3D X-ray micro CT
CT Lab HX

1. Introduction

Recently, products development, failure analysis of electronic devices and quality control requirements has increased demand for X-ray CT 3D image viewing analysis. Powerful CPUs and GPUs have greatly improved computer processing throughput for this technique.

Rigaku has been contributing to the fields of drug discovery and development, preclinical testing, and animal diagnosis since releasing a 3D X-ray micro CT for laboratory animals in 2006 and a CT for animal hospitals in 2013. In 2015, Rigaku launched both the "nano3DX" sub-micron-level resolution X-ray microscope and the "CT Lab GX" industrial materials analysis 3D X-ray micro CT. Since then, Rigaku has been providing nondestructive 3D materials structure analysis solutions and failure/dislocation analysis solutions for electronic devices, resins, and so on.

"CT Lab HX" is a benchtop 3D X-ray micro CT for wide FOV (Field of view) and high-resolution imaging and more, developed by taking advantage of Rigaku's unique CT engineering experience developing 3D X-ray micro CT instruments for industrial materials analysis. "CT Lab HX" is a versatile CT system, having applications as diverse as examining electronic devices and metal casting, to merchandise inspection and performance tests, to basic research and development in medicine and medical treatment, to industrial applications for examining resin, bones, minerals, and so on.

2. CT Lab HX Features

2.1. Wide field of view (FOV) imaging

"CT Lab HX" has a compact size of 980 mm (W) × 700 mm (D), but realizes a Focus to Detector Distance (FDD) of 430 mm. A large, highly precise rotation stage (max. diameter 200 mm) and a vertical range of 150 mm allow imaging with a max. ϕ200 mm × 150 mm FOV and 5 kg weight sample (without XY stage).

"CT Lab HX" is equipped with a 150 × 120 mm flat panel detector, making a wide scope of ϕ106 mm available for standard CT imaging. Using the offset CT imaging function, a wider scope of ϕ200 mm is also available for CT imaging.

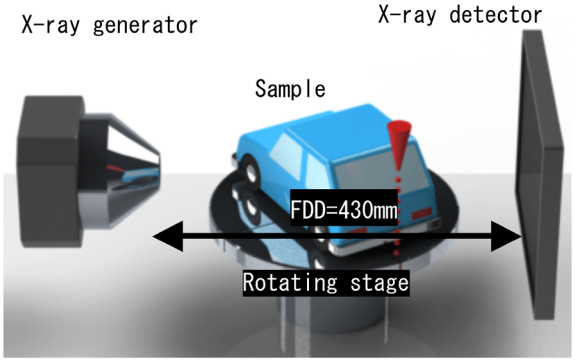

Fig. 1. Industrial 3D micro CT principle.

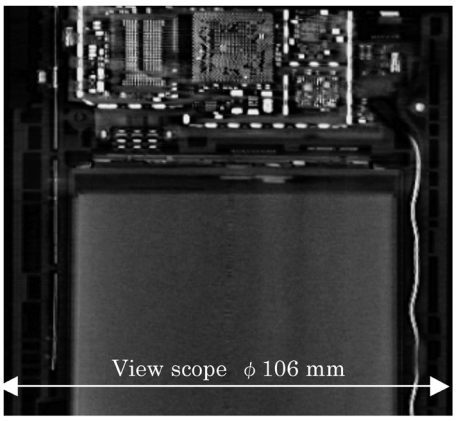

Fig. 2. Wide FOV CT imaging example: Overall failure check (Smartphone).

2.2. High resolution imaging

"CT Lab HX" has a microfocus X-ray source with a focal size of 5 μm, a high-definition flat panel detector with 2944 × 2352 pixels (pixel size: 49.5 μm), and an optical zoom mechanism achieved by shifting the sample stage and detector, making high-resolution CT imaging available.

At the highest zoom ratio (FOV: ϕ5 mm), the maximum resolution is 2.2 μm without digital zoom assistance.

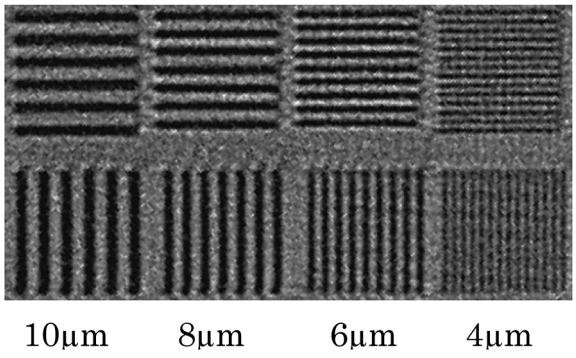

Fig. 3. CTLab HX resolution chart.

2.3. High power X-ray source

"CT Lab HX" has an industry-leading, powerful 130 kV microfocus X-ray source, and allows large sample analysis (ϕ200 × 150 mm) and high throughput, with a top speed of 18 sec for CT imaging.

It covers a wide range of samples, from resins or electronic device materials, to light metals (e.g., aluminum) by adjusting the X-ray tube voltage. It can also perform high-contrast data acquisition in long-period measurements by employing step scan imaging. The measurement time can be changed in the measurement conditions in accordance with the required application.

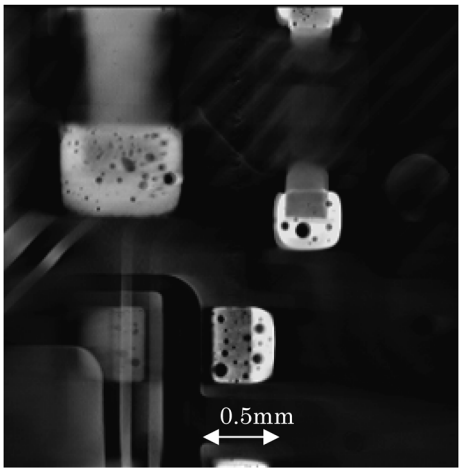

Fig. 4. High-resolution CT imaging example: (Smartphone) Observe the void in the chip bonding.

2.4. Quick operation

"CT Lab HX" software has a user-friendly control panel, with a simplified icon-based design to allow anyone to take an image.

There is no waiting time between scanning and analyzing the CT image. Because the workstation employs a graphic processing unit (GPU) to perform high-speed image restructuring, it takes only 15 seconds or less to create an image from 512 slices of data.

The system has low operating costs because it operates at AC100 V (800 VA). An office wall outlet is sufficient for power supply. There are no daily maintenance requirements, such as cooling water replacement, X-ray tube target replacement, and so on. Radiation is contained within the instrument cabinet, so an "Operations chief of radiography with X-rays" does not need to be assigned.

2.5. Beneficial application software

1) Transmission imaging

Users can observe changes to a sample over time using the X-ray transmission image movie recording function, which allows 30 fps high-throughput real time transmission imaging. Also, users can image 2.2 μm high-resolution transmission data.

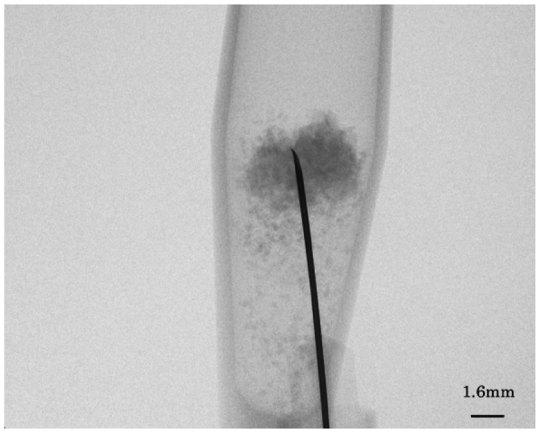

Fig. 5. Water absorbed polymer transmission image.

2) 3D image analysis

"CT Lab HX" software features 3D volume rendering as a standard item. This allows the user to perform 3D analysis while viewing the actual sample structure image.

3) Database

"CT Lab HX" software features a database to manage image data. The database provides convenient operations for image data at various steps, from registering sample information, managing imaging conditions, taking sample images, displaying CT images, to analyzing images. The database also supports exporting of data in various formats so that other general software can display and analyze data from "CT Lab HX".

4) CCD camera

"CT Lab HX" employs a sample observation CCD camera to avoid sample interference and to allow monitoring of the sample's appearance.

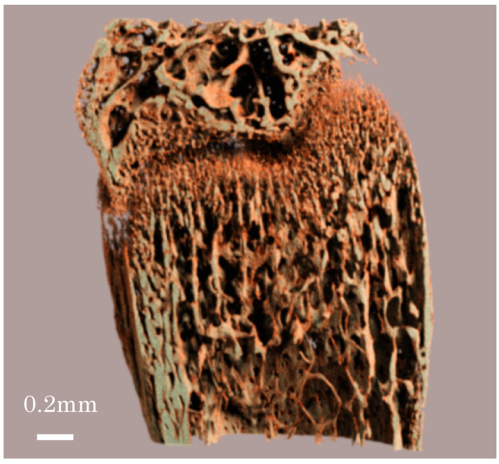

Fig. 6. Femur of mouse 3D image.

5) X, Y stage

"CT Lab HX" employs high-resolution X,Y axes to allow precise sample positioning during high-resolution imaging.

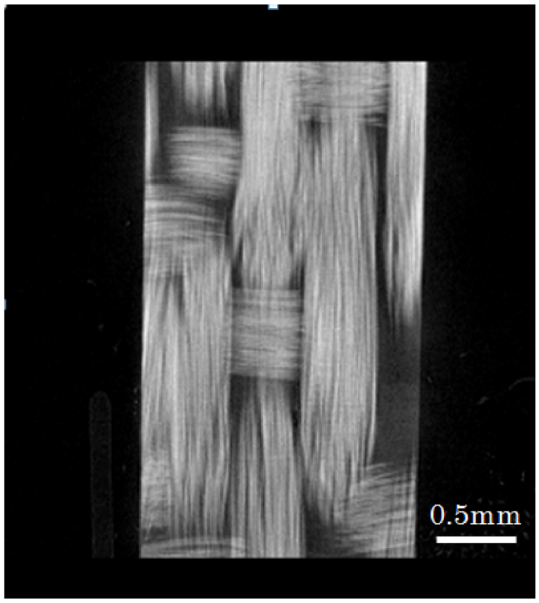

Fig. 7. Carbon Fiber Reinforced Plastics (CFRP) CT image.

3. Conclusion

"CT Lab HX" has a compact benchtop size but it is a high-performance 3D X-ray micro CT scan system with wide FOV and high resolution. Future options will expand the applicable application fields for industrial X-ray micro CT scanning by adding a temperature control attachment, a pressure attachment, more data processing options, and so on. Future system extensibility will provide "CT Lab HX" users with years of use.