Next-Generation
XSight™ Micron LC
Detector for the nano3DX: Higher Resolution, Improved S/N Ratio, and Wider Field of View
—nano3DX: Toward Higher Resolution—

Abstract

The next-generation XSight™ Micron LC detector enhances the imaging performance of the high-resolution 3D X-ray microscope nano3DX by improving system resolution by more than 40%. Since its introduction in 2012, the nano3DX has been used as an X-ray microscope capable of high-resolution, high-contrast 3D imaging with resolution down to 0.6 µm. With the new detector, resolution, signal-to-noise ratio, and field of view have all been improved, enabling more detailed visualization of fine internal structures. The next-generation XSight Micron LC can be installed in newly delivered nano3DX systems and provided as an upgrade for existing instruments, enabling current users to enhance system performance without replacing the entire microscope.

1. Introduction

The nano3DX uses a quasi-parallel beam geometry with characteristic X-rays to achieve high contrast and high resolution. It has been applied across a wide range of fields, including pharmaceuticals, biological samples, and composite materials. In recent years, however, samples are becoming smaller, more complex, and harder to evaluate nondestructively. As a result, higher-resolution imaging is increasingly required to accurately evaluate fine internal features.

To meet these requirements, improvements in both resolution and signal-to-noise (S/N) ratio are essential. The newly developed next-generation XSight Micron LC detector provides higher resolution and an improved S/N ratio compared with the previous model, while also expanding the field of view (FOV). This article introduces the key features of the next-generation detector and demonstrates its performance through practical imaging examples.

2. Features of Next-Generation XSight Micron LC

2.1 Higher Resolution and Improved S/N Ratio

In quasi-parallel beam geometry, system resolution is strongly influenced by detector pixel size and the magnification of the lens used. Reducing the effective pixel size, therefore, contributes directly to improved resolution. Compared with the previous model, the pixel size of the next-generation XSight Micron LC has been reduced by 58%, resulting in a system resolution improvement of more than 40%.

A smaller pixel size can reduce the number of X-ray photons detected per pixel, thereby lowering the S/N ratio. To address this challenge, the scintillator has also

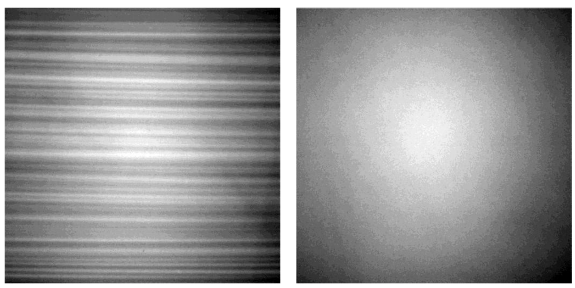

Fig. 1. X-ray images of air scattering. (Left: Previous model, Right: Next-generation model)

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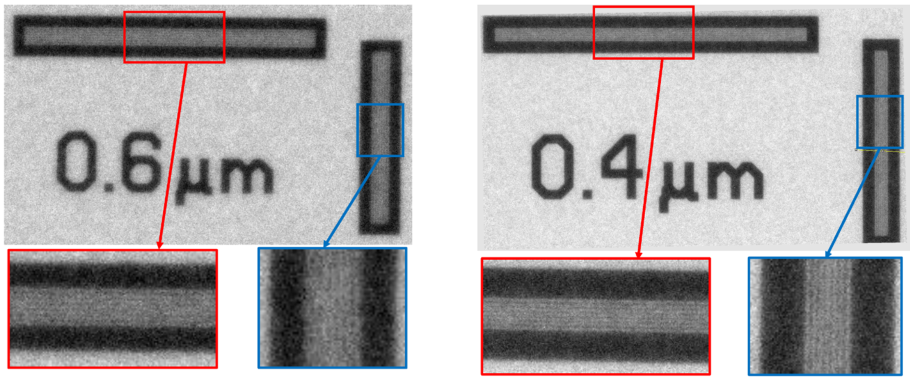

Fig. 2. Transmission images of JIMA RT RC-02B resolution chart. (Left: Previous model, Right: Next-generation model)

been improved for the XSight Micron LC. Compared with the scintillator used in the previous model, the next-generation scintillator provides higher brightness, lower noise, and improved spatial uniformity.

Figure 1 shows X-ray images of air scattering acquired with the previous- and next-generation detectors. Because the scintillator converts X-rays into visible light, higher light output contributes to improved image quality. The next-generation detector produces stronger visible-light output, reduces stripe-like fixed-pattern noise, and improves spatial uniformity compared with the previous model.

To further evaluate resolution performance, Fig. 2 shows transmission images of a JIMA RT RC-02B resolution chart acquired with the previous- and next-generation XSight Micron LC detectors. The improved resolution and S/N ratio provide clearer separation of fine chart patterns. The previous model resolves patterns down to 0.6 µm, whereas the next-generation model clearly resolves the 0.4 µm chart pattern.

2.2 Wide FOV

The detection area of the next-generation XSight Micron LC has been expanded to approximately 1.8 times that of the previous model. This wider detection area captures a larger region of the sample in a single scan, enabling multiple locations or broader internal structures to be evaluated simultaneously.

Figure 3 shows reconstructed CT images of a bamboo sample acquired using the previous and next-generation detectors. With the previous model, only part of the sample's internal structure is visible within the FOV. With the next-generation model, a wider region can be captured, enabling more effective observation of the overall internal structure.

Table 1 compares the lens magnification, resolution, and FOV for the previous and next-generation models. Because the nano3DX uses quasi-parallel beam geometry, magnification is changed by exchanging lenses.

Table 1. Resolution and FOV for each lens

Lens	Magnification	Voxel size (µm)		FOV (mm)	
		Previous	Next-Gen	Previous	Next-Gen
L0270	20	0.325	0.188	φ0.66 × 0.66	φ0.90 × 0.75
L0540	10	0.650	0.376	φ1.33 × 1.33	φ1.80 × 1.50
L1080	5	1.30	0.752	φ2.66 × 2.66	φ3.60 × 3.00
L2180	2.5	2.60	1.50	φ5.32 × 5.32	φ7.20 × 6.00
L4320	1.25	5.20	3.01	φ10.63 × 10.63	φ14.4 × 12.0

3. CT Imaging Examples

3.1 Carbon Fiber Reinforced Polymer (CFRP)

CT images of carbon fiber reinforced plastic (CFRP) are shown in Fig. 4. Compared with the previous model, the next-generation model visualizes fiber morphology, internal structures, and microscopic voids between fibers with higher definition.

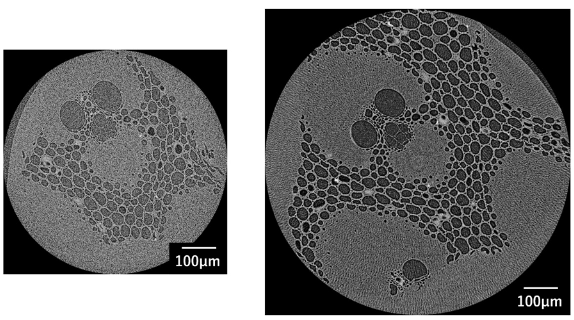

Fig. 3. Comparison of imaging size. (Left: Previous model, Right: Next-generation model)

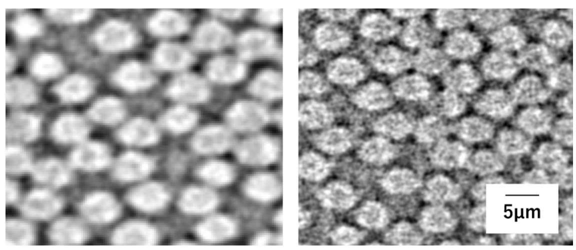

Fig. 4. CT images of CFRP. (Left: Previous model, Right: Next-generation model)

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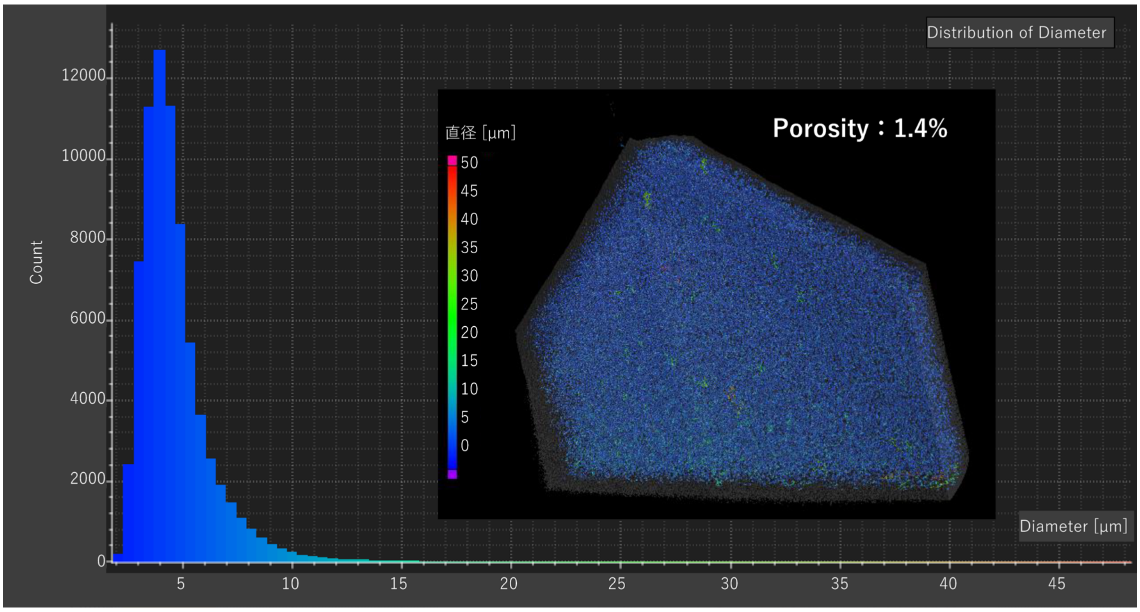

Fig. 5. All-solid-state battery electrolyte: void analysis. Sample provided by: Prof. Tatsuya Nakamura, University of Hyogo

3.2 Void observation in All-Solid-State Battery Electrolyte

An electrolyte used in an all-solid-state battery was imaged to evaluate microscopic voids. Figure 5 shows a CT image and the corresponding void analysis results. Voids smaller than 10 µm are clearly visualized, and the void size distribution indicates a peak around approximately 5 µm for this sample.

4. Conclusion

The next-generation XSight Micron LC detector enhances nano3DX imaging performance by reducing pixel size, improving scintillator performance, and expanding the field of view. These improvements strengthen nano3DX's high-resolution, high-contrast, and wide-field imaging capabilities, enabling more detailed observation and analysis of fine internal structures.

Because the detector can also be installed as an upgrade to existing nano3DX systems, current users can obtain finer structural information, evaluate a wider region in one scan, and upgrade existing nano3DX systems.

References

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