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CT Lab

GX90 / GX130

3D X-ray Micro CT

High-speed, high-resolution stationary
sample micro computed tomography

X-ray computed tomography
for materials science

Rigaku
Leading With Innovation

CT Lab
GX90 / GX130

Rigaku
micro CT technology

Non-destructive 2D, 3D and 4D X-ray imaging for materials science

Modern laboratory based X-ray micro computed tomography (μCT or micro-CT) imaging techniques have had a major impact on materials research by enabling new ways of characterizing materials and objects. These instruments may be used to distinguish the micro-scale structure, features, composition and, to some extent, chemistry of small objects. A significant advantage over other techniques is that intact specimens may be examined without sample preparation.

The new Rigaku CT Lab GX series of micro-CT imagers provides non-destructive two-dimensional (2D), three-dimensional (3D) and four-dimensional (4D) imaging capabilities for specimens across a range of length scales, from a few microns to centimeters. Recent technological developments incorporated into the CT Lab GX series have driven improvements in resolution and contrast to levels unreachable with previous generation projection-based X-ray computed tomography (CT) instrumentation. Non-destructive imaging capabilities of high-resolution micro-CT provide unique opportunities to study samples in their native environments (*in situ*) and to quantify how their microstructures interact in 3D and over time (4D longitudinal studies).

Micro-CT as the core guide for multi-modal imaging and analysis

Rigaku CT Lab GX series delivers a set of unique imaging capabilities that synergize with correlative characterization employing conventional imaging resources, including: scanning electron microscopy (SEM), focused ion beam SEM (FIB/SEM), transmission electron microscopy (TEM), and light microscopy. With the availability of high-speed micro-CT imaging, 3D tomographic screening is now considered as a required guidepost in a variety of correlative metrology workflows. By quickly examining materials in 3D and then identifying regions of interest for closer inspection with highest resolution 3D imaging, a more complete picture of a specimen or experiment emerges. This sophisticated approach then enables most efficient use of other analytical resources (for example, light, electron, or X-ray microscopies). By simplifying the way in which areas of interest within a sample are found and analyzed, the ability to cross-correlate information from multiple analytical techniques becomes both easy to do and highly desirable.

Stationary sample micro computed tomography

With traditional micro-CT imaging systems, core parameters of speed and resolution usually required a tradeoff of one over the other. Rigaku CT Lab GX series of micro-CT imaging systems produces high-resolution images very quickly and with a relatively low X-ray dose. With scan times as low as 8 seconds, the CT Lab GX supports a workflow of up to 30 objects per hour, with acquisition, reconstruction, and 3D visualization in under one minute. This imaging system also comes with a user-friendly software package that includes exceptional visualization tools that minimize the need for third-party micro-CT software tools.

Superior field of view

Wide field of view (FOV) scanning, at 36 mm and 72 mm, allows high-resolution imaging of a wide variety of sample types. CT Lab GX series instruments have three data acquisition modes: high-resolution, high-speed and standard. In the high-resolution mode, a 4.5 µm voxel size resolution can be attained at a 36x36 mm FOV, while a 9 µm voxel size resolution can be attained at 72x72 mm FOV.

High-speed / low dose imaging

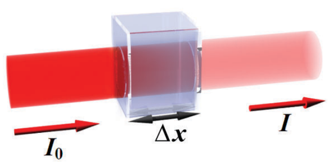
Rigaku CT Lab GX series is the fastest micro-CT system, with industry leading scan times of 8 seconds in the high-speed mode. Such rapid data acquisition means that the sample receives a minimal radiation dose. With a reconstruction time of just 15 seconds, a 3D image can be acquired and rendered in only 23 seconds.

Better workflow for high-resolution scans

CT Lab GX features an advanced workflow for creating high-resolution images from an original whole sample scan. That is, a lower resolution whole object image is typically acquired first. Then regions of interest (ROIs) are defined to reconstruct high-resolution images. The larger field of view scan offers flexibility to select ROIs for detailed study at a later stage. Sub-volume reconstructions, with various resolution settings, can be performed at an FOV defined by the user.

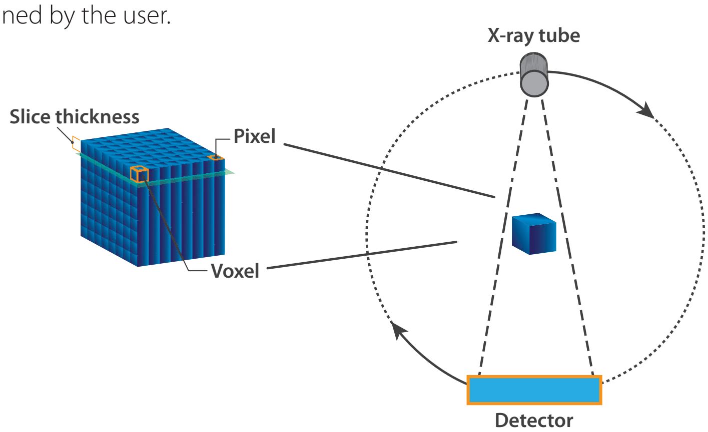
Basic theory of operation

X-ray imaging physics is based on the Beer-Lambert law, which gives for a monochromatic X-ray beam:



$$I = I_o e^{-\mu \Delta x}$$

where I_o is the incident intensity, I is the measured intensity, Δx is the sample thickness and µ is the linear attenuation coefficient of the material. The attenuation coefficient varies along the beam and depends on the local composition of the sample and the photon energy. Traditional 2D X-ray images are a projection of a large amount of information on one single plane. Resulting images may be difficult to interpret if the microstructure is complex along the thickness of the sample. Computed tomography (CT) overcomes this drawback by combining the information of many X-rays, each being taken with a different orientation of the sample in front of the detector. When the angular step between each radiograph is small, it is possible to compute the local value of the attenuation coefficient at each point of the sample from the complete set of radiographs. This information may then be transformed (reconstructed) into a 3D image.



Schematic illustration of basic design concept with stationary sample. The inter-relationship of pixel, slice thickness and voxel are shown.

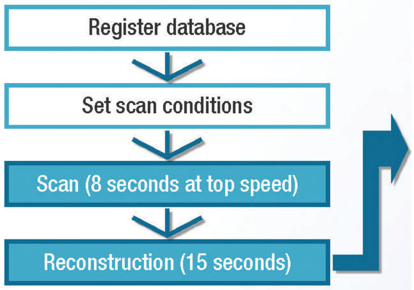
Superior speed, resolution and workflow in one instr

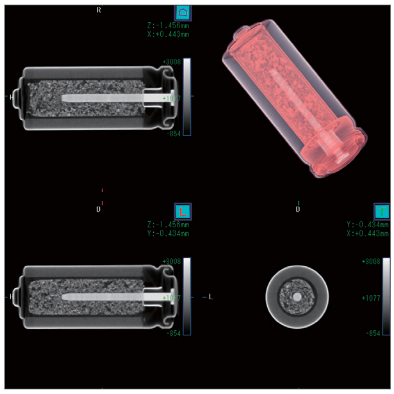
With fast and easy sample mounting, Rigaku CT Lab GX series quickly delivers high-resolution 3D reconstructed images, providing the perfect solution for research and development (R&D) applications or at-line/near-line production quality control. With a micro-CT scan in as little as 8 seconds at top speed, coupled with resolving power down to 4.5 µm and the availability of a wide view imaging function, this new instrument delivers a paradigm shifting level of performance. For superior productivity and enhanced workflow, a 2D high-resolution live mode (with a recording function) is available to allow for operation as an even faster radiographic imager.

High speed

High-speed scan in 8 seconds/
High-speed reconstruction in 15 seconds

- Ready with scan modes from top speed in 8 seconds up to high-resolution mode in 57 minutes
- Image observation available in high-speed mode with reconstruction in just 15 seconds



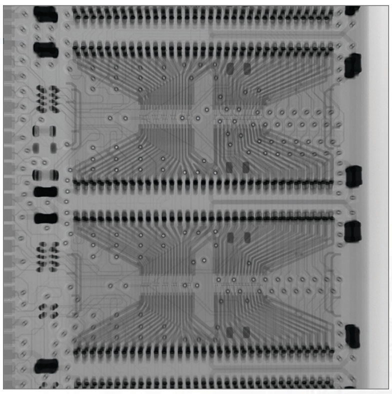


Internal structure of battery

High resolution

Resolution of 4.5 µm at minimum

- Resolution can be selected from 4.5 µm to 144 µm
- Available to use as high-speed computed radiography by the live 2D mode and can be also used for 2D function *in-situ* dynamic observation



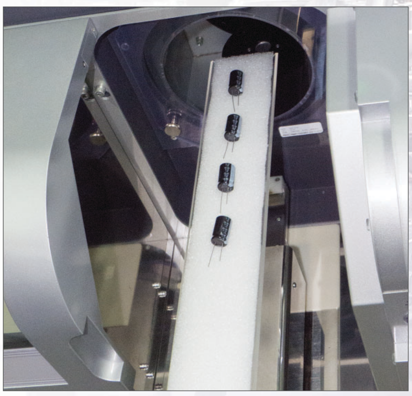
2D image of PCB

4.5 µm image of PCB parts

High performance

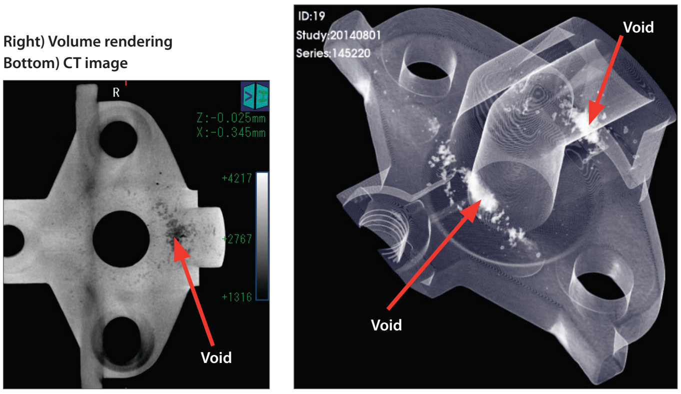
Sample-stationary CT scan

- Quick and easy sample mounting
- High-speed operation from database registration to sample scan, image reconstruction, and CT observation
- Ease-of-use enabled by icon operations
- Includes 3D volume rendering software as standard



rument!

Right) Volume rendering
Bottom) CT image

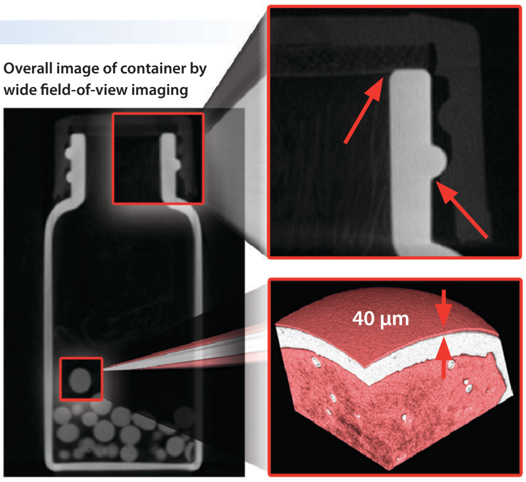


Observing the nest of aluminum die casting

Overall image of container by wide field-of-view imaging

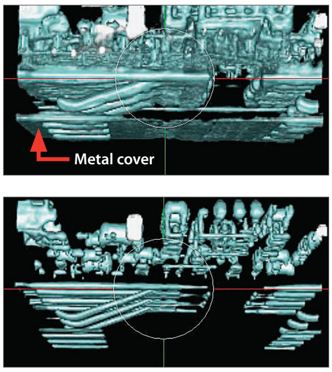
Observing the state of sealing

Observing the structure of pill by 4.5 µm imaging



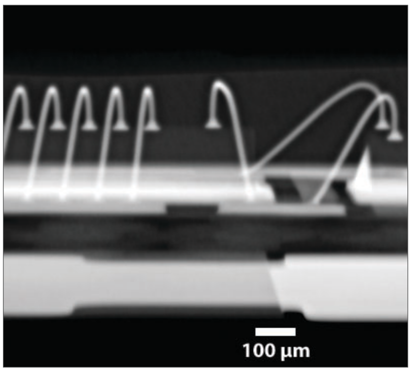
Observing the fitting area of the container and pills

Metal cover



Observing the defect of frame by adjusting the density threshold and eliminating the metal cover

Observing the PCB sample



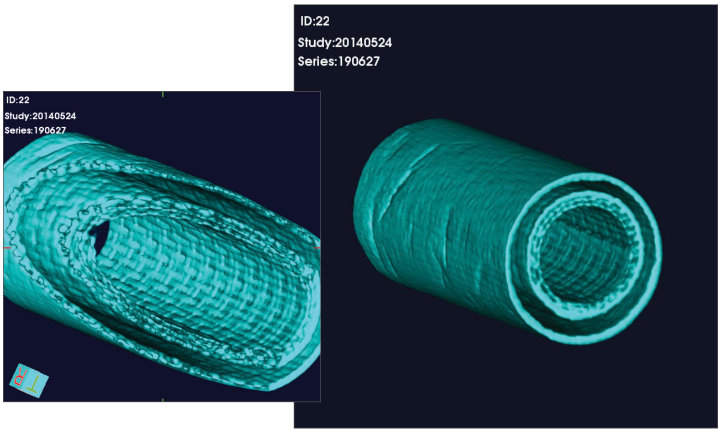
Radiography image of electrode of Li-ion battery for cell phones

Applications and examples

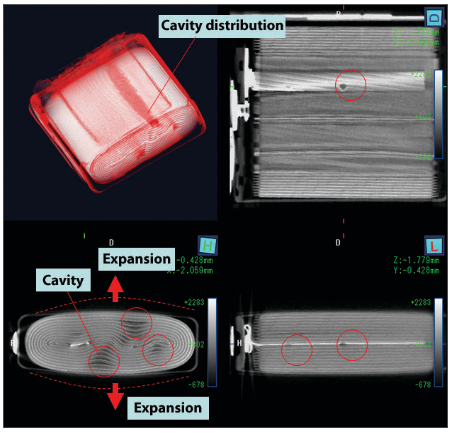
Overview of materials science applications

Rigaku CT Lab GX series delivers superior 2D, 3D and 4D X-ray imaging to enable innovation and analysis across a wide range of fields in materials analysis engineering or research. Rapid non-destructive visualization of microstructural features, across diverse sample types and applications, is at the core of the value proposition of this instrument. Typical CT Lab GX series applications include, but are not limited to, the following:

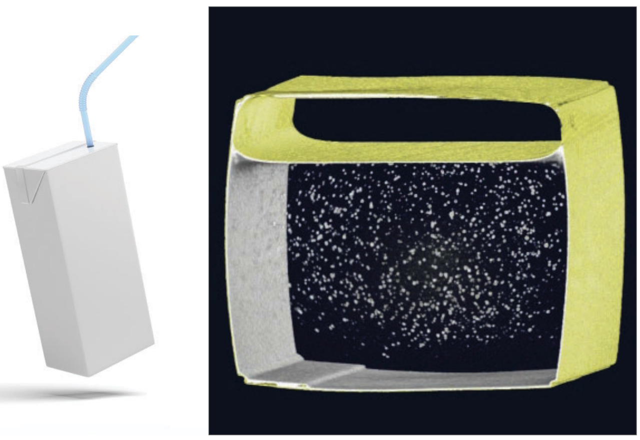
- **Energy storage devices**
  - 4D changes in microstructure
  - voids, porosity, defects
- **Plastics and polymeric materials**
  - internal structure, pore characterization
- **Structural materials**
  - structure-property relationships
- **Metals and alloys (small pieces)**
  - voids, cracks, defects and deformations
- **Archaeological science**
- **Industrial materials**
  - pharmaceuticals, food science, semiconductor
  - components, aerospace, medical devices
- **3D printed materials**
  - quality control, 4D aging studies
- **Natural materials**
  - drilling cores, mineral specimens
- **Electronics**
  - Failure and structural analysis
- **Forensic materials science**



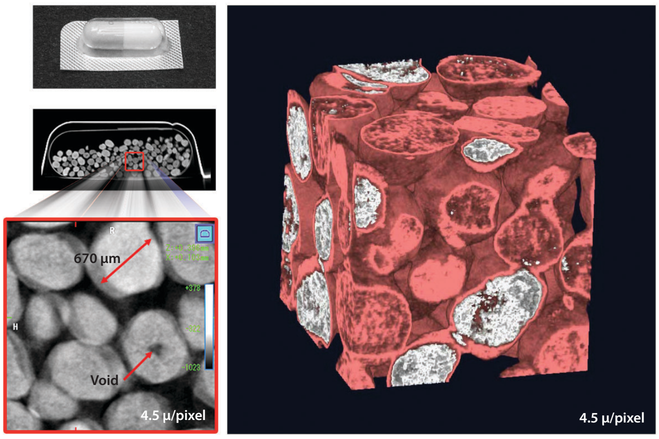
Carbon fiber reinforced plastic (CFRP) part was imaged in 18 seconds. Structure of carbon fiber is clearly observable.



Defective lithium-ion battery showing distribution of cavities and expansion from buildup of gases.



Structure of beverage container is clearly observed. Utility of stationary sample feature is demonstrated as there is no blurring of contents.



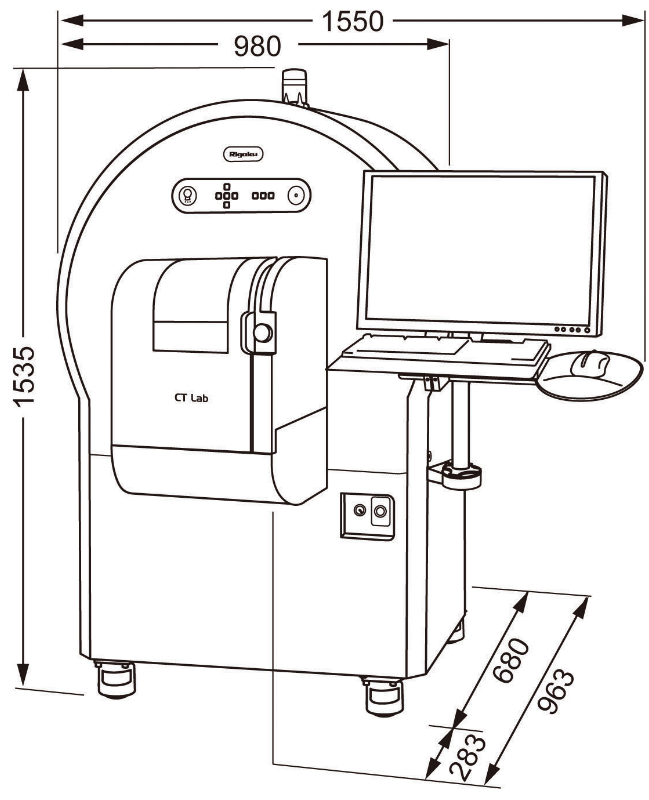
2D and 3D images of a pharmaceutical capsule are shown. Detail of contents is clearly discernible.

Specifications

Type		GX90	GX130
X-ray source	Tube current	~90 kV	~130 kV
	Maximum power	~200 µA (8 W)	~300 µA (39 W)
Detector	Type	Flat panel detector	
CT gantry	Bore size	163 mmØ (Max.)	
	Scanable range	240 mmØ (Max.)	
CT Image	Field of view	72 mmØ (Max.)	
	CT image reconstruction	15 sec. (Min.)	
	Resolution	4.5 µm (Min.)	
	Number of pixels	512 x 512 ~ 8000 x 8000	
Live image	Movie	60 fps (Max.)	
	Photo	16.7 msec. (Min.)	
CPU	OS	Windows® 10	
	Memory	32 GB	
	HDD	512 GB + 2 TB	
Image analysis	2D	Movie, still image, recording function	
	3D	Image measurement function Volume rendering function 3 surface cross section view function	
Installation condition	Power supply	100 – 120 VAC, 1-phase, 15 A 200 – 240 VAC, 1-phase, 8 A	

Specifications and appearance are subject to change without notice.

Unit: mm



Weight: 450 kg

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Rigaku micro CT technology

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CT Lab_brochure_en_Ver4_2019.05.28