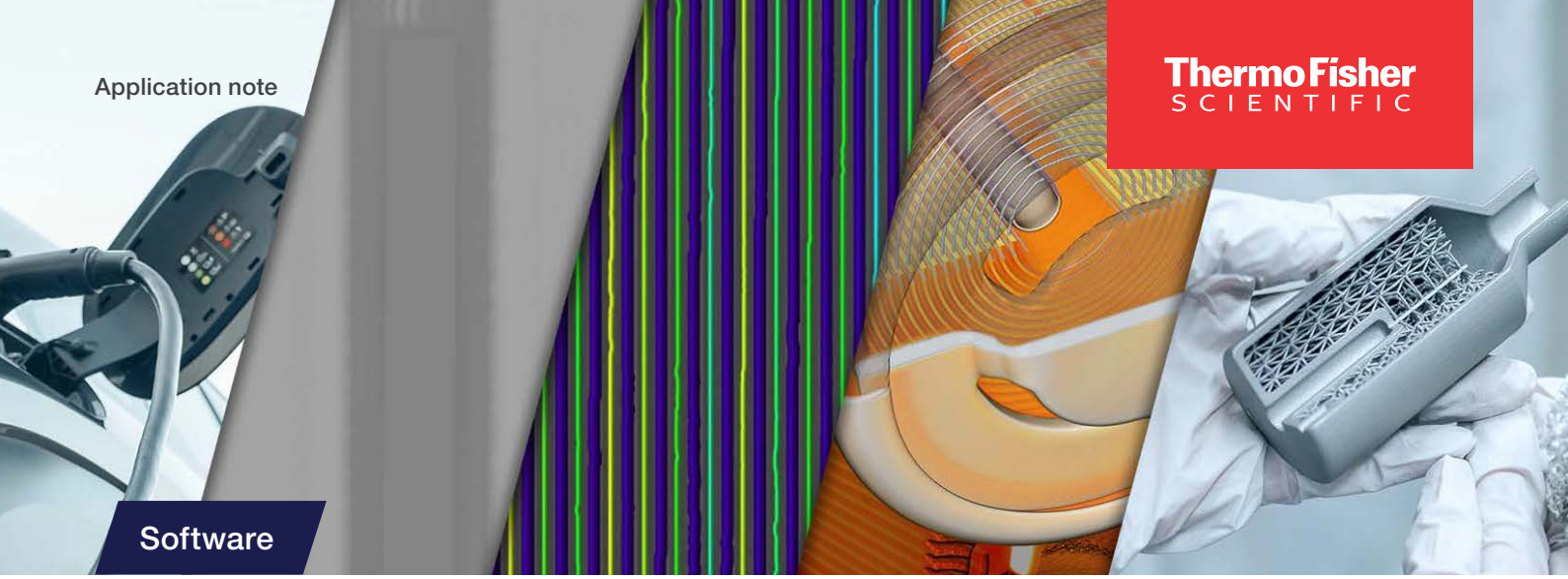
Application note



Software

Analyze Lithium-Ion battery cells at macro scale

Packaging inspection, cell component measurements, aging analysis

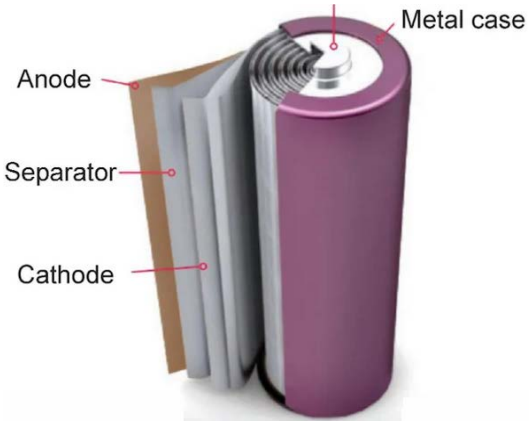
When designing and manufacturing batteries, it is of utmost importance to understand performance by looking at parameters such as transport properties at the micro level. But being able to track defects during the production process or understanding how charging cycles are affecting the conformation of different battery components at the macro level is equally important.

It is challenging to perform the necessary analysis in a consistent and easy way. Organizations struggle because they usually must use several software solutions to go from visual inspection to actual measurements of the battery components. All this information is ultimately used to detect defects faster and with higher accuracy.

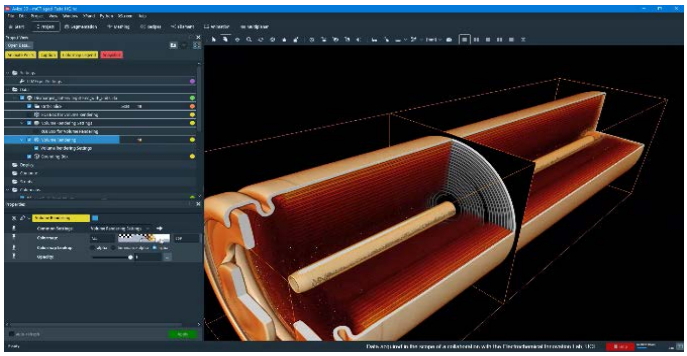
Visual inspection and movie generation of a cell

The first step when looking at an entire cell is the visual inspection. During this process, and once the cell has been imaged, it is necessary to explore the data in 3D, and quickly and easily highlight the different materials in a visual way. Sometimes, these steps will be enough to come to a decision on specific projects. At this point, it may be necessary to present the visual inspection to other people who don't have access to the software or know how to use it, through snapshots or even with video.

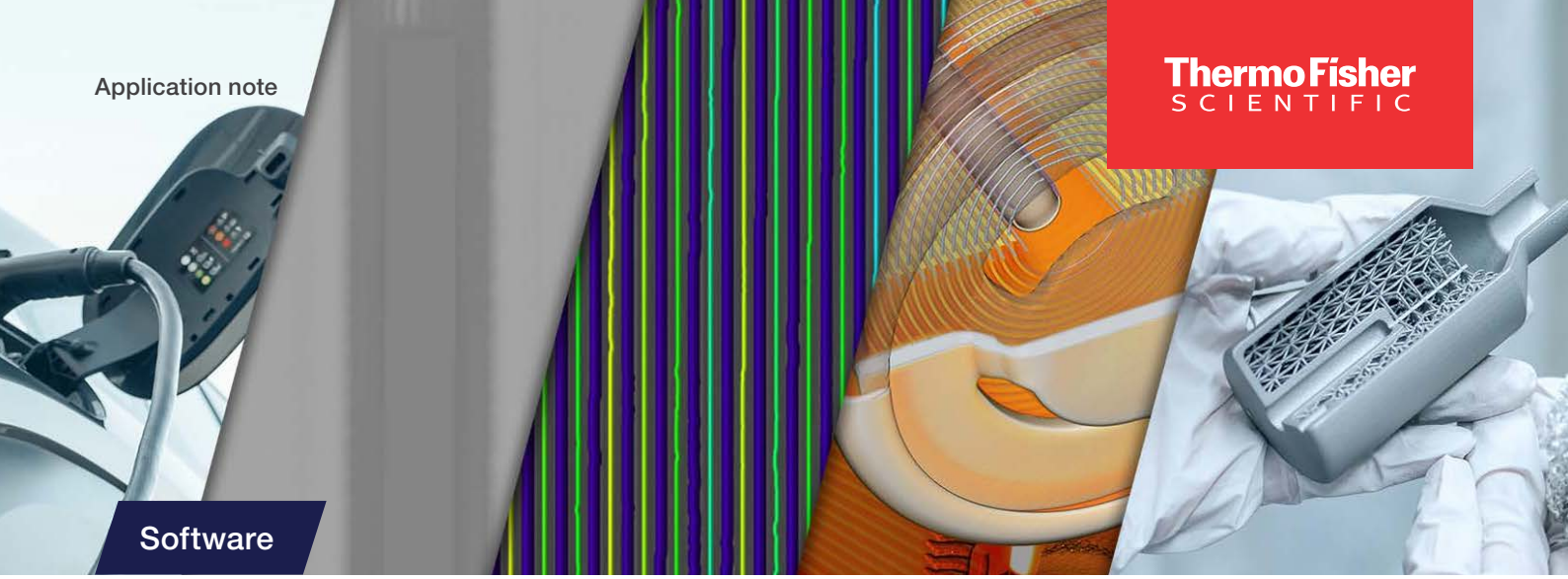
Thermo Scientific™ Avizo™ Software embeds all the tools that allow you to do just that, including an animation and movie editor, and can support a wide variety of file formats.



Once the dataset has been imported, the data usually needs to be prepared for analysis using image enhancement tools to "clean" it and make it ready for analysis. After the image is enhanced, and before analysis can be performed, the individual features need to be identified. This is called "segmentation" and many segmentation tools are available in Avizo Software. These tools range from manual to fully automated, they can be combined, and they include the ability to train a deep learning model which can be used for fully automated segmentation of the various components of the battery.



Application note



Software

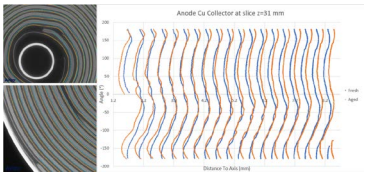
Segmentation and measurement of a cell

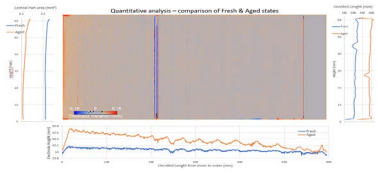
After the initial visualization, it is time to perform measurements on the components of the battery. Once segmented, each feature is individually identified. From there, analysis and classification may be performed through measurement and quantification. Many different parameters may be defined such as radial distance, length, and height, and you may also customize them according to what your organization needs. In this example, once the different components of the battery were identified, we were able to perform measurements. Once the workflow has been created, it's easy to automate it and replay it on future scans of the same type of batteries.

Thanks to the capabilities of Avizo Software, users can even without image processing expertise, segment all components and get measurements, such as anode or cathode height, in a reproducible and automated way, therefore dramatically increasing the analysis throughput.

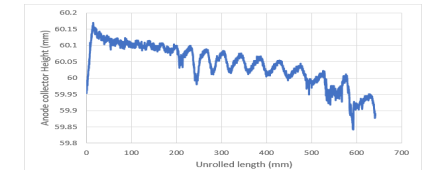
Because of all the steps that allow users to identify and measure the different components in the battery, for example electrode thickness and anode collector height, and which may be automated, it is straightforward to compare the differences between a fresh battery and a used battery.

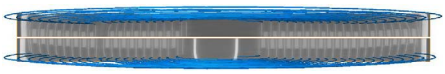
Two images are used as input in Avizo Software for this purpose: one of a fresh battery and the other of a used battery of the same age. Avizo Software was used to quantify morphological changes of the components and detect package defects such as core leakage. Avizo Software contains specific tools for in-situ experiments thanks to Digital Volume Correlation capabilities, or DVC. The DVC solution proposed with Avizo Software provides the most comprehensive package to help you in your strain and stress analysis.

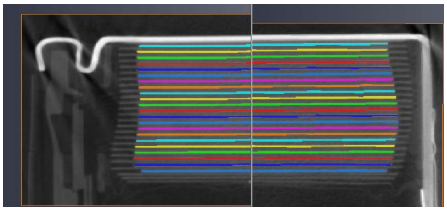


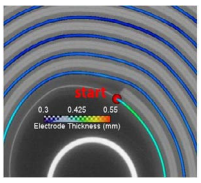


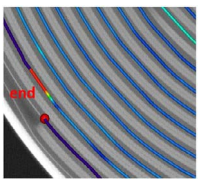
In sum, it is now possible to visualize, identify, and measure battery materials within cells, to assess how charge and discharge are affecting them, and to detect defects faster and with higher accuracy.

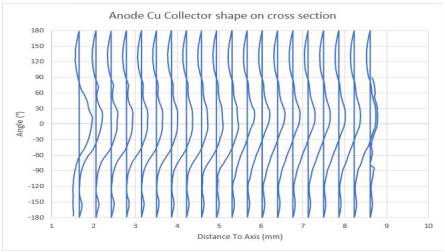


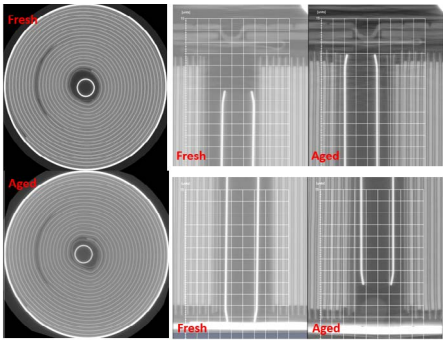












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AN0200-EN-06-2022