Degradation process during the bus application loading cycling in PEMFC

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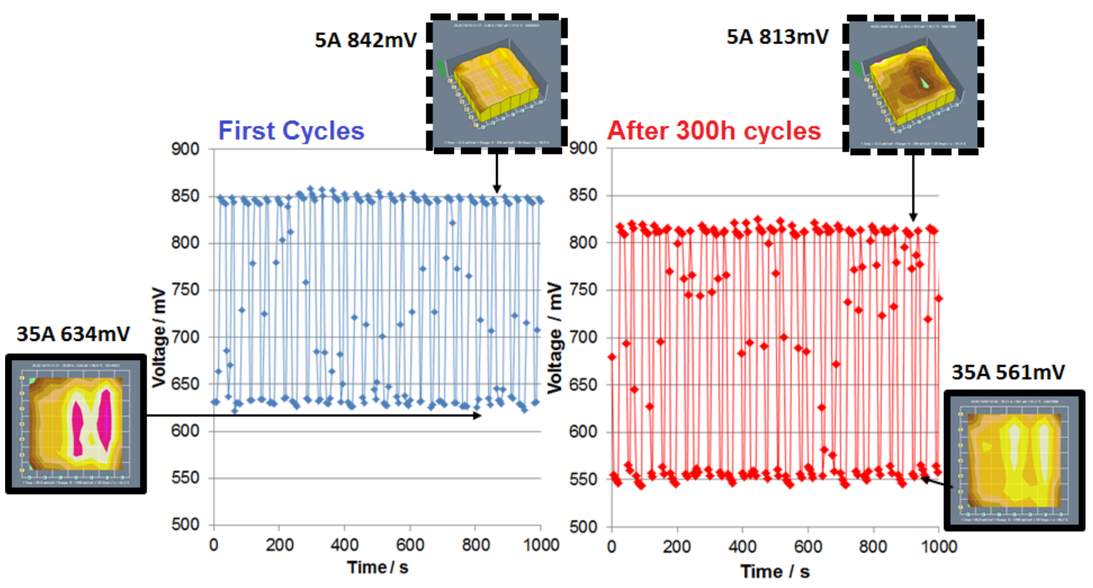
Introduction

Fuel cells, power generation devices, have been recognized as one essential solution to diminishing supplies of fossil fuel, environmental pollution, and global warming. Fuel cell technology has enjoyed great advancement in the last few years being in our days a reality for automation application.
In this work, particular attention is paid to the local analysis of performance and degradation of cells operated under a synthetic cycle for bus application. This cycle it seems to be very aggressive with fast and high changes in current load between 0.2A/cm^2 and 1.4 A/cm^2 the cell was run approximately for 300h under. In order to study locally the degradation influence of inlet gas humidification on cell performance all the experiments were performances with the DLR- PCB segmented cell current density measurements, other global effect were studied using in-situ diagnostic tools, such as cyclic voltammetry. The changes observed locally in the current densities distributions were investigated locally by post-mortem ex-situ investigations by XPS to determine changes in the chemical composition of the different layers during the experiment

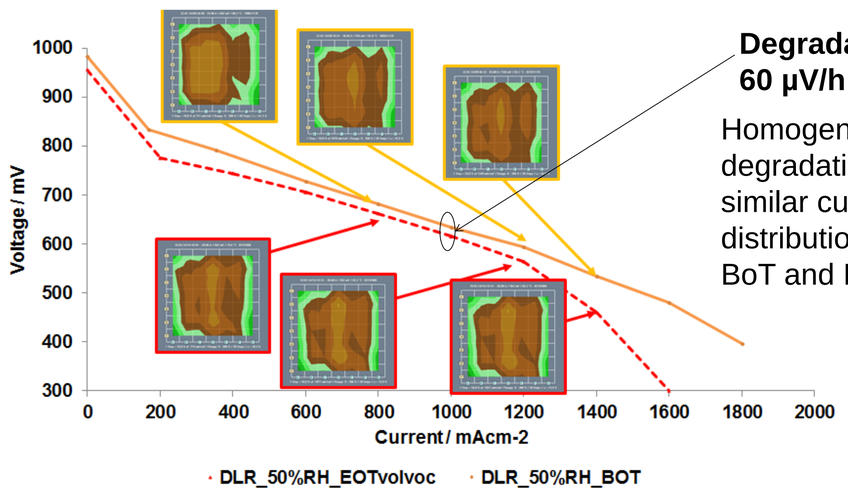
In-situ measurements

Voltage responses at the BoT and EoT during the Cycle



Degradation during the cycle@0.2 A/cm^2: 100 µV/h
Degradation during the cycle@1.4 A/cm^2: 200 µV/h

Polarisation curves between BoT and EoT



Degradation:
60 µV/h @ 1 A/cm^2

Homogeneous degradation process similar current densities distributions between BoT and EoT

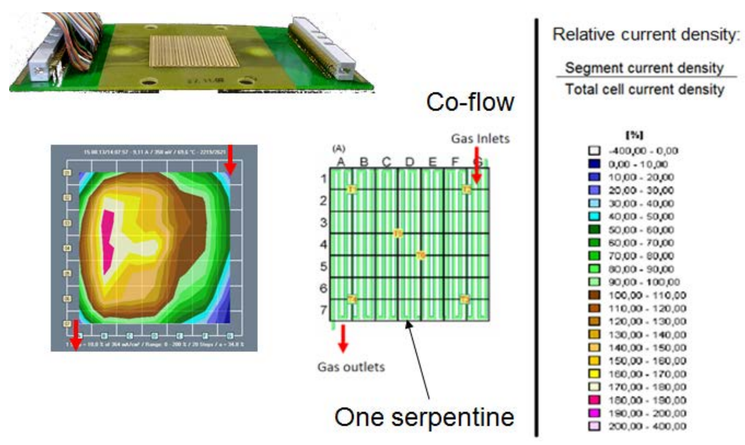
Set-up

Nano-CAT reference MEA

Prepared by the CEA: Screen printed electrodes (CCB) & hot pressed.

- **Anode:** 0.1 mg$_{Pt}$/cm^2 50% Pt/C TKK
- **Cathode:** 0.4 mg$_{Pt}$/cm^2 46% Pt/C TKK (Pt$_3$Co)
- **Membrane:** Nafion® HP
- **GDL:** SGL 24 BC

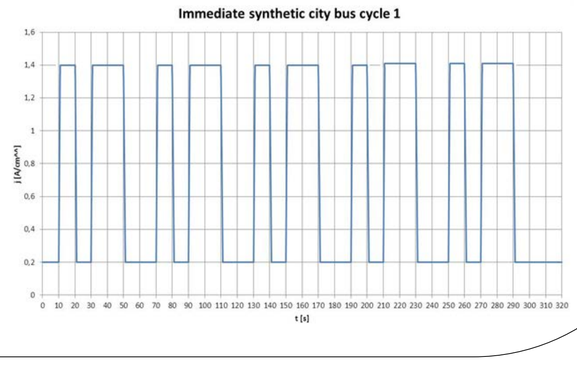
Segmented bipolar plate (DLR)



DLR segmented bipolar plate, based on printed circuit board (PCB) technology for current density distribution measurements

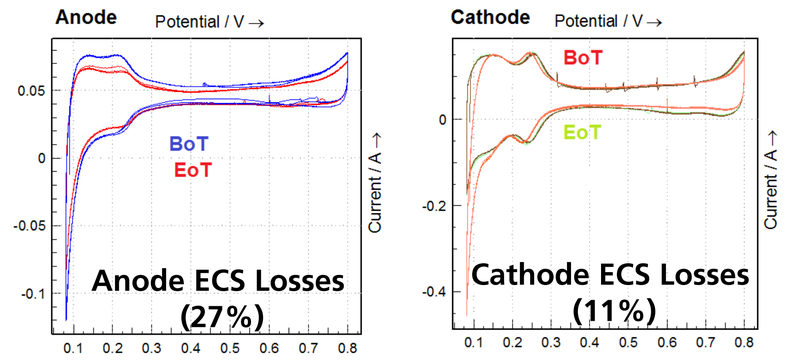
Cycle for bus applications

Synthetic cycle for bus application, fast and high changes in current load.
- Currents: 0.2 – 1.4 mA/cm^2
- Time: 300 h

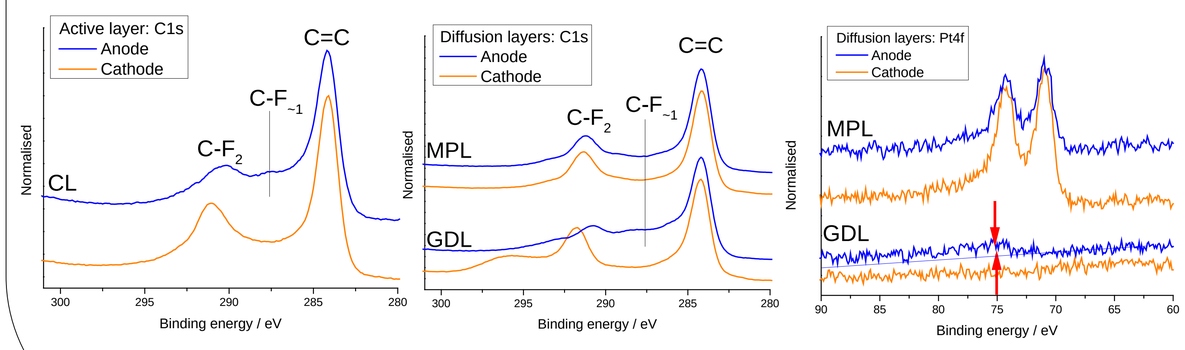


Ex-situ Measurements

CVs on the anode and cathode at the BoT and EoT



XPS



Partial defluorination of anode side ionomer (active layer) and PTFE (diffusion layers)

Traces of Pt in MPLs and even in anode GDL

Conclusions

- Degradation during the cycle
  - At 0.2 A/cm2 :100 µV/h
  - At 1.4 A/cm2: 200 µV/h
  - Same current homogeneity at high current between the first and after 300h cycles
- Degradation between BoT and EoT :
  - At 1 A/cm^2 : 60 µV/h
  - Homogeneous degradation on current densities
  - ECS losses: Anode: 27%; Cathode: 11%
  - Pt dissolution more prominent and ionomer degradation more prominent an anode side

Acknowledgments

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