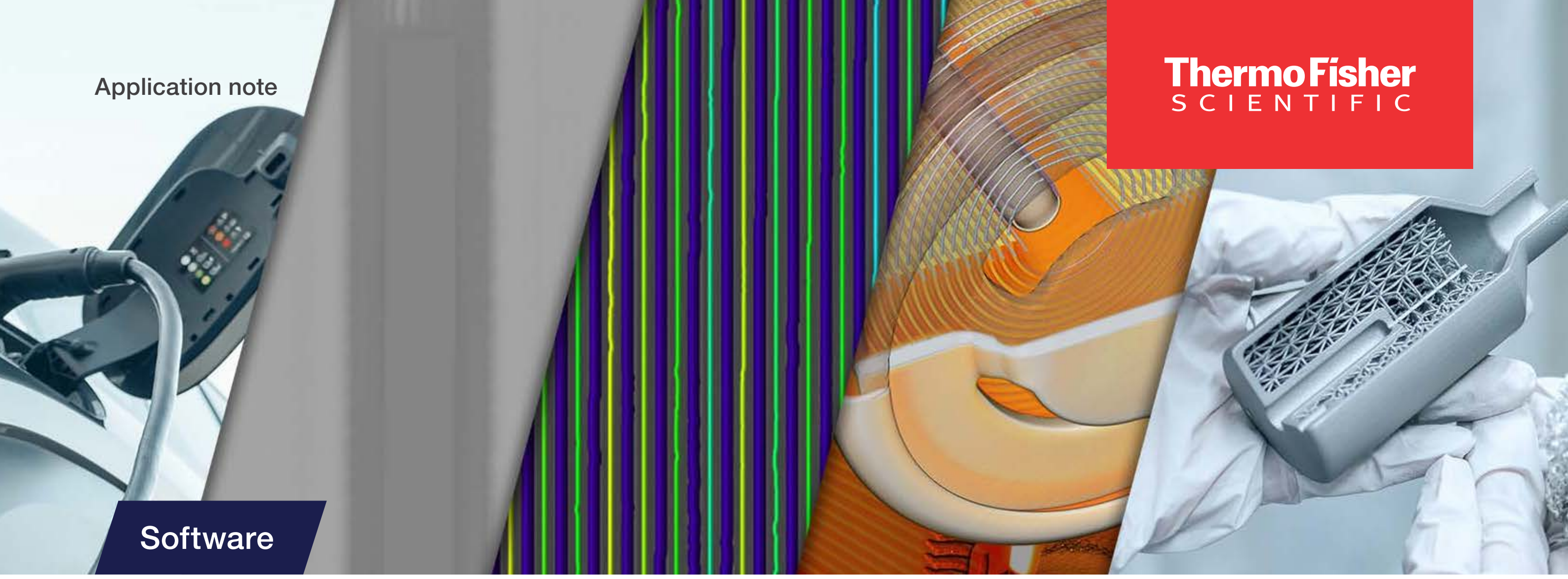
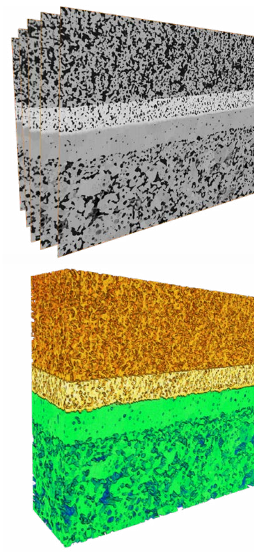



# Fuel cell structure and transport analysis at the micro level

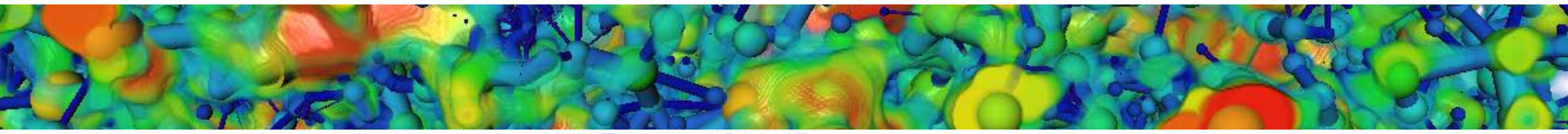
## How to better understand transport properties

Understanding transport properties is key to designing and manufacturing more efficient batteries. This includes simulation of transport properties (such as molecular diffusion or tortuosity).



In this case, a plasma FIB was used for the imaging, allowing both high resolution and large field of view. It is time-consuming, complex, and sometimes impractical to perform lab experiments to measure these properties. A digital workflow was needed to perform the simulation and possibly complement lab experiments. In the end, thanks to Thermo Scientific™ Avizo™ Software, a "full digital lab solution" allowed researchers to perform analysis and simulation directly from images and provided huge productivity gains.

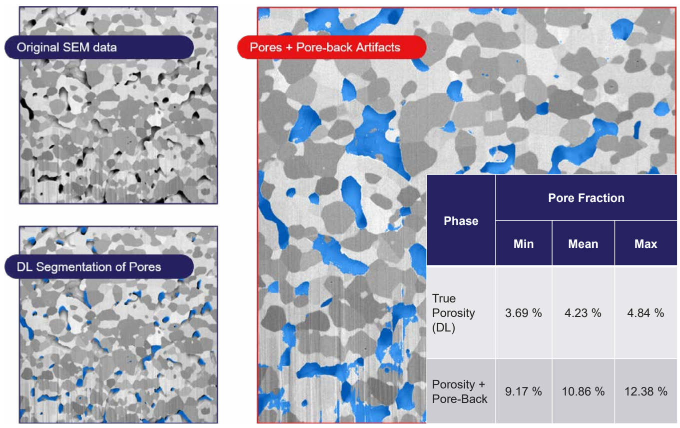
Once segmentation is done, the space between grains can be characterized, and a Pore Network Model can be built, which will then serve to compute transport properties such as tortuosity. Thanks to all these capabilities, simulation in a digital environment allows users to complement lab experiments, and the entire design and manufacturing workflow is accelerated and simplified.



Data courtesy of Jochen Joos, Institut für Angewandte Materialien - Werkstoffe der Elektrotechnik (IAM-WET), Karlsruher Institut für Technologie (KIT)

### Deep learning and artificial intelligence

A typical challenge in analyzing electron microscopy images of porous materials found, for example, in SOFC is the presence of pore-back artifacts. The scanning electron image is returned not only for the face of the specimen, but also the back of the pores. Traditional image processing combining thresholding, top-hat, and watershed segmentation may show true porosity, but also the pore-back region, therefore causing inaccuracies in the estimation of porosity. As can be seen in the images, the actual porosity in the sample is higher than what it is due to the presence of these pore-back artifacts. Using the state-of-the-art deep learning capability of Avizo Software, it is possible to train a model which will predict these hard-to-detect artifacts and generate accurate segmentation of the pores. In this case, users recovered an impressive average difference of 6.7% porosity per slice, preventing a 250% overestimate of the porosity.




| Phase | Pore Fraction | | |
|---|---|---|---|
| | Min | Mean | Max |
| True Porosity (DL) | 3.69 % | 4.23 % | 4.84 % |
| Porosity + Pore-Back | 9.17 % | 10.86 % | 12.38 % |

Learn more at thermofisher.com/avizobatteries


AN0198-EN-06-2022