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Application News

No.N124

Industrial X-ray Inspection System

X-Ray CT Observation of Lithium-Ion Battery Electrodes

Introduction

Today, rechargeable lithium-ion batteries are widely used in a variety of fields and are available in a wide range of shapes, capacities, and applications.
X-ray CT systems are able to non-destructively observe the internal structure of items. Therefore, they can be used to analyze defective batteries, compare conforming and nonconforming batteries, compare battery status before and after charging or discharging, evaluate changes in the internal structure of batteries during cycle testing, and so on. Consequently, they are often used to observe finished battery products.
In this example, an inspeXioSMX-100CT microfocus X-ray CT system (Fig. 1) was used to observe the electrodes in a rechargeable lithium-ion battery.

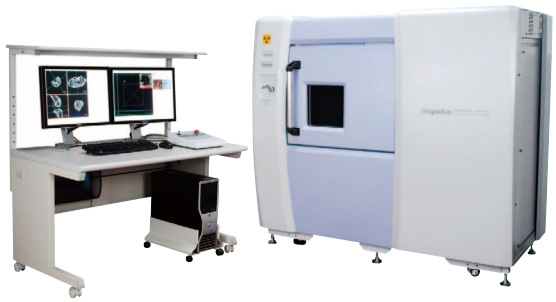

Fig. 1 inspeXio SMX-100CT Microfocus X-Ray CT System

Observation of Electrodes

In this example, to observe the electrodes in more detail, the anode material was removed from the product and cut into specimens about 2 mm wide. X-ray CT systems use the principle of image projection to change the image magnification. Therefore, to observe the electrodes in more detail, the specimen must be cut into a smaller size and moved closer to the X-ray generator (Fig. 2).

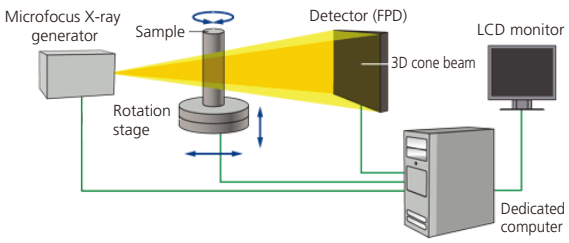

Fig. 2 Operating Principle of X-Ray CT System

MPR images of the anode are shown in Fig. 3. The MPR display mode uses multiple CT images to display any desired cross section. The cross section images corresponding to the two straight lines in the upper left frame are displayed respectively in frames to the right and below.
The copper anode plate is coated in graphite. Graphite has a layer structure consisting of non-uniformly-sized fish scale-shaped sheets. Dimensional measurement results indicate that larger graphite sheets are about 100 µm across (and about 5 µm thick, measured separately) (Fig. 4).

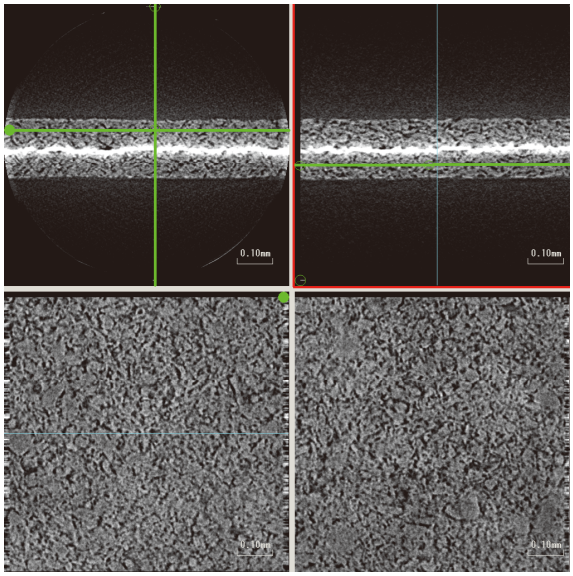

Fig. 3 MPR Images of Anode

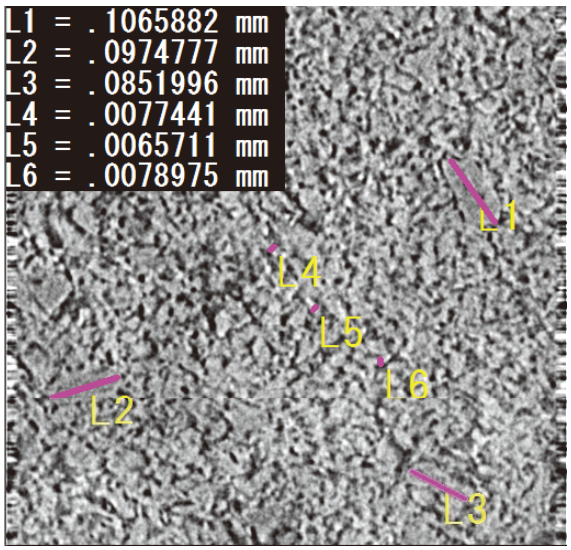

Fig. 4 Dimensional Measurement of Anode

A 3D representation of the anode observation data is shown in Fig. 5. In this figure, the graphite is colored blue to differentiate it from the copper plate, which is colored yellow. In this way, the anode can be observed three-dimensionally by displaying the data in 3D.

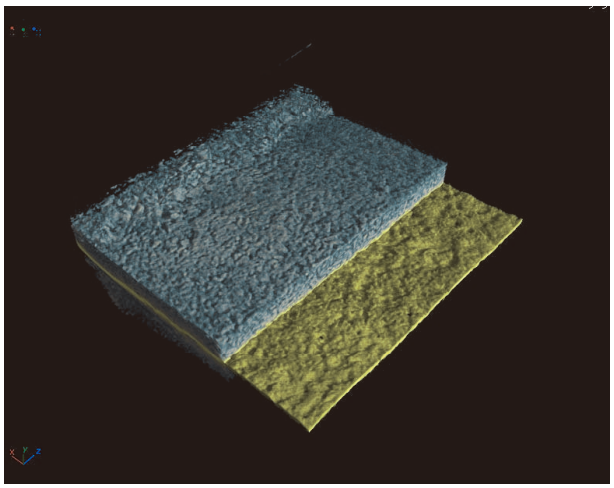

Fig. 5 3D Image of Anode

Next, MPR images of the cathode are shown in Fig. 6. The cathode was cut to a width of about 2 mm, in the same manner as the anode, before acquiring images. However, unlike the anode, it shows that the anode has a granular structure.

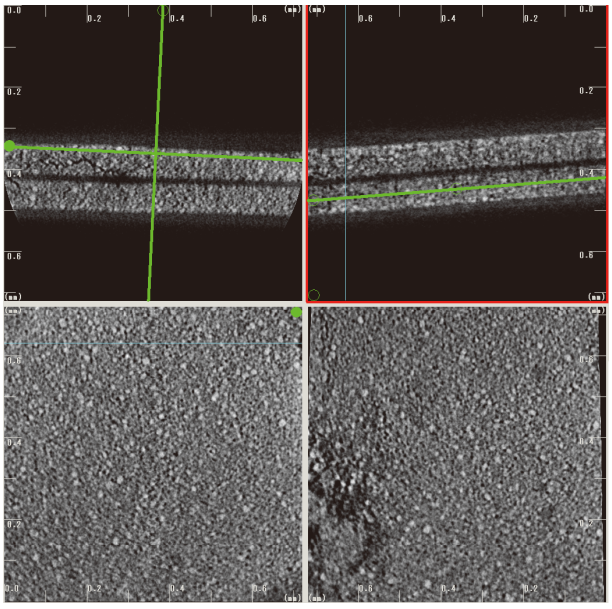

Fig. 6 MPR Images of Cathode

An example of dimensional measurements is shown in Fig. 7. It shows that the sizes of constituent particles are consistently about 20 µm. A 3D representation of this data is shown in Fig. 8. The 3D display makes it possible to confirm that the cathode has a layered structure.

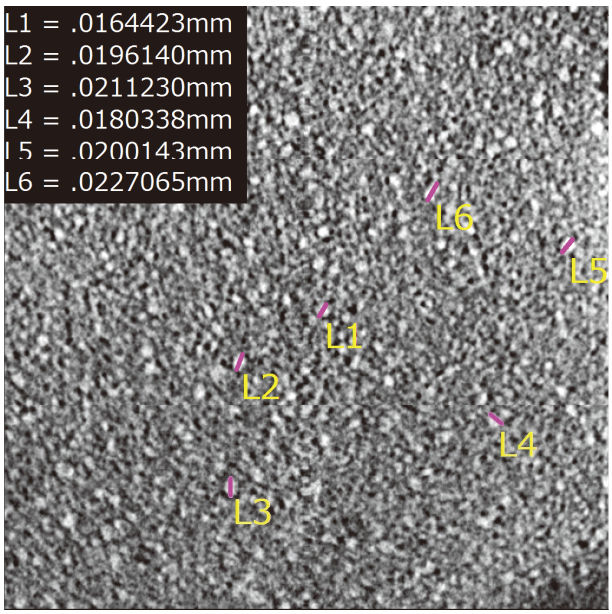

Fig. 7 Dimensional Measurement of Cathode

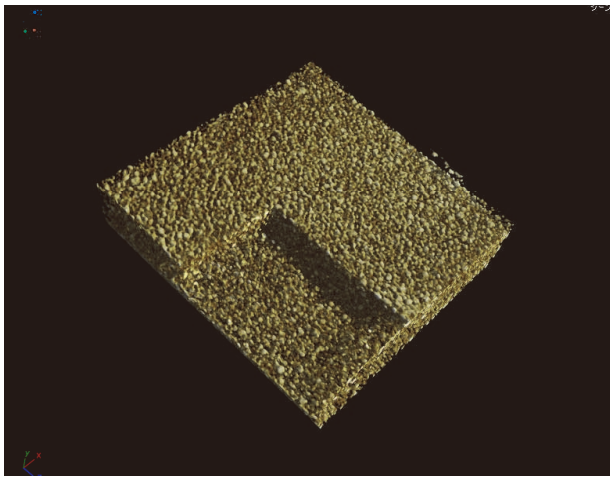

Fig. 8 3D Image of Cathode

Conclusion

The above demonstrates how the inspeXio SMX-100CT can be used for detailed observation of the electrode structure in rechargeable lithium-ion batteries. It also can be used for dimensional measurements, which can be used to easily determine the size of constituent particles, variability in particle size, thicknesses, and so on.

First Edition: Feb. 2014

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