Hydrogen Starvation Tests on PEMFCs Using Segmented Cell Hardware

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Introduction:

In order to enhance the successful commercialization of fuel cells, the operational lifetime of PEMFCs has to be prolonged. Therefore it is essential to understand the degradation mechanisms, identify stress factors and investigate their impact on lifetime.
One important stress factor which occurs in real life operation is fuel starvation. The insufficient hydrogen supply causes an inhomogeneous reactant distribution, and corresponding current distribution, which leads to a rapid degradation of the MEA [1].

Experimental:

The influence of operating conditions cell temperature, relative humidity and current density on the degradation of the MEA during fuel starvation cycling was investigated.
These accelerated stress tests were applied to a single cell with an active area of 25cm².

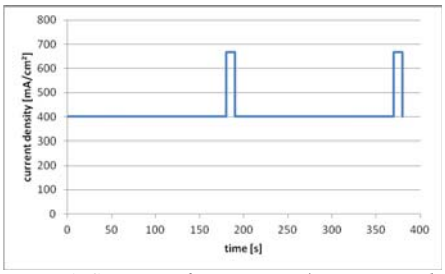

Figure 1: Sequence of two recovery/starvation cycles

A characterization of the cell was done at the beginning-of-lifetime (BoL) by following measurements:

- Polarization curve
- Electrochemical Impedance Spectroscopy
- Cyclic Voltammetry
- Hydrogen crossover current

Afterwards Fuel Starvation cycles (Figure 1) were executed until the cell showed clear signs of degradation, followed by the end-of-lifetime characterization (EoL).

Furthermore a measuring of CO and CO_2 concentration in the anode gas outlet was done to draw conclusions from carbon corrosion.

The use of segmented cell hardware (Figure 2) made it possible to detect the space-resolved current density [2].

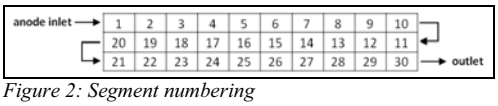

Figure 2: Segment numbering

Results:

The fastest degradation of the MEA was achieved at high temperature (85°C) and low relative humidity (40%).
The performance loss after 50 starvation cycles is more than 0,3V at 400mA/cm².
CO_2- concentrations up to 2500ppm during starvation interval indicate carbon corrosion at the anode side.

Hydrogen crossover measurement showed increased current at and around segment 8 indicating pinhole appearance at this area.

Acknowledgement:

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References:

[1] Baumgartner, W. R.; Parz, P.; Fraser, S.; Wallnoefer, E.; Hacker, V.: Journal of Power Sources 182 (2008) 413– 421
[2] Hacker, V.; Stadlhofer, A.; Mayrhuber, I.; Strasser, R.: Proceedings of EFC2011 (2011) 95-96