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

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Motivation

Present problems of PEFC technology related to the commercialization are the costs, the durability, the reliability, the 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.

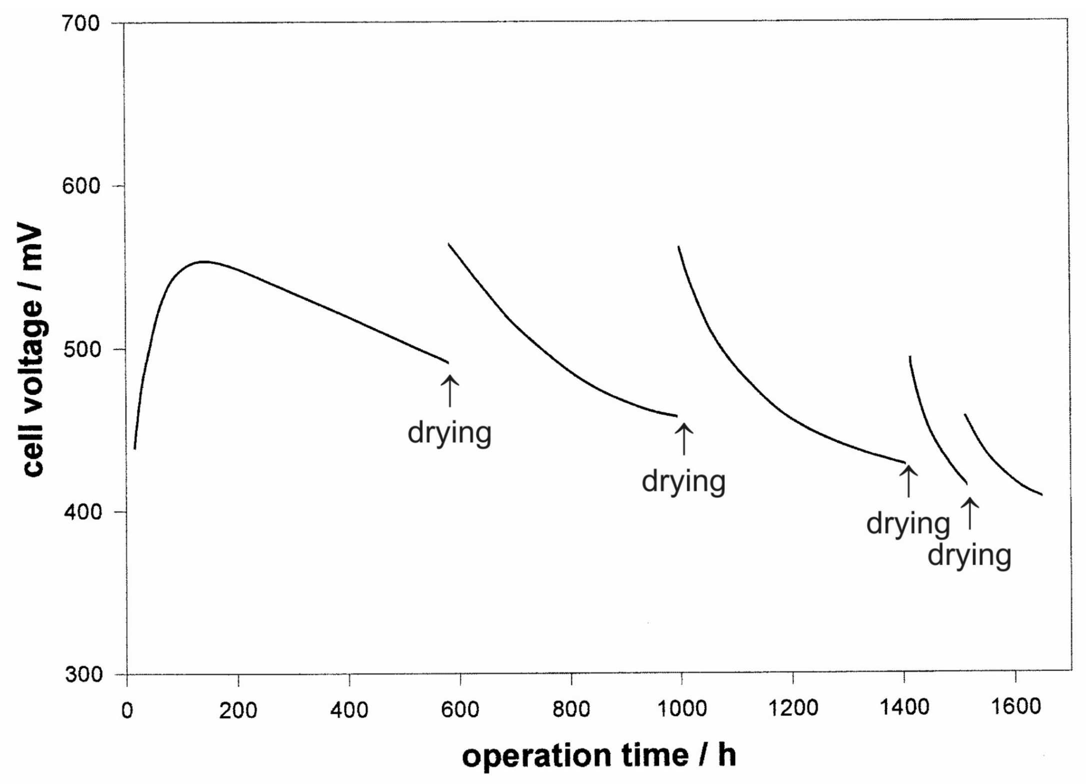

Fig. 1: Alteration of the cell voltage of a PEFC single cell during constant galvanostatic loading in a long-term experiment

The water management influences the degradation, but also the degradation has an effect on the water management, in particular by the decrease of the hydrophobicity of crucial components. The electrochemical performance, namely the cell voltage at galvanostatic operation (Fig. 1), decreases with operating time but after periodic shut-downs and concurrent drying of the cell a large part of the electrochemical performance is recovered. Because of the degradation of the hydrophobic components the water management becomes critical and leads to a faster decrease of cell voltages after drying. This behavior indicates that the decrease of cell voltage is influenced by excessive water inside the cell and a continuous loss of hydrophobicity of fuel cell components.

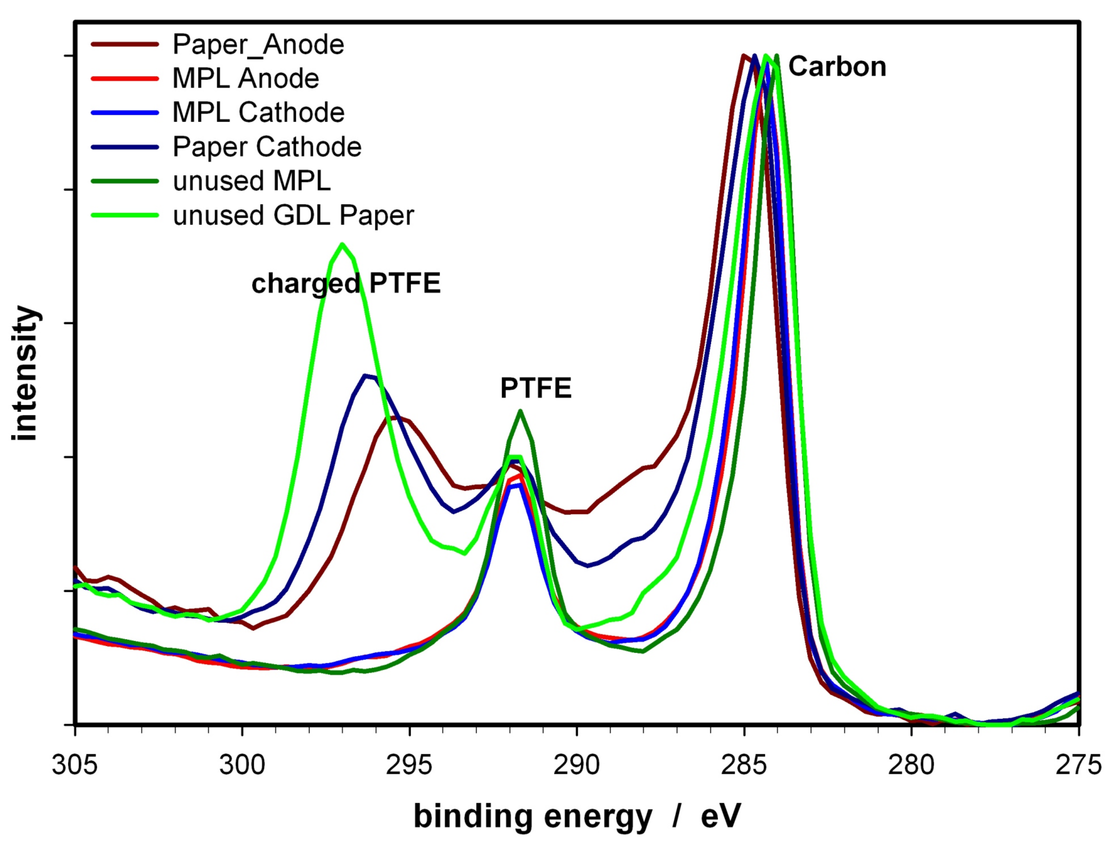

Fig. 2: X-ray photoelectron spectra (C 1s) of new and used GDL

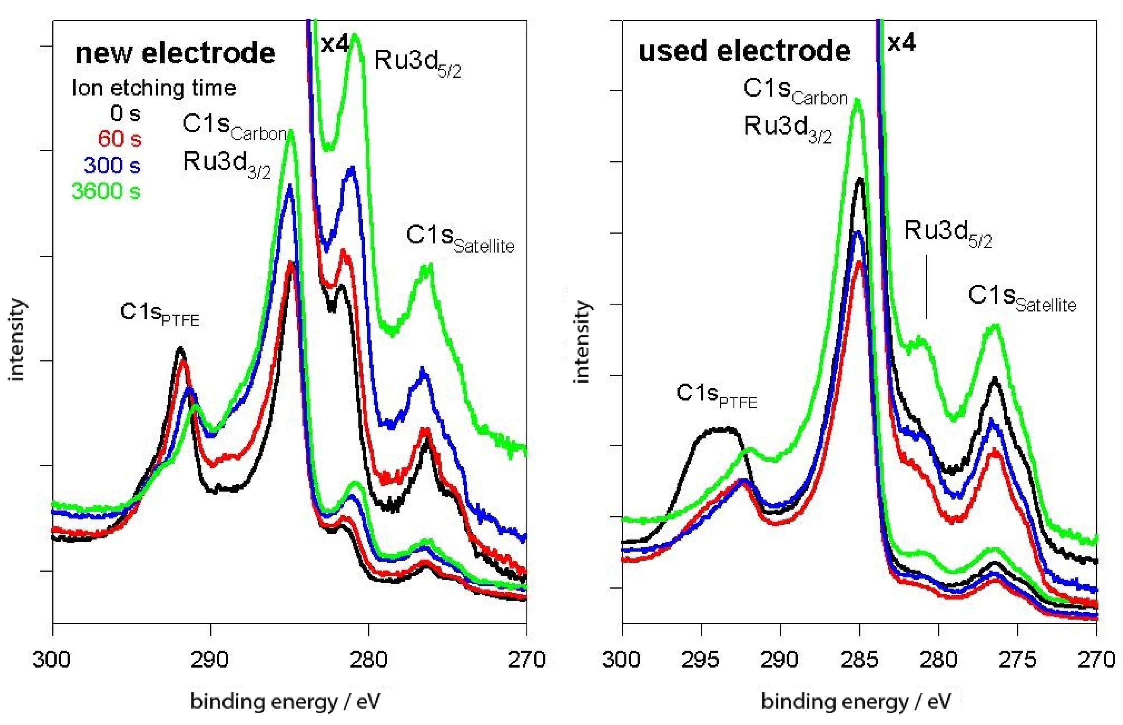

Fig. 3: X-ray photoelectron spectra (C1s) spectra of a DMFC anode before and after fuel cell operation

Objectives

The main objective is to increase the lifte-time of fuel cells for automotive applications focussing on liquid water interactions. For this, different work tasks have to be performed as described above in order to achieve the objectives:

- To assess the relevance of the different degradation processes with focus on liquid water interactions
- To understand the relevant degradation mechansims and the influence of the operating conditions on the relevant degradation processes
- To understand the influence of the degradation processes on the fuel cell performance and on the fuel cell behavior, especially on the water management/water balance in the fuel cell
- To describe the degradation of fuel cells as a cummulative effect based on the individual degradation processes
- To develop accelerated life-time tests for the individual degradation processes
- To develop a method for prediction of life-time
- To derive operating strategies for higher durability, reliability, and stability
- To improve materials for higher durability, stability for fuel cell operation under chosen operating conditons (without basic new developments)
- To prove the improvement of materials and improved operating strategies
- To disseminate the results of the project to the fuel cell community

Many degradation processes are known but not understood in each detail. The most of the other known degradation processes, for example, the catalyst agglomeration, depend strongly on the water balance inside the fuel cell.

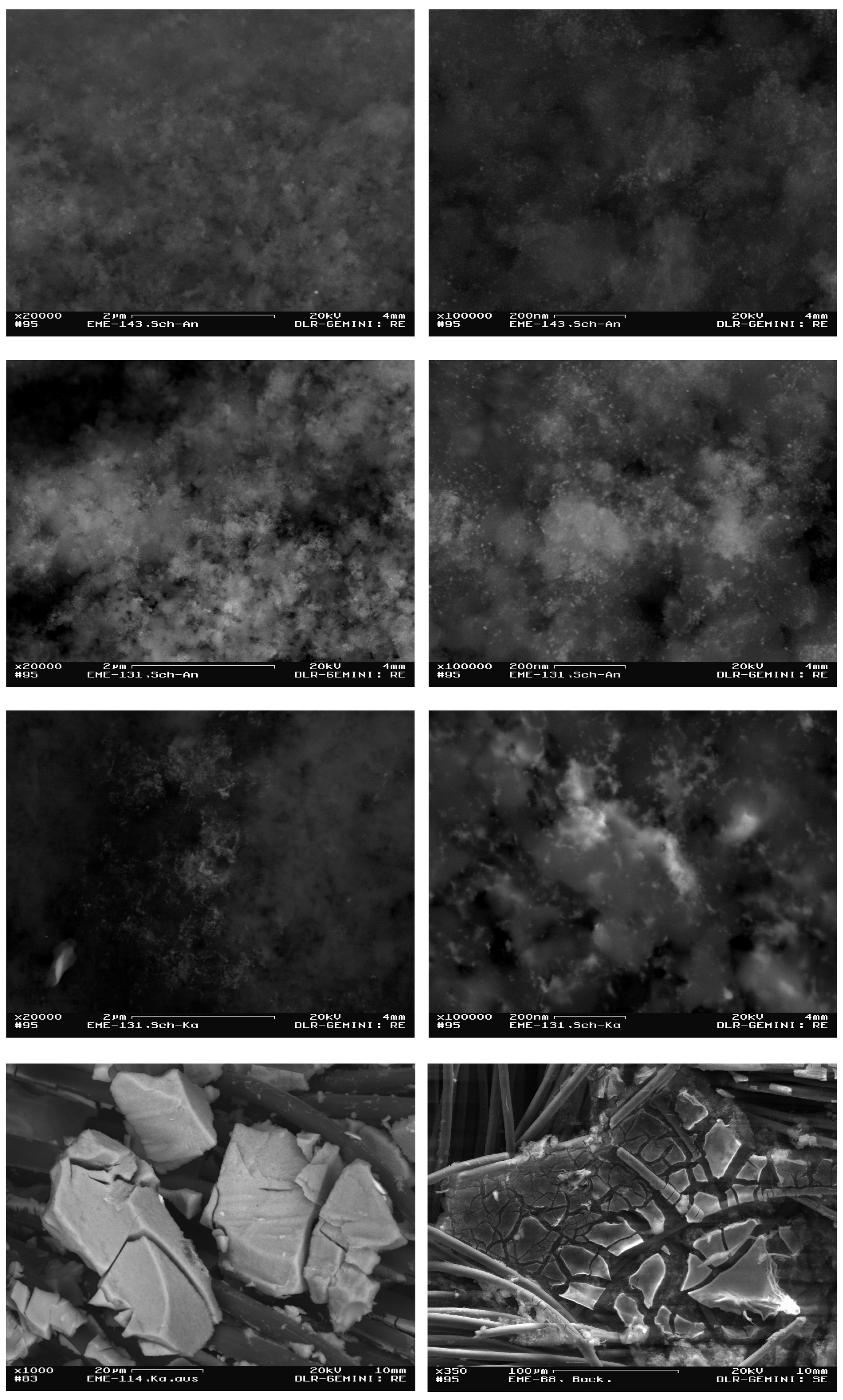

Fig. 4: SEM images of a new electrode (1. row), an used anode (2. row) and an used cathode (3. row) with 20,000-fold magnification (1. columm) and 100,000- fold magnification (2. column); 4. row: 2 SEM images of platinium oxide particles on the cathodic GDL (side in contact with the bipolar plate) of different MEAs which are partially flooded during fuel cell operation

In contrast to the degradation of the hydrophobicity and the catalyst agglomeration, some degradation processes are enhanced due to dry conditions; typically the degradation of electrolyte membrane is accelerated by dry conditions. Other degradation processes like the delamination of membrane and electrodes are enhanced by wet-dry-cycles.

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

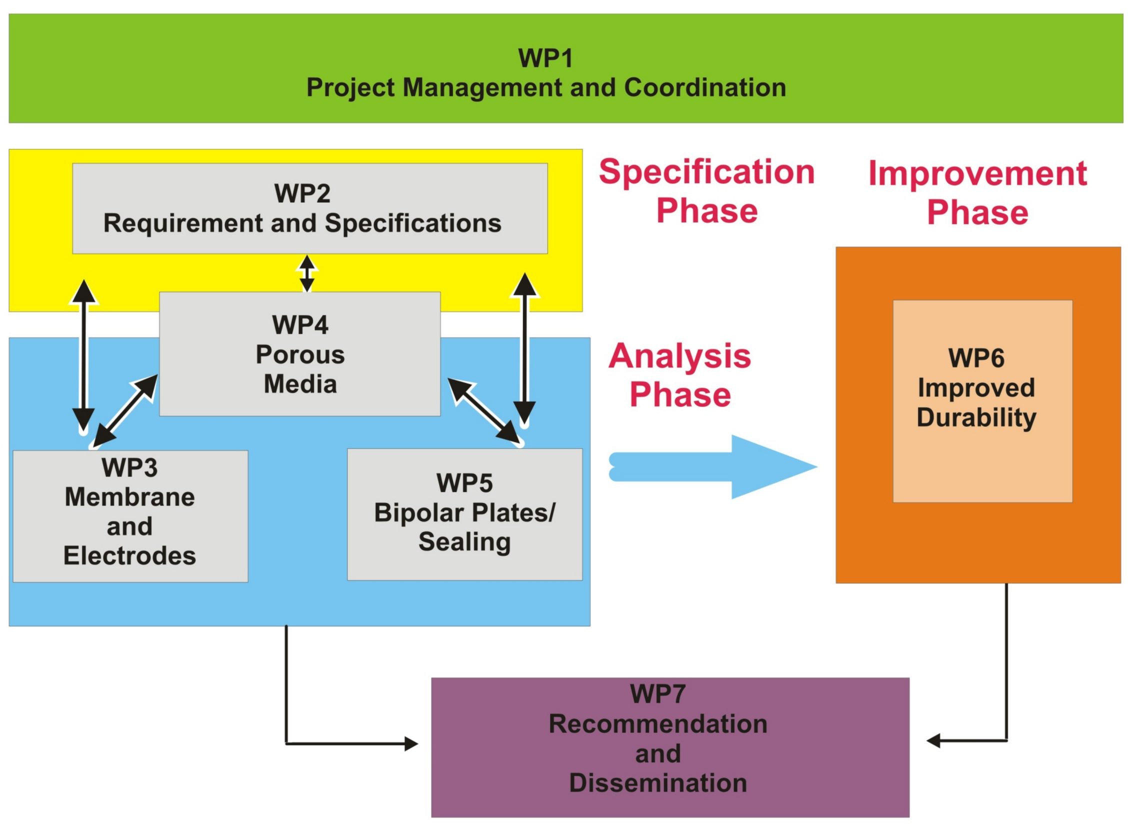

Fig. 5: Work packages and project structure of DECODE

Project Management

Coordinator
K. A. Friedrich (DLR)
G. Tsotridis (JRC)

Partners
DLR
CEA
DANA
GM Europe
JRC
SGLCarbon
Solvay Solexis
University Erlangen
Volvo
ZSW

Steering Committee
Coordinator
Work package leader

Acknowledgement

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