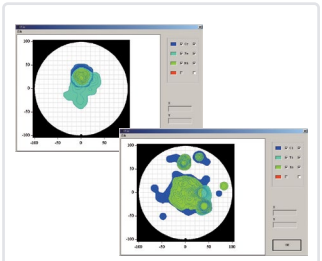
Contamination in wafer transfer

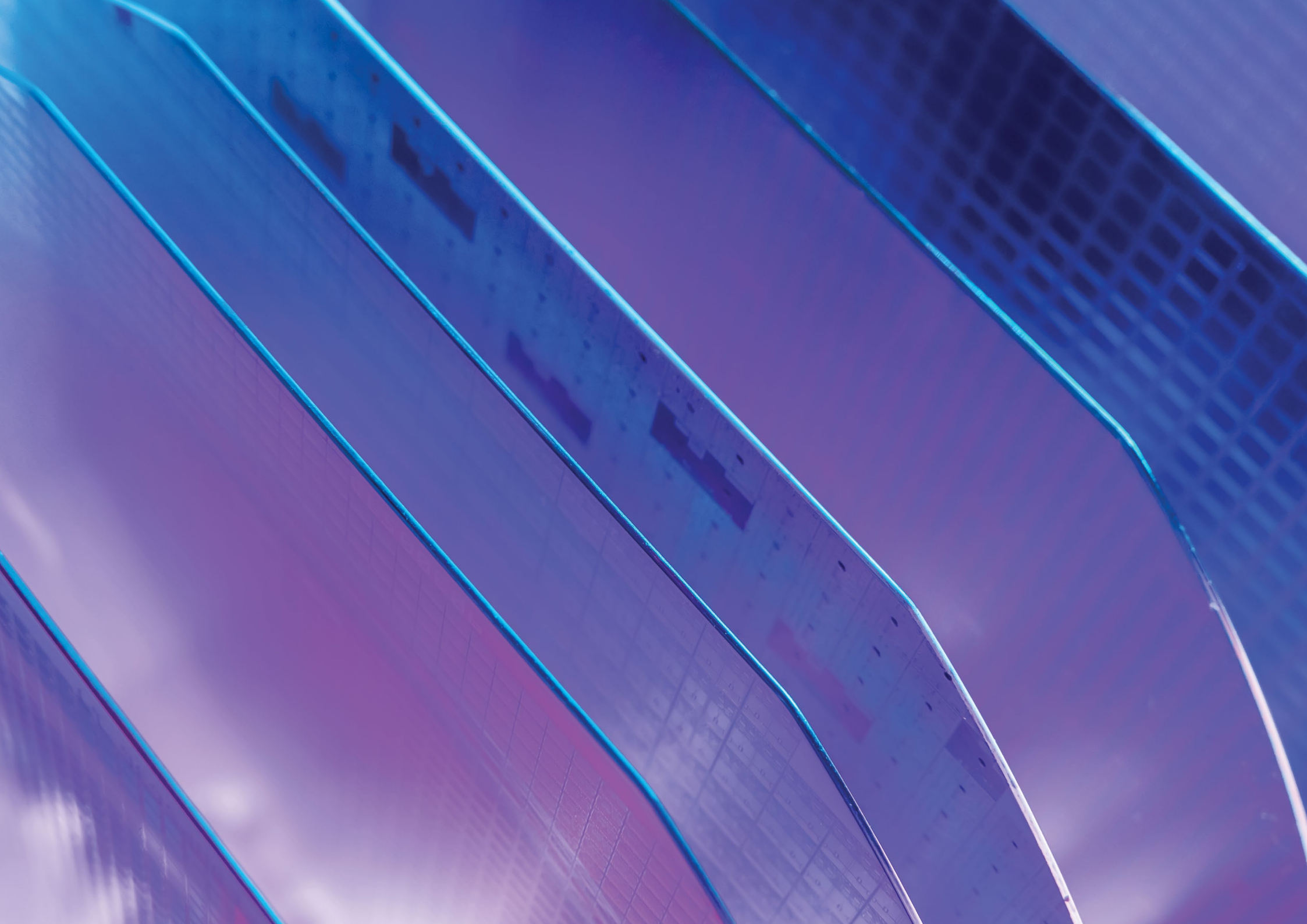


Contamination in the CVD process under normal pressure



Contamination on an organic thin film



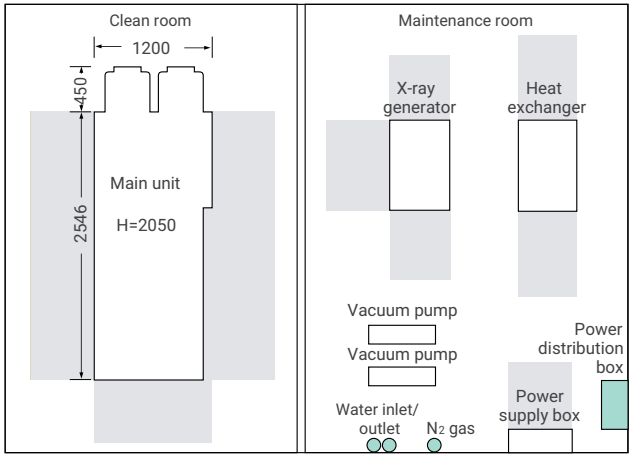


Installation Requirements

Model	TXRF-V310	TXRF 310Fab
Power supply	3 phase, AC 200 V, 50/60 Hz, 125 A	3 phase, AC 200 V, 50/60 Hz, 125 A
Earth grounding	Grounding resistance 30 Ω or less (Dedicated line)	Grounding resistance 30 Ω or less (Dedicated line)
Cooling Water (Tap water) for X-ray source	>25 L/min, 0.2~0.5 MPa, 18 ~ 25 °C With heat exchanger	>25 L/min, 0.2~0.5 MPa, 18~25 °C With heat exchanger
Cooling Water (Tap water) for dry pump	According to pump specification	According to pump specification
Cleaning water (UPW)	10 L/min, 0.1~0.7 MPa, <30 °C	—
N_2 gas (High purity)	0.5~0.7 MPa <30 °C 20 L/min 180 L/min (BAC-TXRF) 40 L/min (Hydrophilic Wafer VPD) 200 L/min (Hydrophilic Wafer VPD + BAC-TXRF)	0.5~0.7 MPa <30 °C 20 L/min 180 L/min (BAC-TXRF)
N_2 gas for dry pump	According to pump specification	According to pump specification
Compressed air (CDA)	40 L/min, 0.6~0.8 MPa , <30 °Cw	40 L/min, 0.6~0.8 MPa, <30 °C
Vacuum for chucking	10 L/min, <-80 kPa (For wafer transfer robot)	10 L/min, <-80 kPa (For wafer transfer robot)
Chemical solution	Hydrogen fluoride for decomposition 49% : 5 kg bottle/6 months Recovery solution (2 %HF + H_2O_2) : 500 mL bottle/100 wafers (Composition recommended by ISO)	—
Acid exhaust (Scrubber)	5000 L/min (-100 Pa at contact gauge pressure)	—
Acid drain (Cleaning solution)	10 L/min	—
Acid drain (Leakage pan)	10 L/min	—
Others	Exhaust for compressed air and dry pump	Exhaust for compressed air and dry pump
Environment	18~27 °C, humidity <75 %RH	18~27 °C, humidity <75 %RH
Weight	1650 kg	1380 kg

(Note) Pressure at gauge

Example of Installation



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Compliance with safety standards | CE | SEMI S2/S8 | Compliance with communication standards | SECS/GEM

ISO 9001/ISO 14001 approved

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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