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Application News

Micro-focus X-ray CT System inspeXio^{TM} 7000

Observation of the Automotive Cylindrical Lithium-Ion Battery "4680" Using a Micro-Focus X-ray CT System

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User Benefits

- The internal structure of the "4680" cylindrical lithium-ion battery for automotive use, which is a market trend, can be observed nondestructively.
- Electrode placement and bonding condition can be verified, which is useful for product quality inspection.

■ Introduction

In recent years, with the proliferation of electric vehicles (EVs), the development of high-performance, low-cost automotive batteries has become an urgent priority. Among these, the cylindrical lithium-ion battery "4680" has attracted particular attention. Compared with the conventional "2170," the "4680" is larger, and its energy density per cell is increased, thereby extending vehicle range. In addition, the adoption of a tab-less structure reduces internal resistance, improving charge/discharge efficiency and thermal management performance, while simplification of the manufacturing process is expected to reduce cost. Owing to these characteristics, the "4680" is drawing attention across both industry and academia as a core technology for next-generation EVs.
Meanwhile, lithium-ion batteries are always subject to concerns about the risk of ignition and explosion due to internal short circuits or foreign matter inclusion. Because X-ray CT enables nondestructive testing (NDT) with three-dimensional visualization of internal structures, it is possible to detect fine defects such as electrode misalignment, separator damage, and foreign matter inclusion.
This article introduces a case study in which the cylindrical lithium-ion battery "4680" for automotive applications was observed using the microfocus X-ray CT system inspeXio 7000 (Fig. 1).

Fig. 1 Micro-focus X-ray CT System inspeXio^{TM} 7000

■ Target Object

As the imaging target (workpiece), we used the "4680" cylindrical lithium-ion battery for automotive use. The designation "4680" is a size specification for cylindrical batteries and refers to a cell diameter of 46 mm and a height of 80 mm. This workpiece is a wound-type cell with a tab-less structure.
The workpiece used in this article was provided by ATTACCATO LLC as part of Nikkei BP's "EV Teardown Project."

Fig. 2 Cylindrical lithium-ion battery for automotive use

■ Imaging Conditions

The imaging conditions for this workpiece are shown in Table 1. To perform high-magnification imaging, we divided the imaging field of view into the battery's upper end, center, and lower end. For the entire battery, we performed multi-scan (a function that automatically stitches CT data after acquisition in three separate scans).

Table 1 X-ray CT imaging conditions

Imaging Conditions	Upper end	Center	Lower end	Overall
Tube voltage	225 kV	225 kV	225 kV	225 kV
Tube current	150 μA	200 μA	200 μA	200 μA
Number of views	6000	6000	6000	2400
Number of averages	2	2	2	2
SDD	600 mm	600 mm	600 mm	600 mm
Field of view (FOV)	49.1 mm	47.8 mm	47.8 mm	55.8 mm
Voxel size	12 μm	12 μm	12 μm	27 μm
Scanning mode	Offset	Full	Full	Full
Number of scans	1	1	1	3

■ Observation results

Cross-sectional images of this workpiece are shown in Fig. 3 and Fig. 4. In cross-sectional images, materials with lower density are generally rendered darker. From the vertical and horizontal cross-sections, structures such as the positive electrode, negative electrode, and current collector foil can be observed. Additionally, if metallic agglomerates are present internally, they are rendered white.

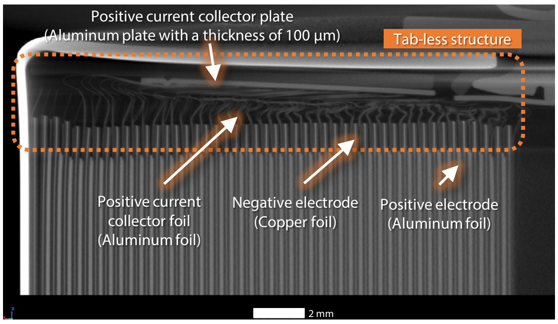

Fig. 3 Cylindrical lithium-ion battery "4680" upper end
(Vertical cross-section)

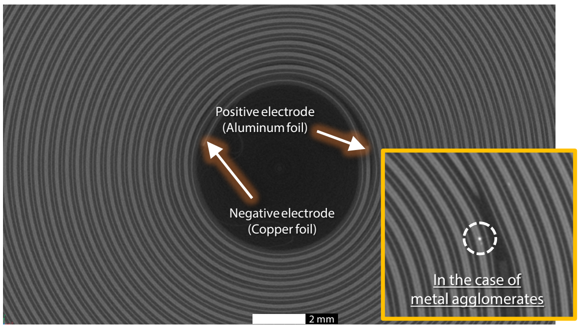

Fig. 4 Cylindrical lithium-ion battery "4680" upper end
(Horizontal cross-section)

Cross-sectional images of the upper end section, central section, and lower end section of this workpiece are shown in Fig. 5, Fig. 6, and Fig. 7, and the three-dimensional image is shown in Fig. 8. By varying the slice position in the vertical cross section, the current collector bonding areas of the positive and negative electrodes can be observed.

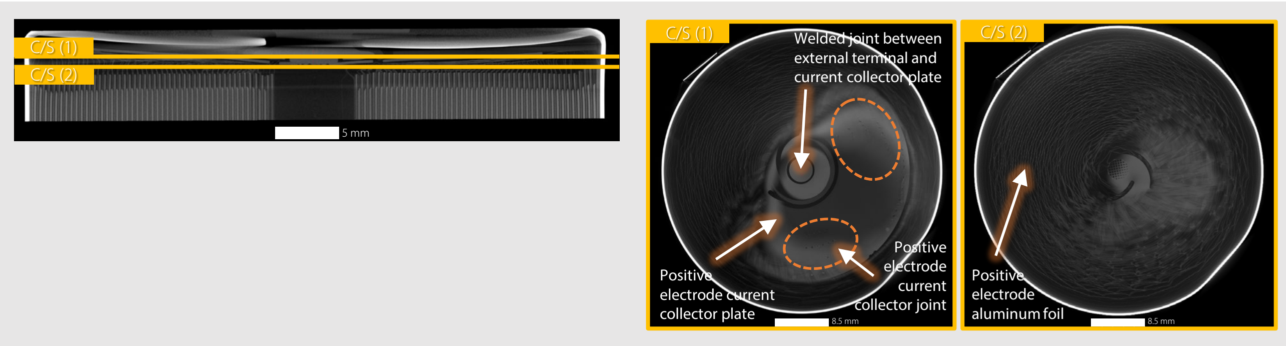

Fig. 5 Cylindrical lithium-ion battery “4680” upper end section

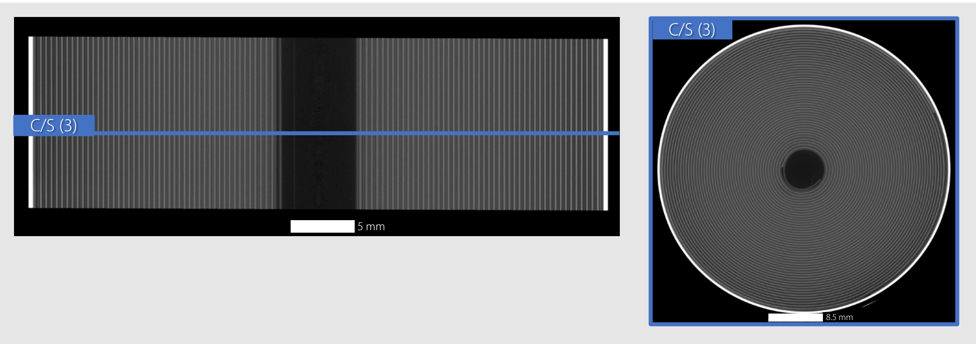

Fig. 6 Cylindrical lithium-ion battery “4680” central section

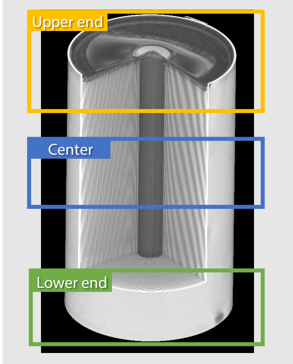

Fig. 8 Cylindrical lithium-ion battery “4680” overall (3D image)

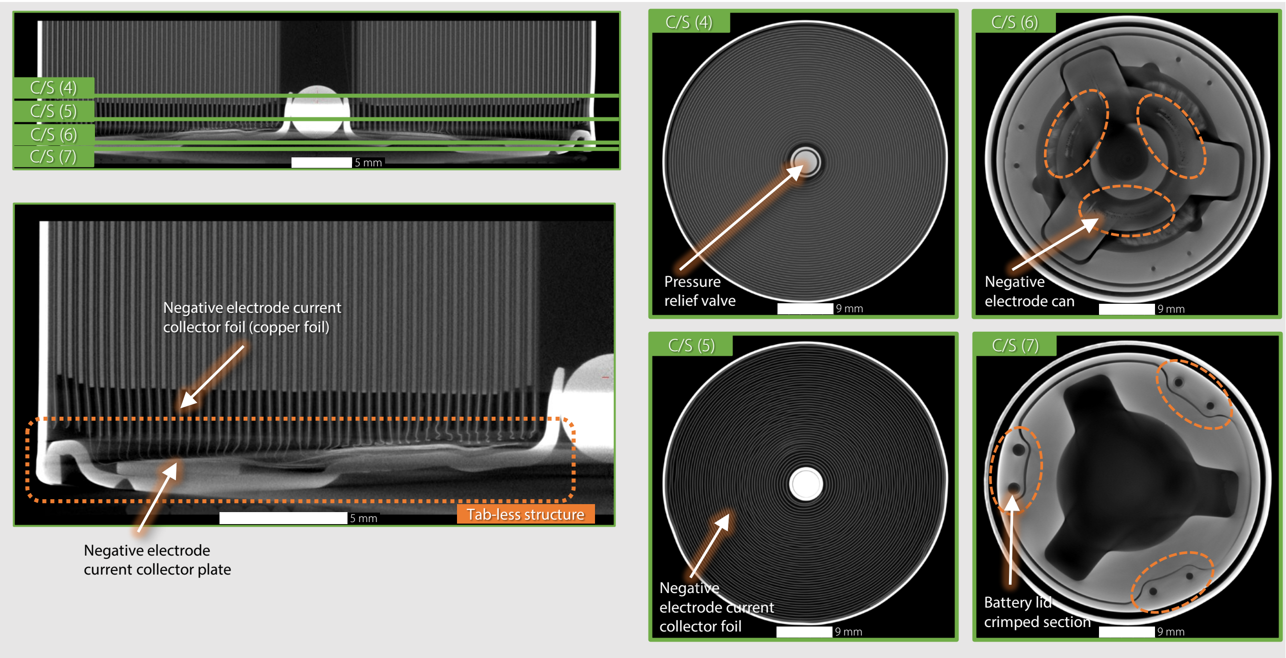

Fig. 7 Cylindrical lithium-ion battery “4680” lower end section

■ Conclusion

We presented a case study of imaging the cylindrical lithium-ion battery “4680” using a microfocus X-ray CT system. By nondestructively visualizing its three-dimensional structure, it is possible to obtain important information on the battery’s internal structure, such as the arrangement of electrodes and their bonding state. Thus, X-ray CT is shown to be a powerful tool that contributes to the advancement of battery technology.

＜Acknowledgments＞
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