The EU Project DECODE: Understanding of Degradation Mechanisms to Improve Components and Design of PEFC

DECODE

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Motivation and Objectives

Present problems of PEFC technology related to the commercialization are costs, durability, reliability, performance, and public acceptance. The DECODE project is focusing on improving durability taking the water management, especially liquid water, into account. Water management of PEFC is one of the crucial issues for the performance and the life-time.

The main objective is to increase the life-time of fuel cells for automotive applications focusing on liquid water interactions with the following tasks:

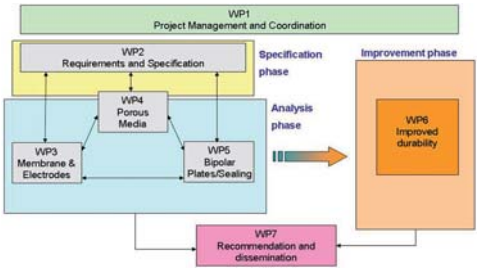
- Understanding the influence of the degradation processes on the fuel cell performance and on the fuel cell behaviour especially on the water management/water balance in the fuel cell
- Description of degradation of fuel cells as a cumulative effect based on the individual degradation processes
- Derivation of operating strategies for higher durability, reliability, and stability

A special strength of the project is the large modelling activity which is expected to significantly advance knowledge and understanding of the processes.

Project Structure

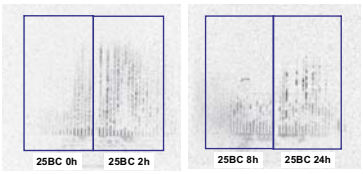
The project plan is split into three phases:

1. The specification and definition phase for materials, components as well as testing and operating conditions
2. The analysis phase for the investigation of the individualism of degradation processes of the components (WP3: membrane and electrodes; WP4: porous media; WP5: bipolar plates) and their interactions
3. In the improvement phase for the generation of the technological progress including development of novel fuel cell operating strategies to mitigate degradation phenomena and to improve components and single cell design



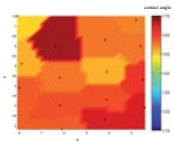
Technical Approach

- Experimental studies of the degradation mechanisms and processes of single components, single cells, and short stacks. All investigations are performed to understand the influence of operating conditions.
- Modelling of transport processes and porous media.
- Improvement of operating strategies and materials based on the knowledge of degradation processes

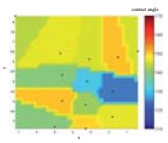


Neutron images of peroxide treated GDLs using a simple ladder type flow field including diffusion zone. T-stack: 55 °C; Anode: dry, utilization: 90%; cathode: Dp 25 °C, utilization: 25%;
Air flow: top left to bottom right; i: 800 mA/cm2

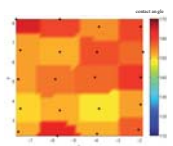
Map of hydrophobic property



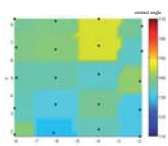
New GDL, substrate side



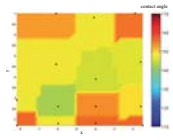
Artificially aged, substrate side



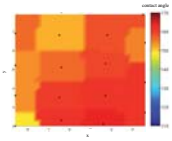
MEA1 cathode, substrate side, sample 1



MEA1 cathode, substrate side, sample 2

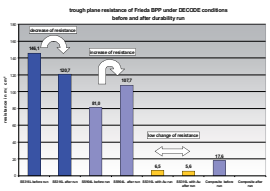


MEA1 cathode, substrate side, sample 3

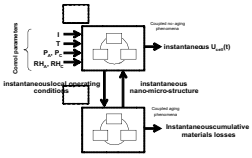


MEA1 anode, substrate side, sample 3

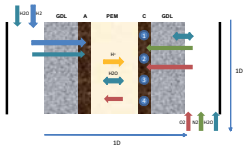
Picture of a assembled stack



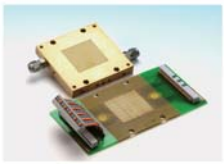
TPR of bipolar plates



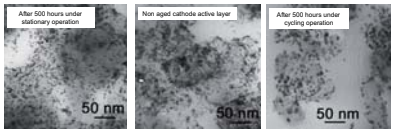
Description of the algorithm behind CEA model MEMEPHYS



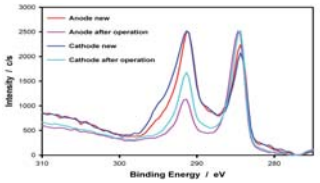
MEMEPhys model with 1D+1D resolution developed for DECODE project

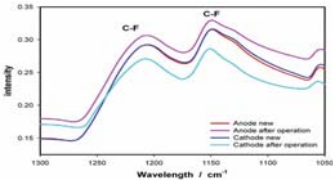


Multisensor cell with 49 segements

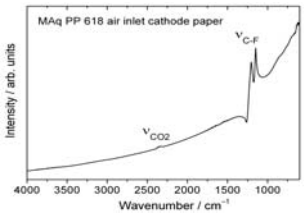


Transmission Electron Microscopy on active layer samples prepared with CEA CCM MEA after ageing in stationary conditions (left), non aged (middle) and after ageing in cycling conditions (right)





X-ray photoelectron (left) and FT-IR (ATR) (right) spectra of used and new reaction layers of a CCM



FTIR spectrum of a GDL operated on the cathode side

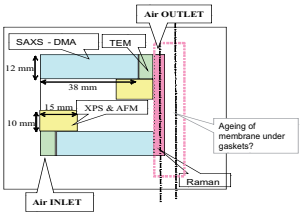


Illustration of the MEA zones considered for the preparation of samples at CEA for the possible analyses on new and aged MEAs.

Acknowledgement

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