camelot

UNDERSTANDING CHARGE, MASS AND HEAT TRANSFER
IN FUEL CELLS FOR TRANSPORT APPLICATIONS

Newsletter #1
February 2021

CAMELOT is a EU supported project to improve the power density of fuel cells by understanding the limitations on the performance of Membrane Electrode Assembly.

CAMELOT is 12 months into its 36-month duration. Due to the current situation with COVID-19, the consortium has not met face-to-face since the Kick-off meeting in January 2020. Despite this, the progress in the project has been good with a lot of experimental and modelling activities that have been shared in the monthly and bi-annual progress meetings.

A considerable activity has taken place for **improving the modelling of water transport in thin ionomeric materials**. The model has been developed as a stand-alone membrane module but will now be implemented into a full-cell modelling framework so that the model parameterisation can be completed using data from the characterisation of the baseline components done in the project.

Two sets of stack hardware will be used in CAMELOT. **Testing protocols** for single repeating units have been established. Test results will be used to validate the **FAST-FC model** with a more robust mechanism for transport of liquid water. The model will then be used to predict mass, charge and heat transport in thin layers and aid further development of beyond state-of-the-art components, leading to a better understanding of the performance limitations for these components.

The project is now entering a very interesting phase where characterisation and modelling work comes together: an important milestone for this project at month 18.

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 875155. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme, Hydrogen Europe and Hydrogen Europe Research.

Event

Fuel Cell Powertrain Ltd. (FCP) participated in the F-cell - Energizing Hydrogen Markets event, 29-30 September 2020 in Stuttgart Germany.

This annual event for hydrogen and fuel cell experts provided an extensive overview for relevant international markets and industries as well as technological advancements and gave the opportunity to FCP to present the highly innovative FCH-JU funded Project CAMELOT

www.camelot-fuelcell.eu

Consortium

Sintef
www.sintef.no

Johnson Matthey Fuel Cells Ltd
www.matthey.com

Chemnitz University of Technology
www.tu-chemnitz.de

Fuel Cell Powertrain
www.fuelcellpowertrain.de

Bayerische Motoren Werke
www.bmwgroup.com

University of Freiburg IMTEK
www.imtek.de

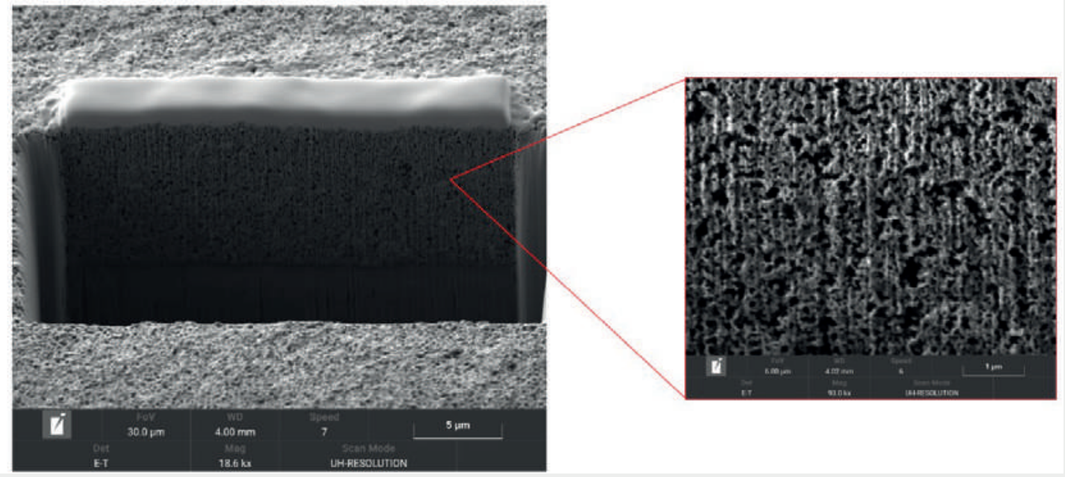
Pretexo
www.pretexo.com

WP4 - Diagnosis of MEA Limitations

As part of the WP4 activities the CAMELOT consortium has focused their work on characterising and diagnosing the fundamental transport properties limiting the performance in SoA membrane electrode assemblies (MEAs) and materials. These methods are complementary to the theoretical analysis and, together, used to construct a complete picture of correlated relationships between the observed performance, voltage loss at the cell level and the fundamental material property characteristics of the MEA.

Among several characterisation techniques, the project is using FIB-SEM tomography to reconstruct catalyst layers with a voxel size below 10 nm. Additional reconstruction will comprise the tomography and post-processing in order to generate a 3D dataset of the catalyst layer.

The fuel cell characterisation has been performed using advanced and automated fuel cell test stations in combination with commercially available 3D and 1D single cell fuel cell hardware. By performing cyclic voltammetry, CO-stripping, EIS and polarisation curves in O_2, Air and Helox at different relative humidity and temperature, the consortium is able to pinpoint and isolate the **specific irreversible losses of the MEA**.

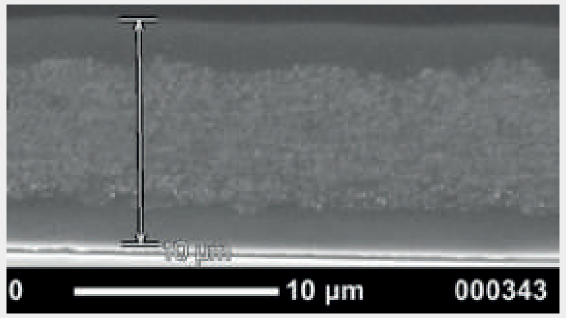


FIB/SEM of catalyst layers

WP3 - MEA Layer Development

In WP3 initial work has focused on understanding the effects of decreasing the layer thickness for catalyst and membrane layers on the performance and characteristics of the MEA. Performance testing has taken place to investigate the effects seen when moving to a low platinum loaded (0.1 mgPt/cm²) cathode catalyst layer. The main losses seen for the performance of these layers were kinetic seen at low current densities, and increased mass transport losses when moving above 2 A/cm². Following on from the investigation of thin catalyst layers, work in the next project period will look to utilise disruptive catalyst layer deposition techniques to understand the effects of changing the catalyst layer properties in the X, Y and Z directions.

Initial membranes were coated to achieve a challenging target thickness of 10 μm and were characterised against the standard (thicker) membrane. The thin membrane showed good mechanical properties, comparable to the standard, and showed some differences in terms of slightly increased rate of water uptake and reduced ex-situ resistance. In-cell testing showed limited differences in performance, but increased H_2 permeation. The next stage of work in this area will be to optimise the membranes to reduce H_2 permeation at the 10 μm thickness.



Cross sectional SEM of a CAMELOT 10μm reinforced membrane.

Highlights

News

SINTEF BLOG - March 2020 - *New project to improve the power density of Proton Exchange Membrane (PEM) fuel cells*

January 1, 2020 was the start date for a new FCH JU funded project coordinated by SINTEF. The project objective is to improve the power density of PEM fuel cells. Through modelling of transport phenomena and advanced characterisation of state-of-art MEA components, performance limiting factors will be identified. By the optimisation of layers and interfaces construction in order to minimise these limiting factors, disruptive performance increases will be enabled.

https://blog.sintef.com/sintefenergy/new-project-to-improve-the-power-density-of-pem-fuel-cells/