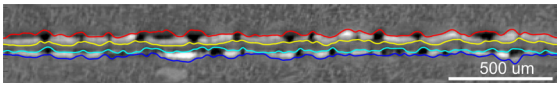
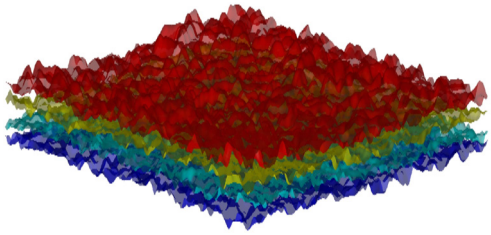
Electrolyte thickness in fuel cells

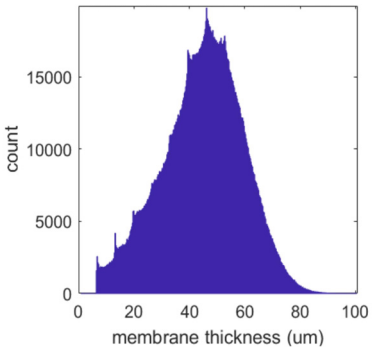
Danish Power System ApS is a leading company in production of membranes for high-temperature Polymer Electrolyte Membrane (PEM) fuel cells. The electrolyte in such cells contributes as an ion transport medium. It should be thin, but still sufficiently thick to separate the fuel and oxygen regions in the cell. The electrolyte thickness is an important parameter for fuel cell performance. In this study, the 3D Imaging Centre at DTU helped Danish Power Systems ApS to develop a method for measuring electrolyte thickness. Important aspects were to be able to perform non-destructive measurements over large cell areas.



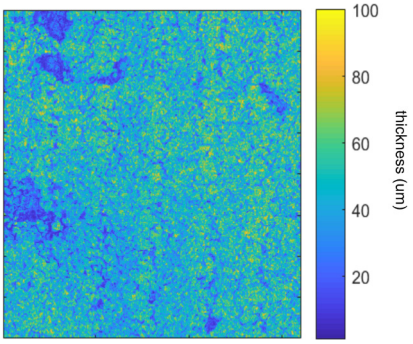
Slice showing the borders of layers in a 2D cut of the CT data.



3D representation of the detected layers.



Thickness of the electrolyte layer.



2D thickness map of the electrolyte layer.

Challenge

High-temperature PEM fuel cell membranes are mainly composed of polymers, noble metal catalyst nanoparticles and a phosphoric acid electrolyte. In X-ray images, the contrast between polymers and phosphoric acid is poor, while almost too high between those and the noble metals. This makes it difficult to exactly determine the electrolyte layer thickness, which is placed between the noble metal layers.

Collaboration

The fuel cells were tested at Danish Power Systems ApS and investigated using micro X-ray Computed Tomography (CT) at the 3D Imaging Centre at DTU. This collaboration was part of the LINX project, in which researchers at leading Danish universities collaborate with scientists in industry to solve industry relevant problems using advanced neutron and X-ray techniques. Besides projects for the members of the LINX association, the LINX project also supports outreach projects for companies, which are not members of the LINX association. In this way, companies can test how they can benefit from X-ray- and neutron-based techniques.

Results

The fuel cell membranes where investigated using X-ray CT before and after testing the cells at Danish Power System ApS. This made it possible to determine the influence of the operation of the cell on the electrolyte thickness. A method to detect individual layers, which had been developed at DTU previously, was applied to find the interfaces between the electrolyte and other layers in the cells. These interfaces could then be presented in 3D. Furthermore, electrolyte thickness histograms and electrolyte thickness maps could be extracted from the cells before and after testing. This made it possible to identify regions in the cells where the electrolyte thickness was particularly thin.

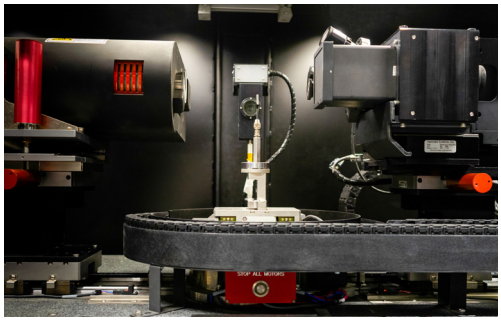
Perspectives

Now that methods have been developed for non-destructive X-ray CT measurements, an obvious next step is to develop *in situ* methods that allow for testing the cells simultaneously to X-ray CT measurements. With such a method, dynamics of the active cells can be better understood which helps the company in further cell development.

Imaging Industry Portal

The Imaging Industry Portal is a part of the 3D Imaging Centre at DTU and assists companies in using and implementing 3D Imaging in research, development and production. The portal offers research-based 3D Imaging services and provides companies with the latest equipment and the most advanced knowledge within 3D Imaging and data analysis. The Imaging Industry Portal works as a gateway to ESS and MAX IV, as well as other large scale facilities.

www.imaging.dtu.dk/english/Industry-Portal



DTU 3D Imaging Centre