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APPLICATION NOTE

Lithium Ion Battery Foils

Visualization of internal structure leads to improved manufacturing

A solution that implements the HeliScan microCT to visualize porosity, delamination and possible internal structural defects in Lithium Ion battery foils.

Challenge

In rechargeable lithium ion batteries, metal foil current collectors play a vital role in supporting the anode and cathode, directly influencing the batteries' performance. Improving this performance is increasingly important, as lithium-ion batteries power more and more items of our everyday life, from smartphones to electric vehicles.

An efficient and cost-effective measure to implement in any manufacturing process is to accurately identify microscopic defects in the final product. An artifact-free scanning method greatly improves this defect identification process, allowing for improvements to the manufacturing technique.

To improve the manufacturing process of lithium ion batteries, their internal structure is explored. In this example, a high-resolution scan of a large volume of the Lithium Ion battery foil sample was acquired. Typically, these samples are run on conventional micro CTs with a cylindrical acquisition method that does not allow for scanning of the sample in only one sweep. However, due to the Thermo Scientific™ HeliScan™ microCT's helical single-scan ability, it is possible to avoid such artifacts induced by stitching of multiple circular scans.

Method

The sample was cut into two smaller pieces, which were then mounted on a glass tube sample holder. To avoid damaging and/or peeling off the electrode layers, firstly +/- 10 × 20 mm piece of the foil was cut off, covered from both sides with the sticky tape, followed by more precise cutting of the +/- 2 × 6 mm samples. Two cathode and two anode samples were then stacked together and glued to the glass post.

Scan parameters

- Tube voltage: 60 kV
- Voxel size: 1 µm
- Scan type: Double Helix
- Total scanned volume: 2.6 × 2.6 × 3.6 mm (Aspect ratio: 1.4:1)
- Scan time: 1 hour

Results

Figure 1 shows the mounting of the sample on the left, while the microCT-based visualization of the Li battery foils sample is displayed on the right.

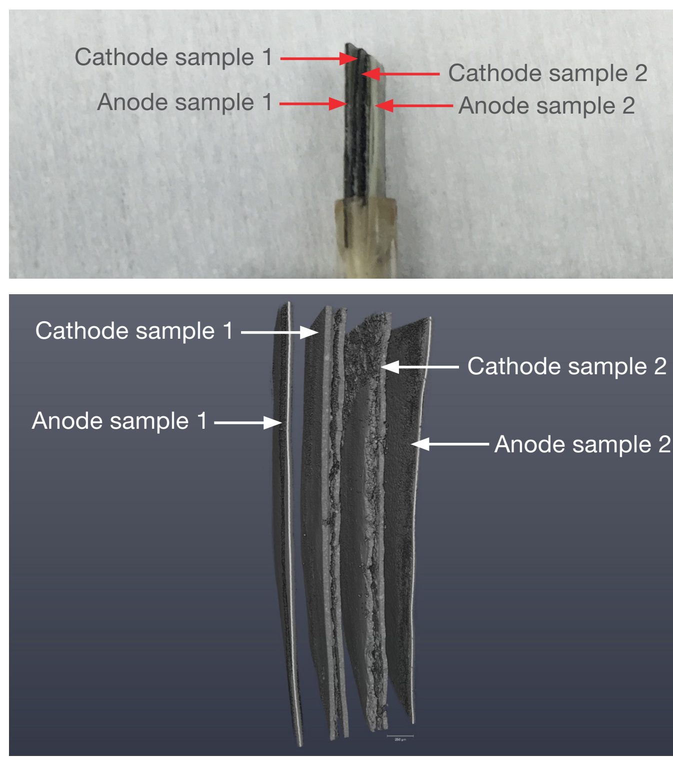

Figure 1. Digital image and microCT-based 3D visualization of the scanned anode and cathode samples.

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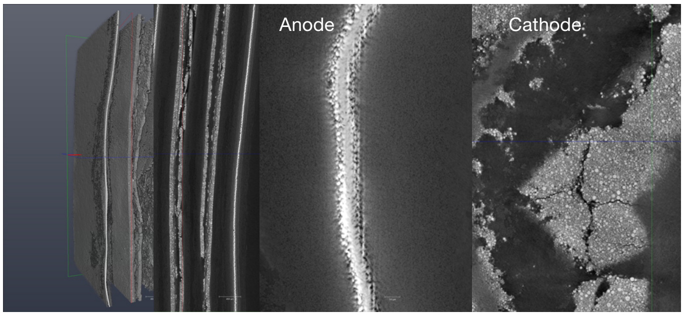

Figure 2. microCT-based 3D visualization of the Li battery foils sample.

In Figure 2, the two images on the left show the microCT-based 3D visualization of the Li battery foils sample, while the two images on the right show the microCT-based 2D visualization of the anode and cathode internal structures.

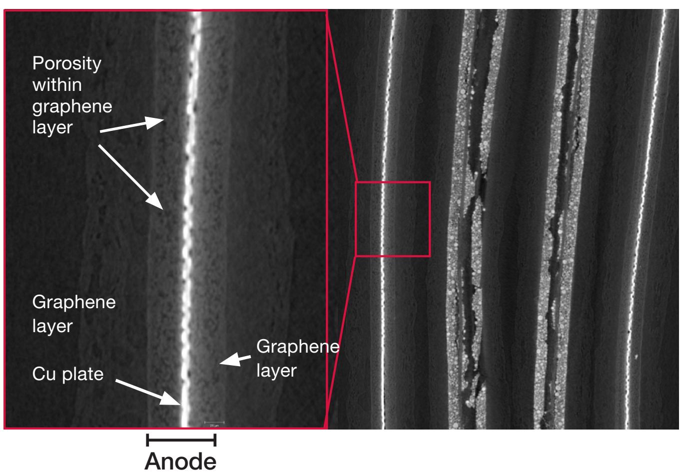

Figure 3. microCT-based 2D visualization of the anode internal structure.

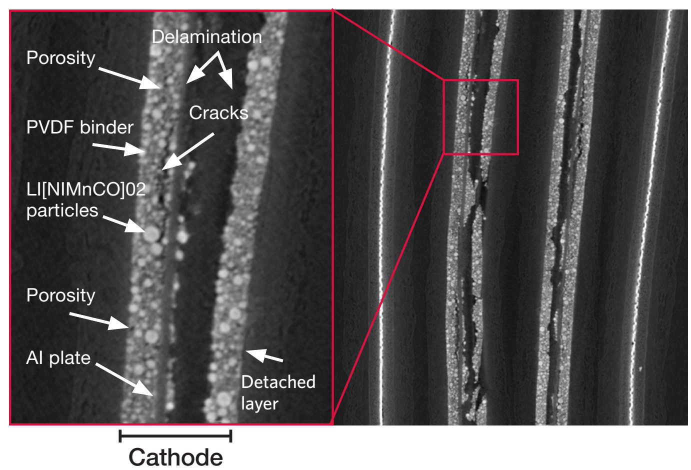

Figure 4. microCT-based 2D visualization of the cathode internal structure.

Figure 3 displays the detection of porosity in graphene layers. Different components can be seen within the sample (see Figure 4). Delamination and longitudinal cracks were also visualized.

In Figure 4, the pores (voids) are shown in red while the dense particles are colored blue.

Conclusion

HeliScan microCT-based visualization of the Li battery foils revealed the internal porosity present in the anode foil, as well as the layers' delamination and unexpected longitudinal cracks within the cathode structure. The latter was not seen before; therefore, obtained results can be used for further improvement of the manufacturing process.

Sample courtesy Prof. Joachim Mayer, RWTH Aachen University.

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