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Disruptive pemfc stack with nOvel materiaLs, Processes, arcHitecture and optimized INterfaces

Newsletter #2
April 2020

The M6 and M12 progress meetings took place in ZSW (Ulm, Germany, 25-26/06/2019) and in Hexcel (Les Avenières, France, 14-15/01/2020).

M6 meeting at ZSW in Ulm

The overall aim of the project is to validate **disruptive technologies for 100 kW light-weight & compact fuel cell stack designs,** reaching outstanding (specific & volumetric) power density while simultaneously featuring enhanced durability (under automotive application conditions) compared to state-of-the-art, and compatible with large scale/mass production of full power-stacks.

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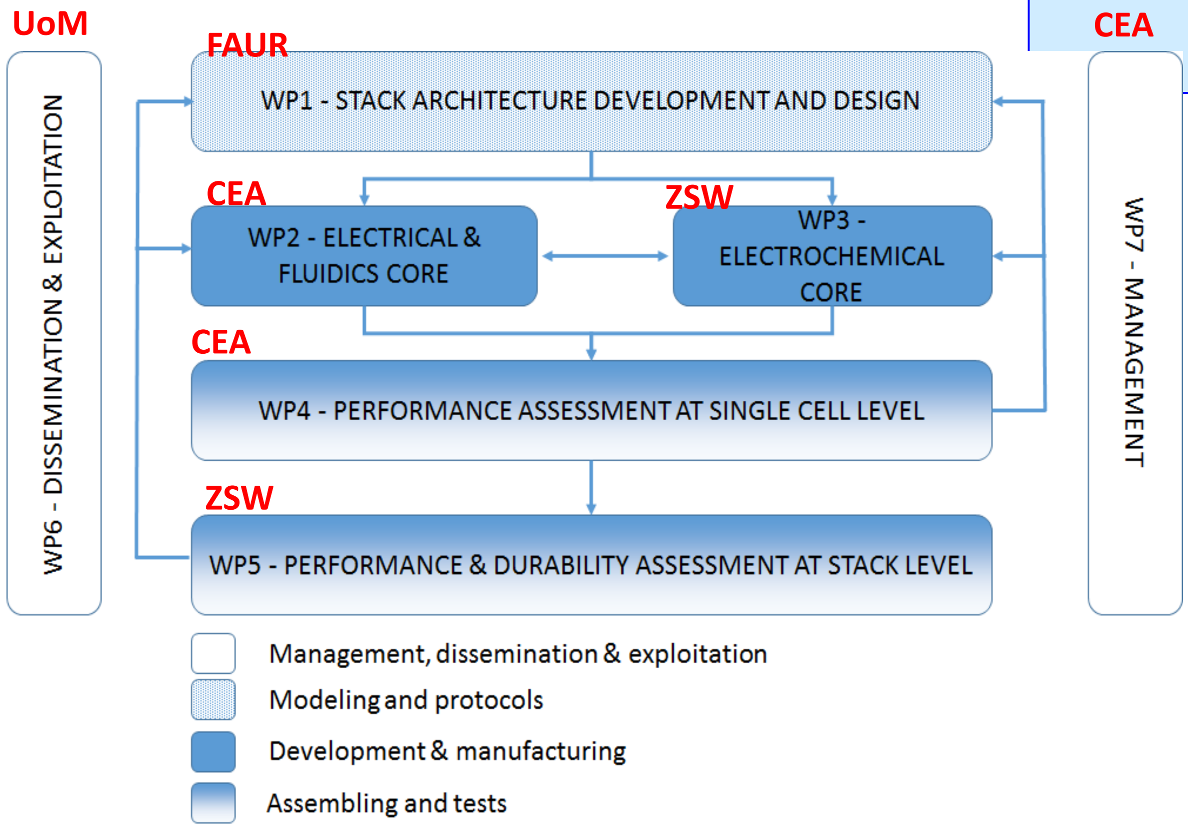

Contact:
Dr. Joël Pauchet
CEA-Tech LITEN
17 rue des martyrs
F-38054 Grenoble
France
joel.pauchet@cea.fr

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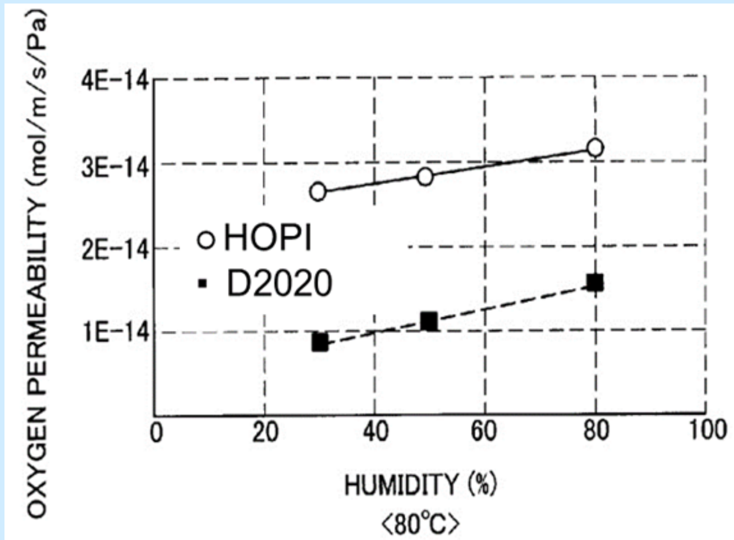
Main Achievements

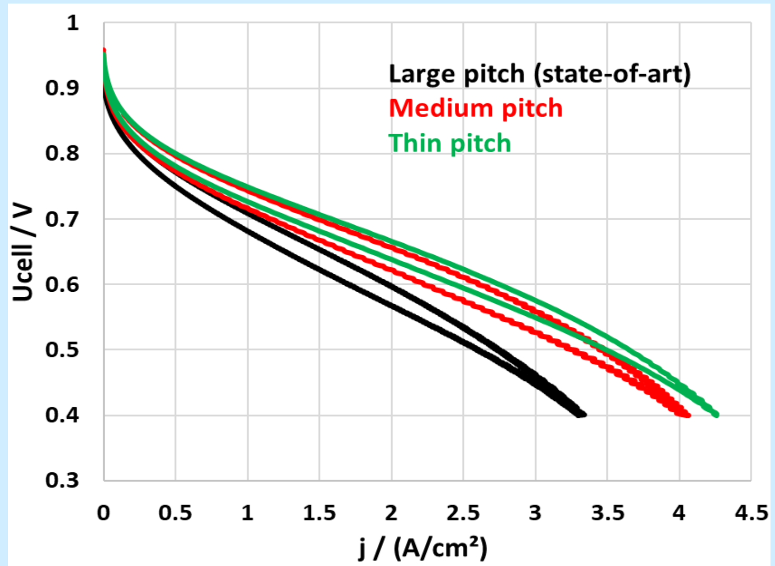
WP2 “Electrical and Fluidic Core” focuses on the manufacturing and characterization of thin Bipolar Plates (BP) and Gas Diffusion Media (GDM).
New thin metal and carbon sheets have been produced and characterized. In parallel, different cutting-edge techniques are studied to manufacture BP based on these sheets. Specific printing and additive manufacturing techniques have already allowed producing thin rib-channel designs on them (see figure). Ex-situ gas tightness and electrical characterizations have been carried out and single cell tests have started (WP4) to evaluate the performance in different PEMFC operating conditions representative of a real stack.

WP3 “Electrochemical Core” aims at developing innovative components and integrate them into a pioneering electrochemical core (EC) concept, i.e. a catalyst coated membrane (CCM) extended by protective and functional layers to reduce mass transport resistance and improve performance. On one hand, a significant improvement in membrane performance could be demonstrated and preliminary results for an innovative ionomer show that local O_2 transport resistance can be cut by approximately 50%. On the other hand, integrating the EC has been tackled, at first employing reference materials, by e.g. developing processes for transferring single layer graphene (SLG) onto small and larger-area membranes for reducing hydrogen crossover. Challenges regarding the application of the catalyst layer on such SLG-coated membranes have been approached.



High Oxygen Permeability Ionomer (HOPI) for the cathode catalyst layer compared to commercial product

WP4 “Single Cell Tests” objectives are to characterize at different scales the different types of Electric and Fluidic Cores (EFC) and Electrochemical Cores (EC).
Model EFCs have been produced with machined rib/channel from State-of-Art design (“large” pitch) down to ultra-thin pitch. These reference EFCs have been tested in a small surface area single cell (*ca.* 1.8 cm²) under well-controlled and homogenous conditions (also known as differential / zero-gradient cell). Such cell also makes it possible to mimic the local conditions encountered in a real stack. Results show that the thinner the pitch, the better the performance, especially at high current densities (see figure). The same characterizations will be performed with EFC and EC prototypes made by advanced materials from WP2 and WP3 to select the most promising materials and manufacturing processes. The test campaign is ongoing and shall help to define and structure innovative EFCs and ECs for large-scale cells in the next forthcoming months.



Example of polarization curves obtained in differential cell for the reference EFCs and ECs using different rib/channel pitches

WP5 “Stack Tests” focuses on the design and manufacturing of composites terminal plates (ITP) to replace aluminum and reduce weight & volume and cost of the terminal plate.
Specific shapes considering the manufacturing process and types of materials employed have to be implemented into the design. This approach is utilized to run a preliminary analysis. It provides visibility for improvement loops. As a first step, the analysis model has been built up. The validation of the models is carried out by displacement and stress output comparison. Modelling of the ITP is being done using suitable materials in several configurations (carbon, glass composites), with the objective of meeting load and displacement requirements. Mechanical testing will be conducted to check the correlation between tests and modelling and to select the best solution in terms of mechanical behavior and cost.