HORIBA
Scientific

XGT

X-ray Analytical Microscope

XGT-7200

XGT-5200

ISO9001 JQA-0288 ISO14001 JQA-E-90039 IMS HORIBA Group is operating Integrated Management System OHSAS18001 JQA-OH0068

XGT celebrates over 30 years of products!

1981

MESA-1130

1987

MESA-7000

MESA-2000K

1988

1989

MESA-7000

MESA-2000S

1990

XGT-7000V Series

XGT-2000 Series

1994

2014

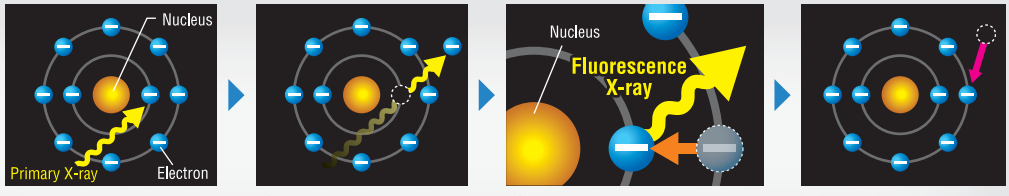
XGT-7200

XGT-5200

XGT-5000 Series

Principle of X-ray Fluorescence

X-ray fluorescence is a non-destructive analytical technique which characterizes solids, liquids, and powders qualitatively and quantitatively.
Micro-XRF combines this with microscopic analysis, so that individual particles and features can be analyzed, and images of the distribution of elements can be generated.



1 Absorption of primary X-ray.

2 An electron is knocked out by the primary X-ray.

3 Unstable state: The energy generated when an outer-shell electron falls back to the inner shell becomes a fluorescence X-ray.

4 An external electron is absorbed and the atom is stabilized.

Applications

The XGT can be used to examine samples in various fields, from small parts to mounted substrates.
Choose a measurement approach based on your application, whether single-point analysis, or mapping.

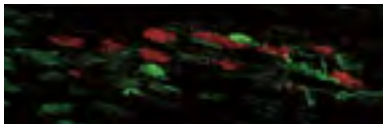
Analysis of two similar paintings by Vincent van Gogh

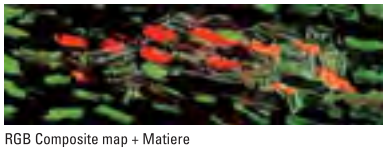
Two well-known examples of van Gogh's "Le Jardin de Daubigny" exist, and are displayed in two separate museums: Hiroshima and Basel. In the Basel "Le jardin de Daubigny", a black cat is painted, while in the Hiroshima version, the cat seems to be covered with paint. Both versions have the same composition and are of the same size. A photograph of the Hiroshima painting taken years ago tells us that a cat used to be there. Through a mapping measurement by the XGT-5000, the existence of a black cat was investigated.

Hiroshima (Japan)

Basel (Switzerland)


Analysis area


RGB Composite map (Green: Cr; Red: Fe)

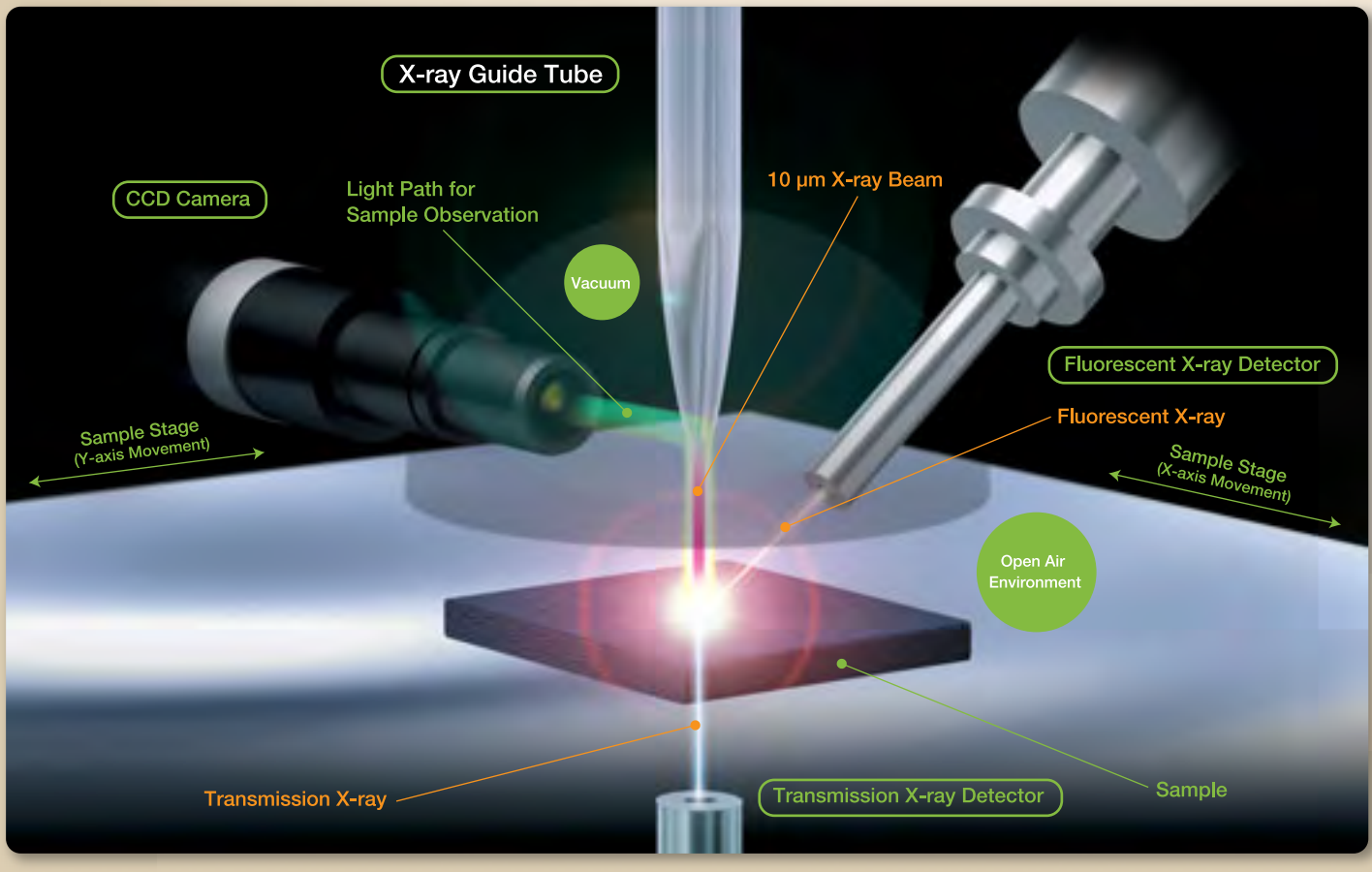

RGB Composite map + Matiere

The part of the Hiroshima picture with the alleged black cat was analyzed via XGT mapping. The paints van Gogh used are known to have characteristic elements. With the XGT-5000, X-rays irradiated the various paints to create a map of elemental distributions. From this map, the types of paints were determined. Via a map of chromium composition, the composition of the head, neck, front paw, and tail were found. For the map of a composite of chromium and iron, the original dark-brown iron-bearing paints (retouching) appeared strong, but iron also existed within the area of the black car. Thus the black cat's paints were judged to be a mixture of chrome yellow (Cr) and Prussian blue (Fe).

10 µm Technology

The X-ray guide tube, which focuses the X-ray beams, revolutionizes the very foundation of sample observation and analysis.

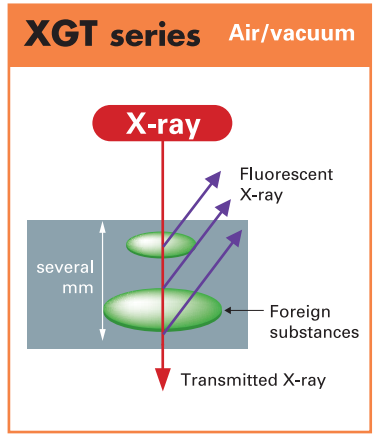
The ultra-narrow 10 µm X-ray beam has been made possible with the development of HORIBA's original X-ray guide tube. While the sample is being scanned, the X-ray guide tube irradiates the sample with an X-ray beam, with the CCD camera and X-ray detector working together. The result is a completely seamless merger of optical microscope observation and the element analysis functions of the X-ray analyzer. The XGT Series represents a completely new generation of microscopes, and the XGT leading the way to a new era of science.

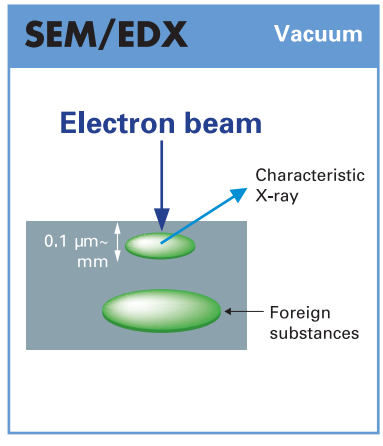


The XGT Series provides simple measurements without sample preparation or special techniques

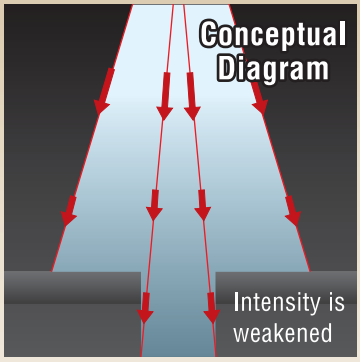
Comparison with SEM/EDX

Use of an electron beam (SEM/EDX analysis) means the technique is suitable for surface analysis only. The XGT series benefits from the penetrating nature of the primary X-ray beam, allowing visualization and characterization of features invisible to the eye, and offers higher detection-limits compared with SEM/EDX, because more atoms are analyzed. Above all, the XGT series offers easier use, and is suitable for analysis even of large samples, with or without a vacuum.

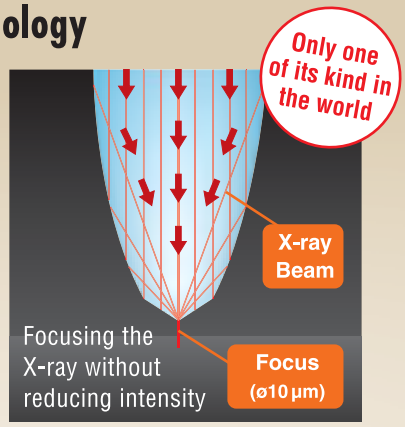




X-ray Guide Tube Technology



Collimator



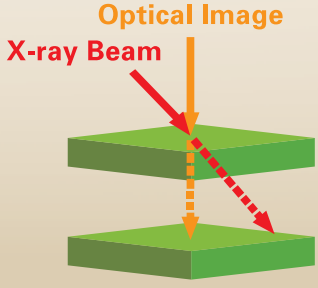
XGT Use an X-ray guide tube

The HORIBA X-ray Guide Tube (XGT) provides X-ray beams with high intensity and microscopic diameters, ranging from 1.2 mm down to a unique 10 µm. They allow fast and easy elemental analysis of individual particles and features. The exclusive use of mono-capillary optics in the XGT Series ensures analytical clarity with parallel beams, which are optimized for micro-XRF analysis. These offer "focus-free" analysis: Even for rough samples, precise, well-defined elemental images can be obtained. Acquisition times are kept to a minimum, because time-consuming "auto-focus" procedures are not required.

Parallax-Free Optical System

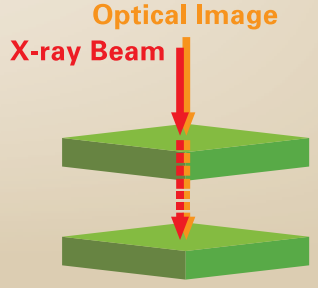
The XGT Series use a structure that places the CCD sample observation image along the same axis as the X-ray beam. There is no parallax of the analysis position, even for samples with uneven surfaces, providing a perfect merger of sample-observation operations and analytical results.
The XGT Series provides an outstanding combination of ease of use and accuracy of data.

Non-Coaxial Method



Parallax

XGT Series
Coaxial Method



Parallax-Free

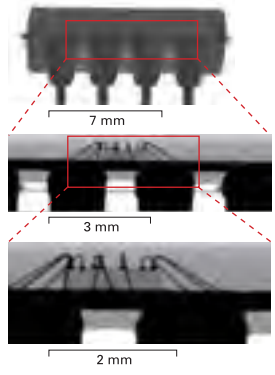
Comparison of various types of analyzers

The XGT series combines advantages of various types of measurement devices.

	XGT series	SEM/EDX
Sample Positioning Using Optical Image	○	△ Electron Microscope Image (Monochrome)
Maximum Analysis Area	○ 10 cm × 10 cm	△ 1~2 mm
Minimum Analysis Area	△ ø10µm	○ ø0.Several µm
Measurable Range	△ $_{11}$Na~$_{92}$U	○ $_{4}$Be~$_{92}$U
Sample Preparation	○ No	△ Conductivity Processing
Sample Damage	○ No	△ Yes
Sample Contamination	○ No	△ Yes
Measurement at Normal Atmospheric Pressure	○ Yes	× In Vacuum
Acquiring Image/Element Map	○	○
Transmission X-ray Image	○	×
Optical Image	○	×

X-ray transmission image

With the XGT Series, the penetrating nature of X-rays can be harnessed to view the internal structure of a sample - without having to open it up. The collimated beams generated by the X-ray Guide Tube allow unevenly shaped samples to be imaged with high resolution.



XGT-5200

1 Place the sample in the sample holder.

There is no need for sample preprocessing, such as conductivity processing or drying. The measurement position is also specified from the monitor after the sample is loaded into the XGT-5200.

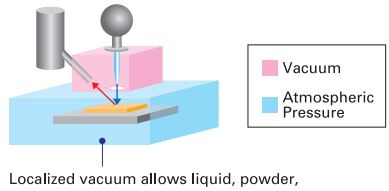
2 Load the sample holder into the XGT-5200. There is no need to make a vacuum.

There is no need with the XGT-5200 to perform preprocessing operations such as creating a vacuum, so after loading the sample, proceed right to specification of the measurement position.

3 The sample is analyzed at normal atmospheric pressure.

The sample chamber is maintained at normal atmospheric pressure, so even samples that would be damaged by a vacuum (samples containing water, living samples, etc.), can be analyzed with no preprocessing.

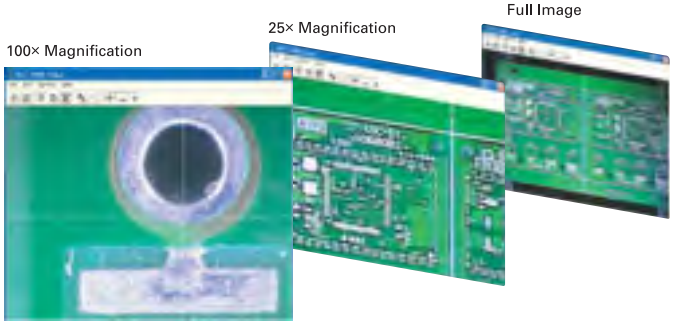
[Localized Vacuum]



Localized vacuum allows liquid, powder, and biological samples to be measured.

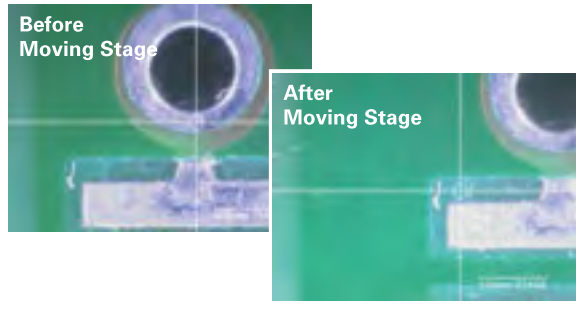
4 Quickly proceed from a view of the entire sample to the selection of the target point.

After the image of the entire sample is displayed on the monitor, select the exact point for high-precision 10 µm analysis in just 3 mouse clicks.



5 Move the sample stage by clicking the optical image.

When you need to make minor to the measurement position, simply click the displayed optical image to move the sample stage. There is absolutely no need for complex operations.



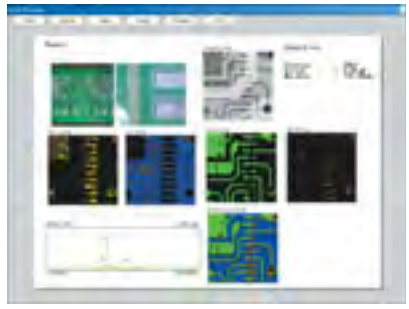
One of the major advantages of the XGT is that it provides superb, seamless operations, from optical image observation to element analysis. In just three easy clicks, you go from a view of the entire sample to specifying the 10 µm point to be measured. All operations, from sample loading to the creation of the analysis report, are done with natural, intuitive operations.

Mapping start screen

The area to be mapped is selected while viewing the sample on the monitor.

Example of a measurement results report.

Optical images, X-ray mapping images, and X-ray transmission images can be saved in one file, making it easy to quickly draft analysis reports.



Multi-point analysis

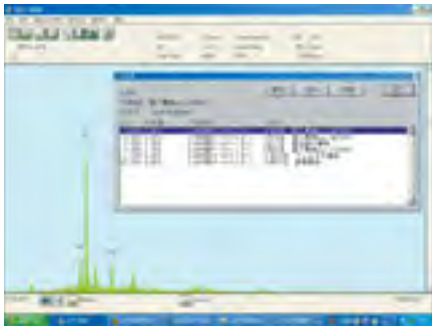
If points are selected for multiple locations, the spectrum at each location can be collected automatically.

Line analysis

The XGT-5200 can also perform line analysis, which is effective for analyzing areas such as a sample cross-section.

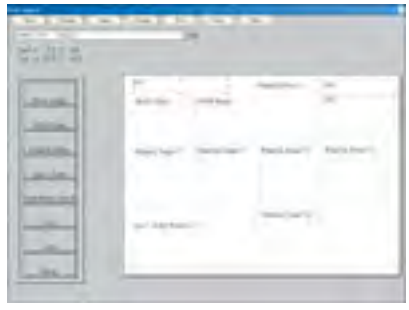
Matching functions

Previous data can searched in spectra similar to the current results, and the search results can be displayed in order of similarity. Saving data acquired from unknowns makes it possible to identify quickly new substances.



Data layout can be arranged freely

Analytical results can be printed, with optical images, spectra, mapping images, and text freely arranged in the printing layout.

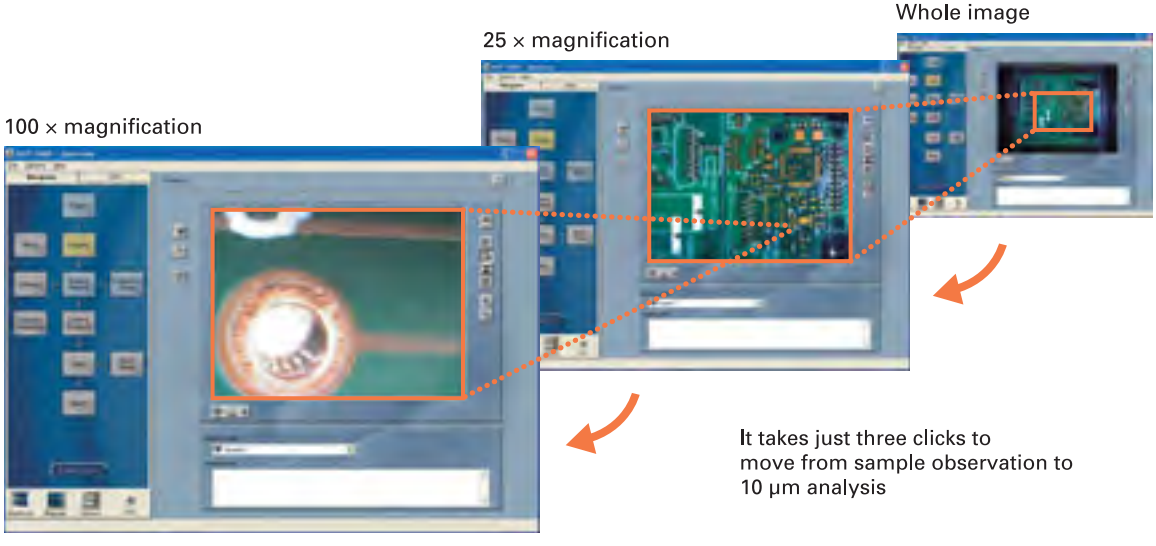


Freely position data within the layout.

XGT-7200

Spacious sample chamber

The spacious sample chamber accommodates samples of all shapes and sizes.
The integrated XYZ stage ensures easy handling.
You have complete control over sample movement and analysis position via three integrated CCDs.



It takes just three clicks to move from sample observation to 10 µm analysis

XGT-7200 software

Navigator

Easy operation

An intuitive Navigator window steps the user through the experiment, from sample set up, through acquisition, to complete data analysis.

Complete acquisition

The XGT systems offer the user a wide choice of acquisition methods.

- Single point analysis
- Multi-point analysis
- Hyperspectral elemental imaging
- Transmitted X-ray imaging

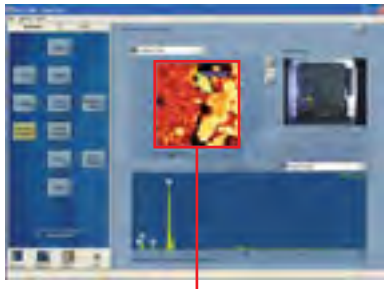
Full data analysis capability

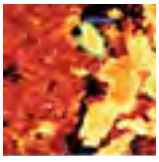
With the data collected, the XGT-7200 software offers a complete data-analysis package.

- Qualitative (Auto ID)
- Quantitative (Standardless, Single Standard, Calibration)
- Multi-layer thickness analysis
- Spectrum generation
- Match
- Compare and Overlay
- RGB composite image
- Report generation

SmartMap

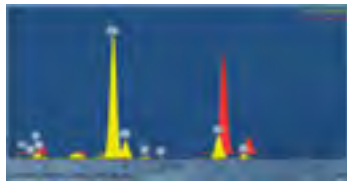
The XGT-7200's SmartMap software gives unlimited analysis flexibility. The XRF datacube which is acquired during a mapping experiment, contains both spatial and spectral information. After the acquisition, the user can generate element images at will, or extract spectra from specified regions within the map. Thus it is possible to both examine element distribution and perform qualitative/quantitative spectral analysis from a single dataset.

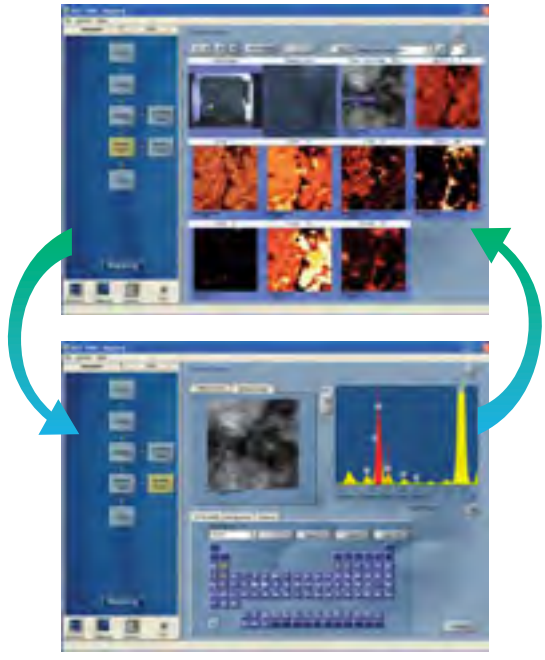




Generate a spectrum from a user defined region within the element image.

Spectra from different regions can be compared in order to identify their differences in elemental composition

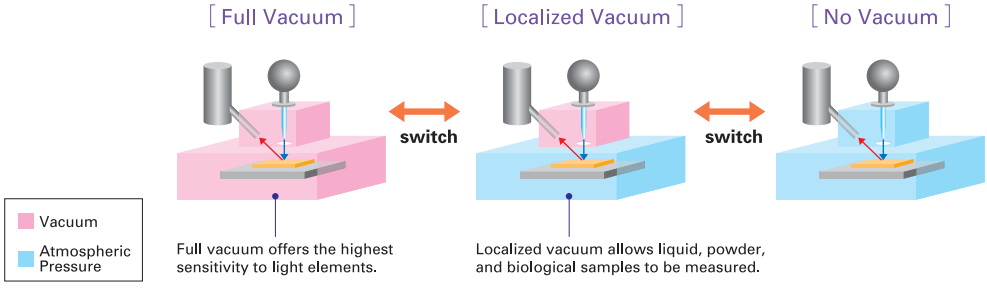


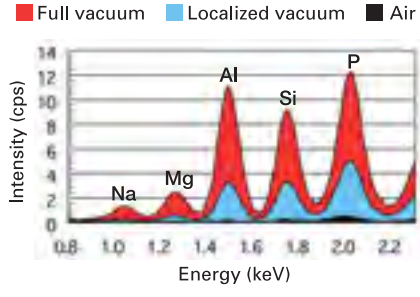


Element images can be generated during acquisition, or at any time afterwards. Simply select the element and view its distribution image.

Dual vacuum modes

Within seconds the user can switch between the Dual vacuum modes available within the sample chamber. These allow chamber conditions (and measurement results) to be optimized for different samples.





Application

The introduction of the XGT-Series into a laboratory provides fundamental solutions to a wide range of analytical work problems that could not be resolved with conventional systems. In this section, we examine some specific examples of these problems, looking at the factors that caused the problems and the ways in which the XGT Series solved them.

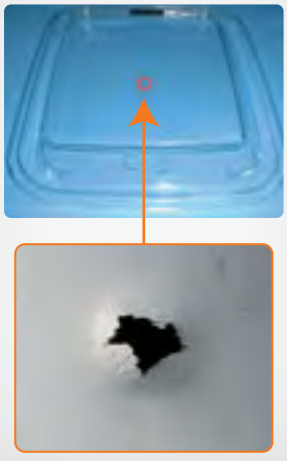
Analysis of a foreign substance in plastic

Measurement Conditions: X-ray Tube Voltage: 50 kV
X-ray Tube Current: 1.0 mA
X-ray Radiation Diameter: 100 µm

Sample Measured: A foreign substance inside a plastic sample

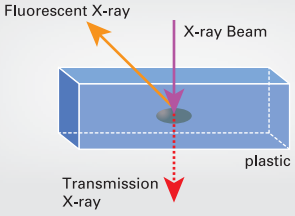
Designating a point from an optical microsope:Direct measurement of a foreign material portion
(without pre-treatment of extracting the cross-sectionand removal of foreign matter).

The foreign substance can be seen, but it would be difficult to remove.



Optical microscope image

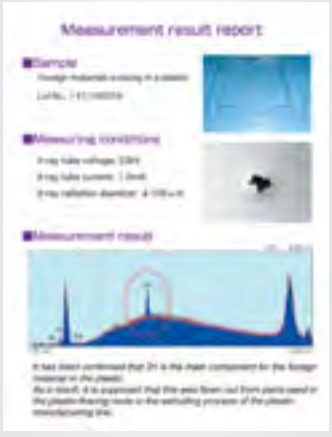
Illustration of the sample cross-section



Measurement Results

Blue: Foreign Substance, Red: Background

Example of a measurement results report



Less than 10 minutes from the time the sample is loaded until the report is drafted.

Analysis of an ulcerated section of the stomach of a rat

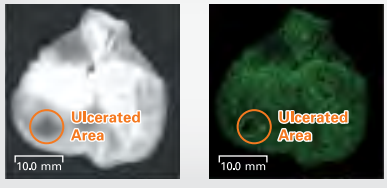
Measurement Conditions: X-ray Tube Voltage: 30 kV
X-ray Tube Current: 1.0 mA
X-ray Radiation Diameter: 100 µm

Sample Measured: Tissue from a rat's stomach. The stomach is cut at the center, the sample submerged in formalin, and then sandwiched between two sheets of film for analysis.

Zinc components are said to contribute to the healing of gastric ulcers. In order to verify the effects of zinc, rats having gastric ulcers were orally given medication containing zinc, and the micro-quantities of elements in the area surrounding the ulcer were examined. Rats not given the zinc medication showed the same type of improvement as rats given the medication, which was thought to be caused by the natural healing powers of a living organism. When testing the tissue samples, if the samples are dried, the zinc distribution could be altered. Therefore, the XGT is highly effective for use in the analysis of tissue samples from living organisms.

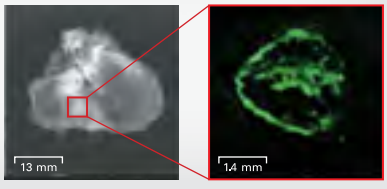
Mapping results

Stomach of a rat receiving the oral medication



Transmission X-ray Image　Zn-Kα

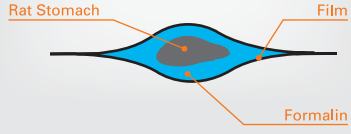
Analysis results for the stomach of a rat not receiving the medication



Transmission X-ray Image　Zn-Kα

Sample pre-treatment

The rat stomach is cut at the center. After immersion in formalin, the tissue sample is sandwiched between two sheets of film and analyzed.



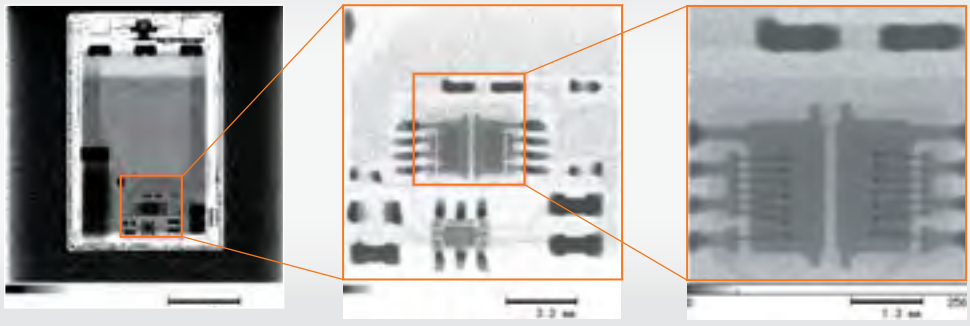
Analyze a defect inside a digital camera battery

Measurement Conditions: X-ray Tube Voltage: 50 kV
X-ray Tube Current: 1.0 mA
X-ray Radiation Diameter: 100 µm

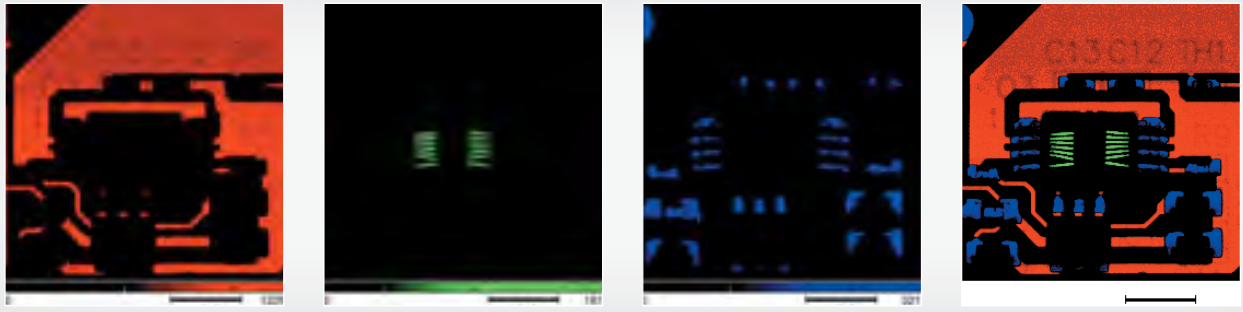
Sample Measured: Digital camera battery, measured directly.

With electronic parts encased in molded plastic, the external appearance of the parts provides no information about the internal circuit structure. With the XGT, however, transmission X-ray images can be used to check the internal structure. After the location of the defect has been identified, X-ray mapping images can be used to analyze the part's interior, and deduce the cause of the defect.

Internal observation using transmission images



Mapping results



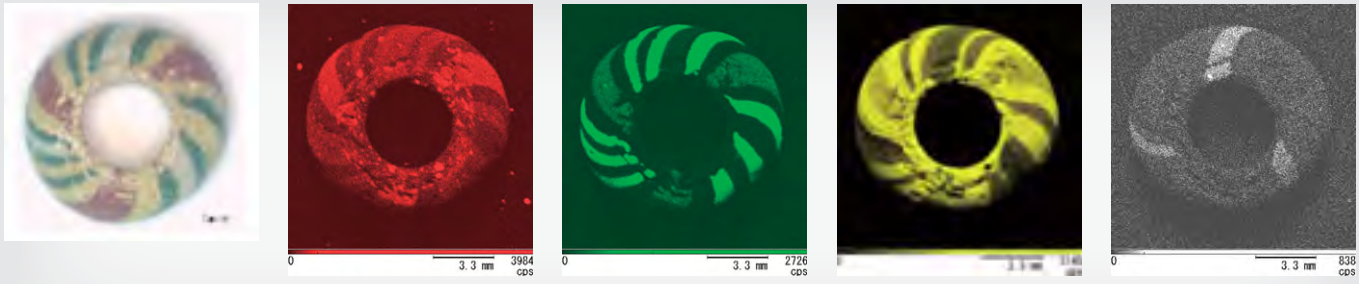
Cu-Kα | Au-Lα | Pb-Lα | RGB Composition image (R:Cu G:Au B:Pb)

Analysis of cultural assets

Measurement Conditions: X-ray Tube Voltage: 50 kV
X-ray Tube Current: 1.0 mA
X-ray Radiation Diameter: 100 µm

Sample Measured: Glass bead (Gangi-dama from the Funakiyama old burial mound)

Large samples that are difficult to divide into smaller pieces, such as rocks, can be loaded into the XGT-5200 as is (maximum sample size: 350 x 400 x 40 mm). Wide-range mapping can be performed over a maximum area of 100 mm x 100 mm. Procedures such as element segregation can also be performed easily, and transmission X-ray images can be obtained for rock samples up to 25 mm thick.



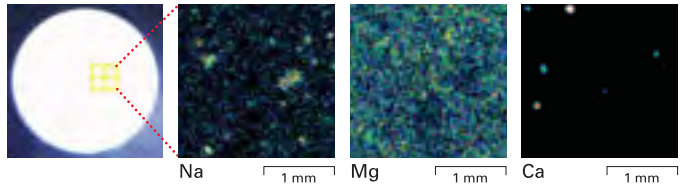
Fe | Cu | Pb | Mn

This precious sample is one of the few that can be found in Japan.

Analysis of pharmaceuticals

The full vacuum mode of the XGT-7200 offers the highest sensitivity to light elements. It provides optimized analysis conditions for pharmaceutical tablets, mineral sections, and light element alloys.

X-ray irradiation diameter : 100 µm
Mapping area : 2.5 mm × 2.5 mm
X-ray tube voltage : 15 kV

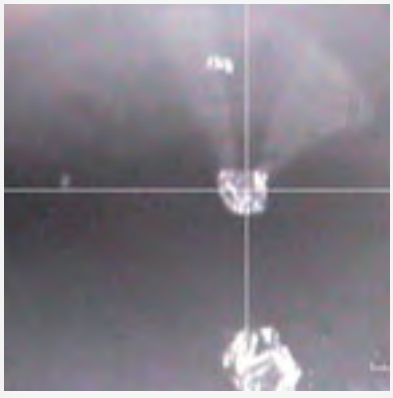


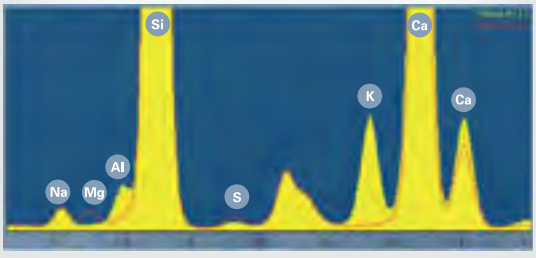
Non-destructive analysis for forensic science

Forensic scientists generally require fast and non-destructive analysis of a very wide range of materials. Often these materials are presented in very small quantities, as evidence collected from a crime scene. The elemental "fingerprint" which XRF reveals is used to identify unknown materials, match crime scene materials to those found on suspects, and provide vital information on explosive / gunpowder constituents. Furthermore, XRF mapping allows gunshot residue patterns to be observed, and paint cross-sections to be characterized.

Glass

Microscopic glass fragments are often found at crime scenes and on the clothing of criminal suspects. By analyzing the glass, it is possible to gain valuable evidence linking a suspect to a specific crime scene. The images show a 100 µm particle viewed with the XGT-7200 optical microscope, and spectra from two particles which illustrate clear compositional differences.

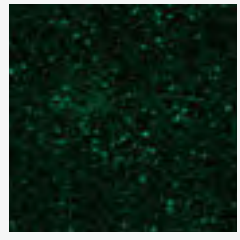




Gunshot Residue (GSR)

GSR is a mixture of explosives, propellants, and metal fragments expelled from the gun barrel during firing. Analysis of GSR composition and patterning provides information on the gun and bullets, and the proximity of the weapon when fired. Matching GSR materials on a victim and suspect can be used to assist prosecution.

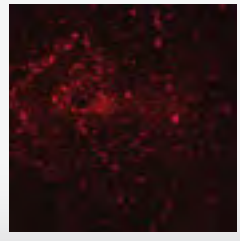

White light image


K


Fe


Cu


Ba

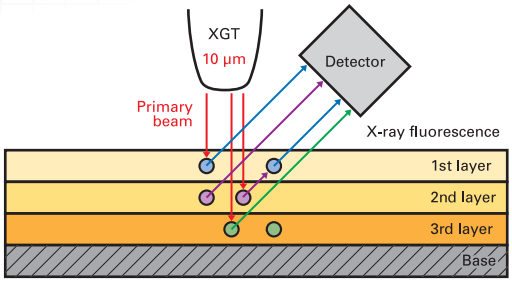

Pb

Fast thickness measurement of thin metal coatings by XGT series

The XGT series provides a fast, non-destructive method to measure the thicknesses of a multi-layered components. The combination of this method with the unique 10 µm spot size can be used to generate accurate 3D descriptions of layered components.

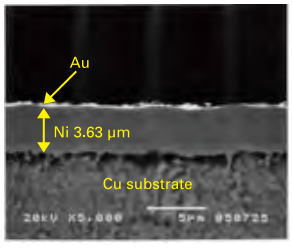
FPM thickness calculation

Knowing the order and element composition of the different layers equations can be set up, containing expressions for primary and secondary X-ray excitations for each element in each layer. These complex equations also include many physical and hardware fundamental parameters (e.g., X-ray absorption, incident beam energy and intensity, etc.). The parameters in question (eg, layer thickness and concentration) are then adjusted, and the results are compared with the actual X-ray intensities of the sample spectrum. Using iterative processing, the thickness and concentrations of each layer can be calculated.



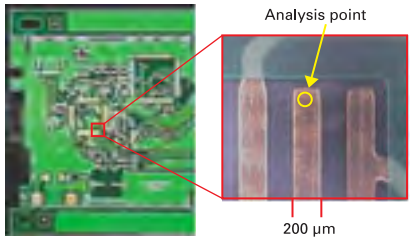
Plating thickness analysis

A bonding pad for lead-free soldering contains gold and nickel coatings on a copper base. The nominal thickness of gold ranges from 0.03 to 0.05 µm. A cross section of the specimen was prepared for observation on a scanning electron microscope, and clearly shows the nickel plating to be 3.63 µm thick. The gold is too thin to be evaluated.



SEM micrograph of cross section Au/Ni plating on Cu substrate

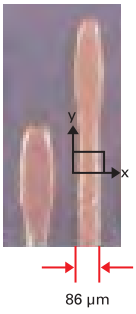
Without any destructive preparation of the sample, the XGT Series allows the thicknesses to be quickly calculated: 0.036 µm for the gold plating and 3.41 µm for the nickel plating.

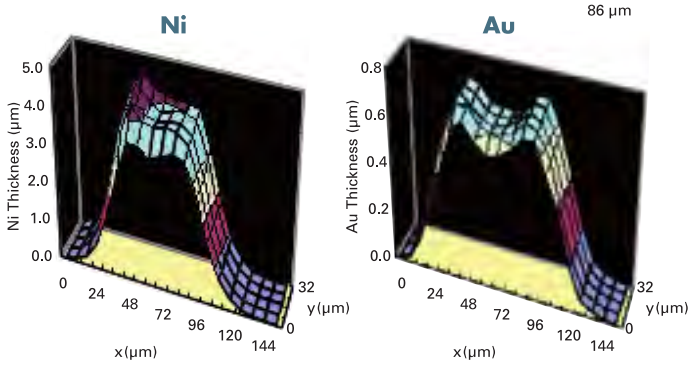


Images of a bonding pad on the circuit board, low-resolution overview camera (left) and high-resolution detailed camera (right) integrated in the XGT Series

This unique combination is applied to another pad on the board to check plating homogeneity. The measurements cover an array of points across the width of the pad (152 µm x 32 µm, 20 x 5 points).

Analysis area
152 x 32 µm²
20 x 5 points





Variations of gold and nickel layer thicknesses, acquired across the region shown in the optical image.

Multi-layer thickness analysis

Even complex multi-layered systems can be analyzed using the FPM thickness calculation module. In this packaging sample a gold plating thickness of 5 nm is expected on the very restricted area where electrical contacts should be made. The 100 µm beam available on the XGT Series allows these microscopic areas to be discretely analyzed.

FPM layer thickness results by XGT Series

String of connectors used to package the microelectronic components. Analysis point is shown by the cross-hairs,and the thickness calculation results are indicated.

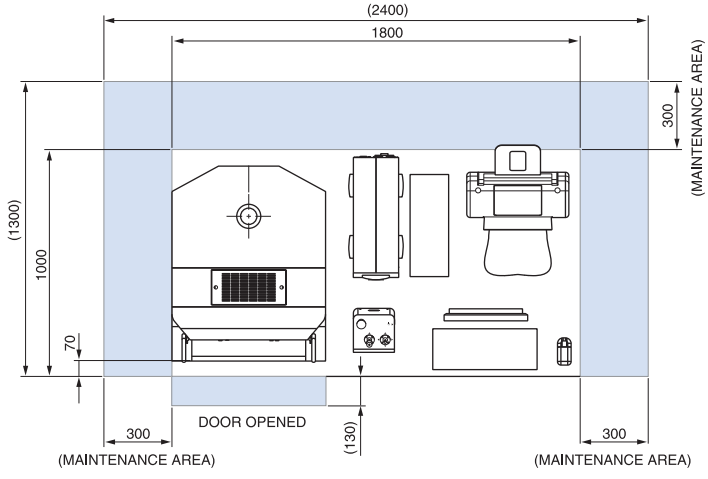
Au	5 nm
Pd	129 nm
Ni	1031 nm
Cu	99.84% +Fe0.16%

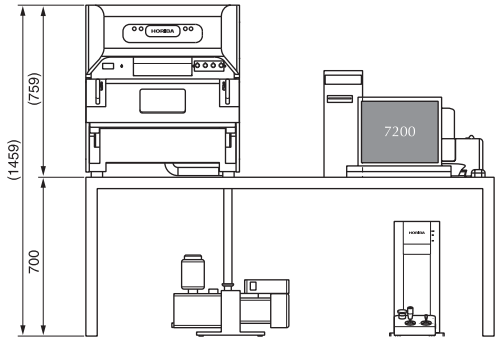
Specifications of XGT-7200

XGT-7200

Basic	Principle	Energy dispersive X-ray fluorescence spectrometry
	Detection range	Sodium ($_{11}$Na) to Uranium ($_{92}$U)
	Sample type	Solid, Liquid, Powder
Detector	Fluorescent X-ray detector	SDD (LN_2 Free)
	Transmitted X-ray detector	NaI(Tl) scintillator
X-ray generator	X-ray tube	Rh target Tube voltage: 15/30/50 kV Tube current: Max 1.0 mA
	X-ray guide tube	High intentsity mono-capillary (dual-tube combination) Standard: 10 μm + 100 μm, 1.2 mm + 10 μm, 1.2 mm + 100 μm Option: Primary filter wheel for 1.2 mm
Sample chamber	Sample Chamber Size	450(W) × 500(D) × 80(H) mm
	Atmosphere	Dual vacuum modes: Full vacuum, Localized vacuum (sample at atmosheric pressure) and air
	Sample size	340(W) × 250(D) × 80(H) mm, 1 kg or less
	Sample stage	Motorized XYZ
	Optical Image	Whole sample image: ×2 magnification Detail image: ×100 magnification Sample height image: ×2 magnification
Analysis	Data acquisition	Single/Multi point analysis, Line analysis, Grid analysis
	Qualitative analysis	Peak Auto ID, KLM marker, Peak search, Spectrum matching, Automatic qualitative function
	Quantitative analysis	FPM (No standard needed), FPM with single standard calibration, Calibration curve, Multi-layer thickness FPM (Optional)
	Mapping	XY mapping area; Max 100 mm × 100 mm
	Date Management	Data export to Excel (Option)
Utility	Power Supply	AC120 V, 220 V, 240 V±10%, 50/60 Hz
	Power Consumption	Below 1.8 kVA
	Operation	PC (Windows 7)
Dimension	Instrument Weight	Approx. 200kg (Main unit)
	Outer Dimensions	Main unit: 700(W) × 900(D) × 800(H) mm

Dimentional outlines (Unit: mm)



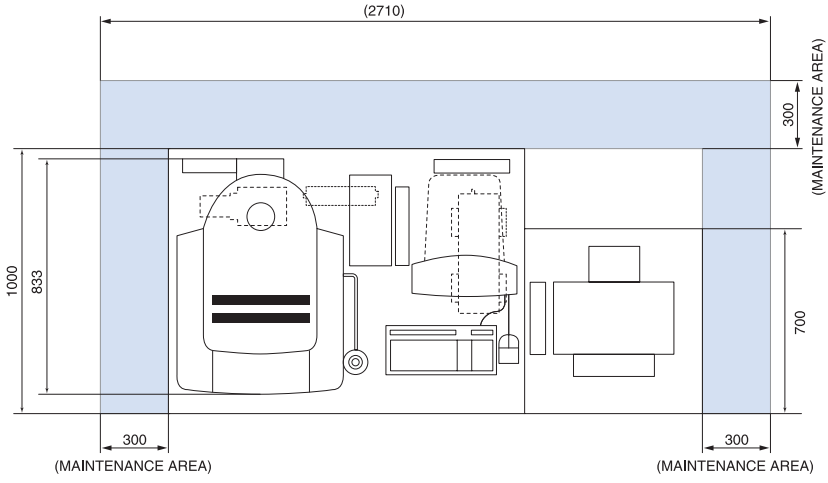


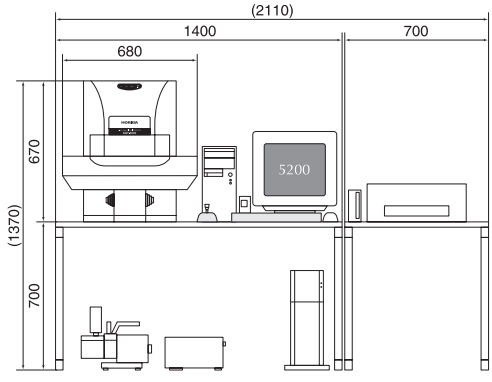
Specifications of XGT-5200

XGT-5200

Basic	Principle	Energy dispersive X-ray fluorescence spectrometry
	Detection range	Sodium ($_{11}$Na) to Uranium ($_{92}$U)
	Sample type	Solid, Liquid, Powder
Detector	Fluorescent X-ray detector	SDD (LN_2 Free)
	Transmitted X-ray detector	NaI(Tl) scintillator
X-ray generator	X-ray tube	Rh target Tube voltage: 15/30/50 kV Tube current: Max 1.0 mA
	X-ray guide tube	High intentsity mono-capillary (dual-tube combination) Standard: 10 μm + 100 μm Option: 10 μm + 400 μm, 100 μm + 400 μm, 10 μm + 50 μm
Sample chamber	Sample Chamber Size	350(W) × 400(D) × 40(H) mm
	Atmosphere	Localized vacuum (sample at atmosheric pressure)
	Sample size	300(W) × 250(D) × 40(H) mm, 500 g or less
	Sample stage	Motorized XY stage and Z axis by manual
	Optical Image	Whole sample image: ×2 magnification Detail image: ×100 magnification Sample height image: ×2 magnification
Analysis	Data acquisition	Single/Multi point analysis
	Qualitative analysis	Peak Auto ID, KLM marker, Peak search, Spectrum matching, Automatic qualitative function
	Quantitative analysis	FPM (No standard needed), FPM with single standard calibration, Calibration curve, Multi-layer thickness FPM (Optional)
	Mapping	XY mapping area; Max 100 mm × 100 mm
Utility	Power Supply	AC120 V, 220 V, 240 V±10%, 50/60 Hz
	Power Consumption	Below 1.4 kVA
	Operation	PC (Windows 7)
Dimension	Instrument Weight	Approx. 120 kg (Main unit)
	Outer Dimensions	Main unit: 680(W) × 900(D) x 680(H) mm

Dimentional outlines (Unit: mm)



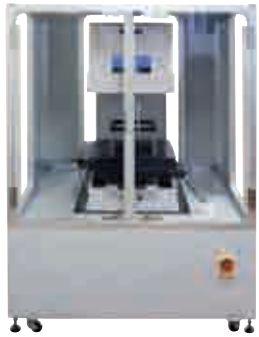


Analyzers for large-sized samples

XGT-5200 type S

with large sample chamber

Sample size:
500(W) × 350(D) × 85(H) mm
Mapping size:
200 mm × 200 mm



XGT-5200 type SL

with super-sized sample chamber

Sample size:
500(W) × 500(D) × 300(H) mm
Mapping size:
200 mm × 200 mm

＊Please ask for more information

Dedicated analyzers for WEEE/RoHS testing

XGT-5200WR

Systems include dedicated WEEE/RoHS analysis for the electronics manufacturing and supply industry

MESA-50

Small!
208(W) × 294(L) × 205(H) mm

MESA-50 can work as long as 6 hours when powered by internal battery.

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