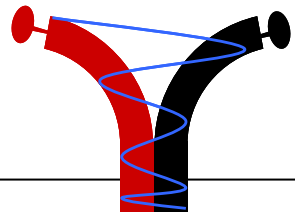


Electrodes ageing: local degradation insights

Sylvie Escribano – Laure Guetaz



Poster: "Pt nanoparticle coarsening during PEM fuel cell operation: influence of active layer water content"



DECODE WP3 members

DECODE WP3 results

S. Escribano
L. Guetaz

CHALMERS P. Johansson
P. Jacobsson

JRC D. Veyret
EUROPEAN COMMISSION G. Tsotridis

L. Merlo
M. Corasaniti
C. Oldani
E. Pagano



M. Schulze
A. Haug
A. Friedrich
R. Reissner

VOLVO M. Holber
A. Selimovic



- **Objective**
 - **Catalytic layers local degradation**
- **DECODE MEA**
- **In-situ ageing tests**
- **Local degradation analyses**
- **Conclusions & Further steps**

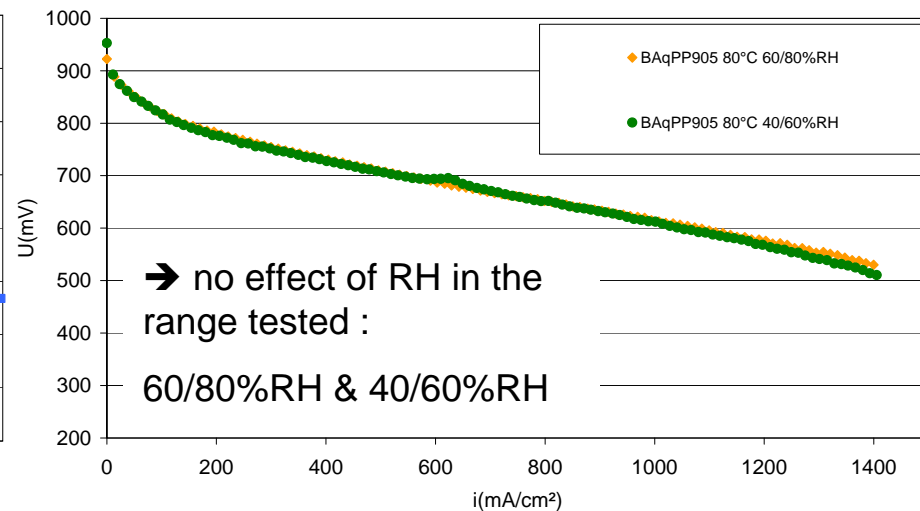
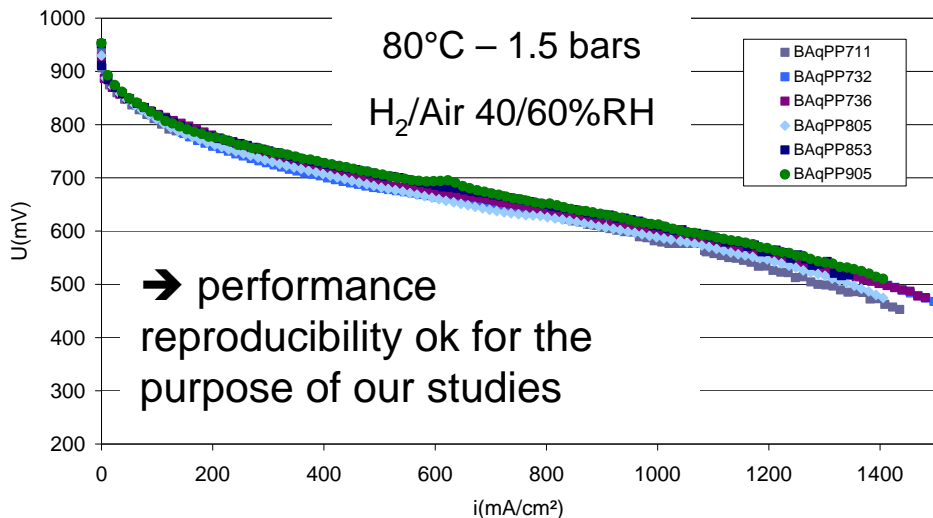
- MEA type : CCB (Catalyst Coated Backing)

- GDL : SGL 25BC
- AQUIVION™ membrane: E79-03S (EW 790 – 30μm)
- AQUIVION™ electrolyte solution
- Active layers Pt loadings: with 46%Pt/C Tanaka
 - Cathode : ~ 0.4 mgPt/cm²
 - Anode : ~ 0.25 mgPt/cm²

Technical objective: electrodes reproducibility

Main issue : ink preparation and AL structure

- MEA initial performance

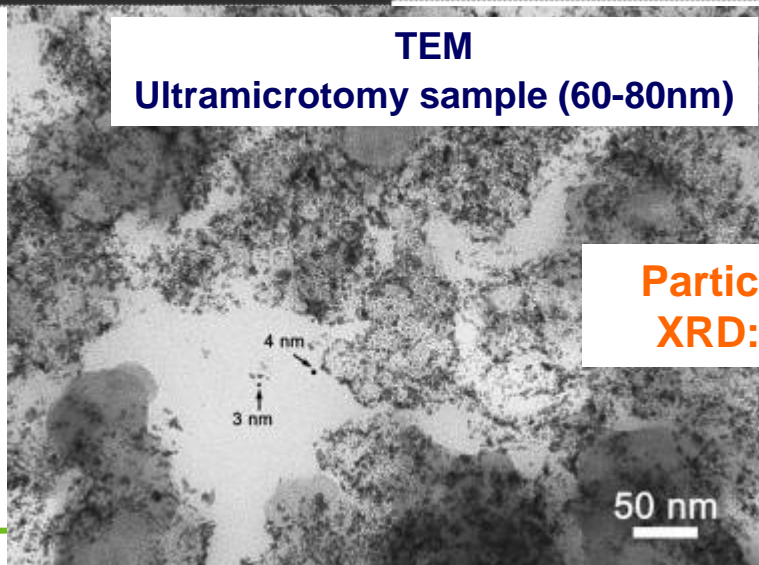
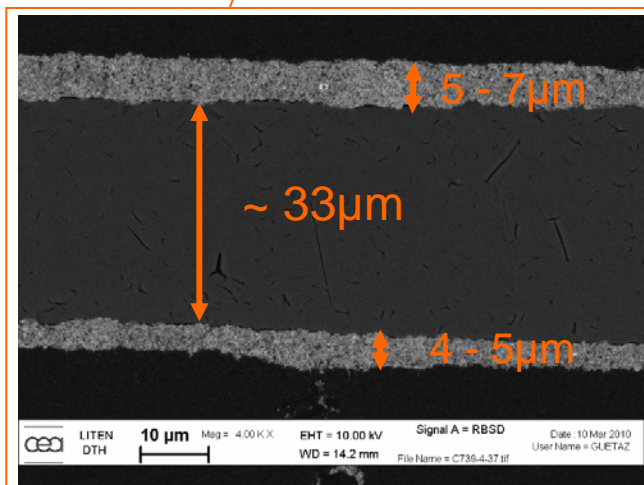
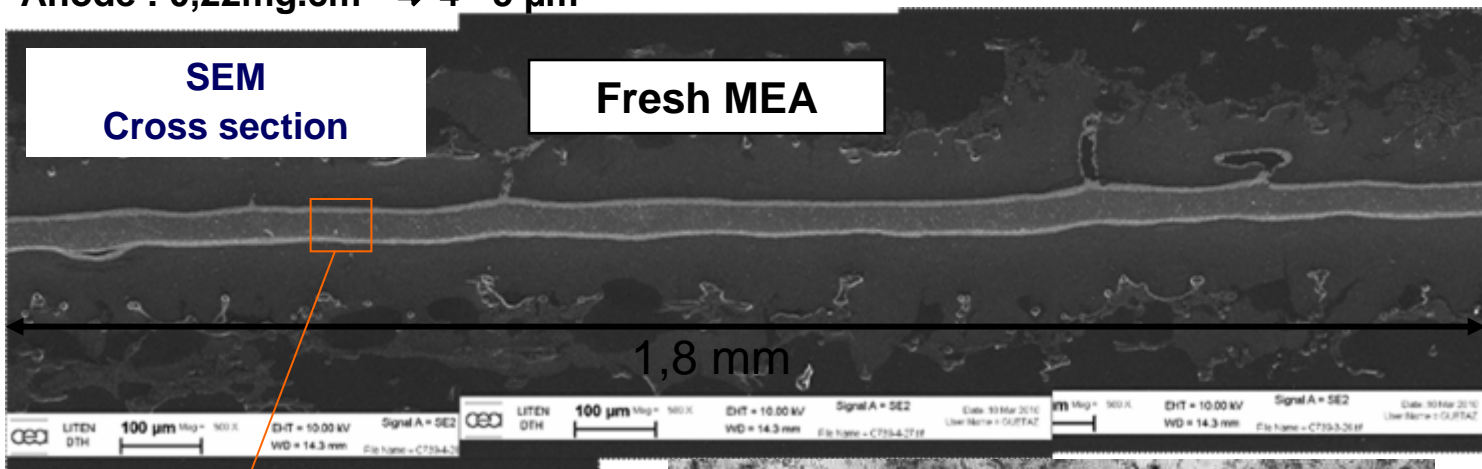


- MEA initial aspect & microstructure

Cathode : $0,38 \text{ mg.cm}^{-2} \Rightarrow 5 - 7 \mu\text{m}$

Membrane thickness : $32,5 - 34,5 \mu\text{m}$

Anode : $0,22 \text{ mg.cm}^{-2} \Rightarrow 4 - 5 \mu\text{m}$



Particle size
XRD: 3 nm

- Ageing test procedures

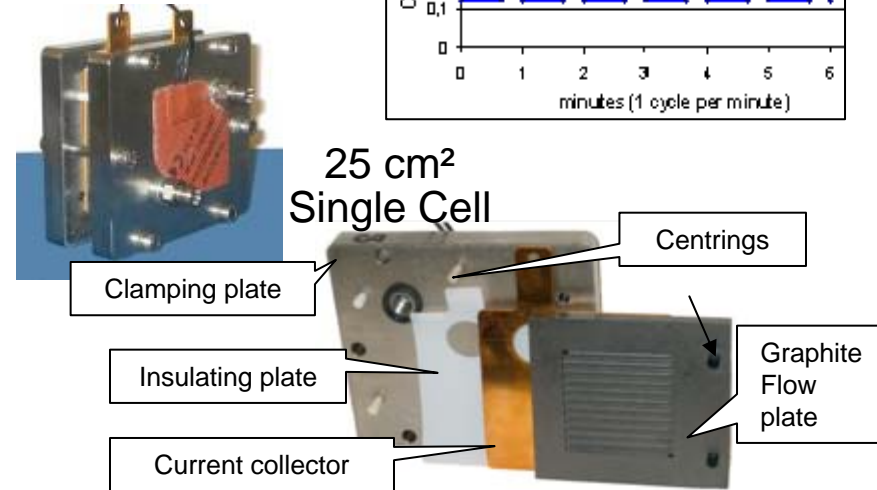
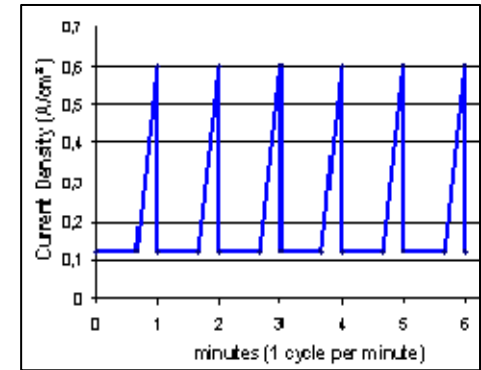
1. Stationary operation at fixed $i = 0,6\text{A/cm}^2$
2. Load cycles: 1 cycle/min $0,12\text{A/cm}^2$ & $0,6\text{A/cm}^2$

- In-situ analyses BoT & EoT:

- i-V curves
- EIS
- LSV (i_{H_2} cross over)
- CV (H_2 ads/desorption)

- Operating conditions

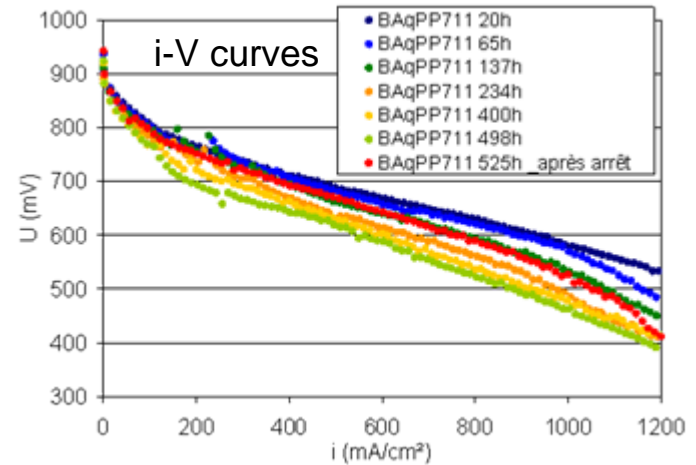
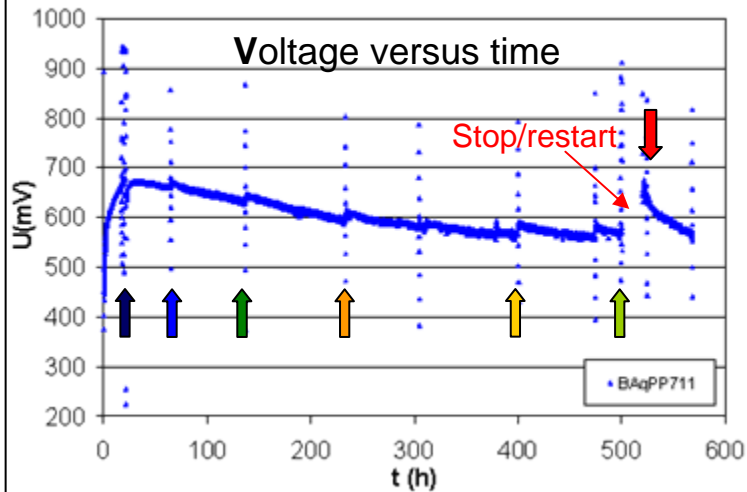
- T cell = 80°C
- P = 1,5 bars
- H_2 / Air: st 1,5/2 ($i_{\text{min}} 0,1\text{A/cm}^2$)
- Gases humidification: H_2 40% / Air 60%
- Counter-flow operation



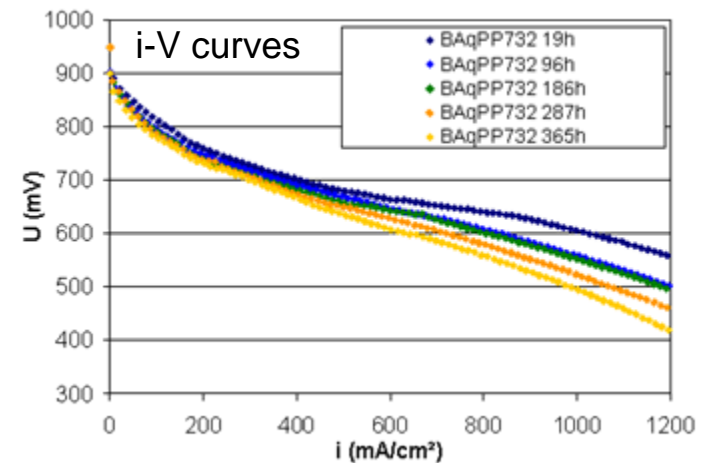
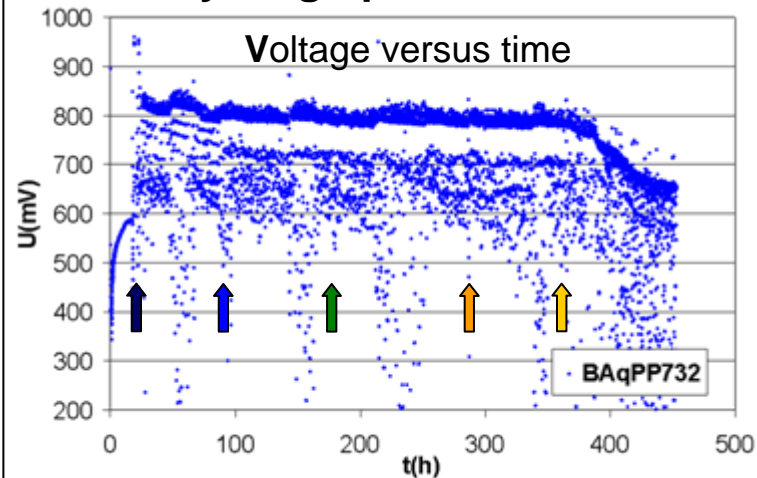
Test station

→ Comparison of two MEAs

• Stationary operation at 0.6A/cm² - 80°C, 1.5 bars, 40/60%



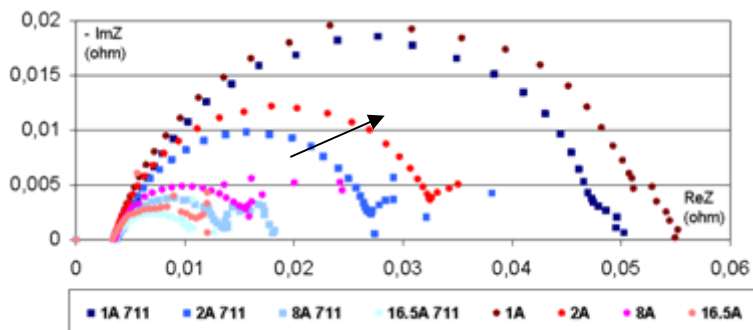
• Load cycling operation at 0,12_0.6A/cm² - 80°C, 1.5 bars, 40/60%



- Stationary operation at $0.6\text{A}/\text{cm}^2$ - 80°C , 1.5 bars, 40/60%

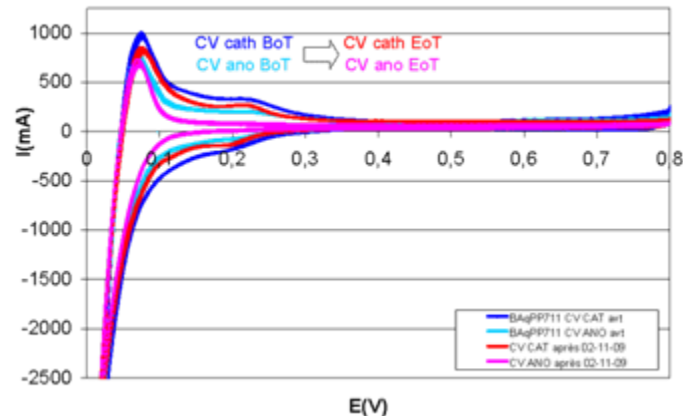
Electrochemical Impedance Spectra

BoT & EoT



→ mainly electroactivity losses

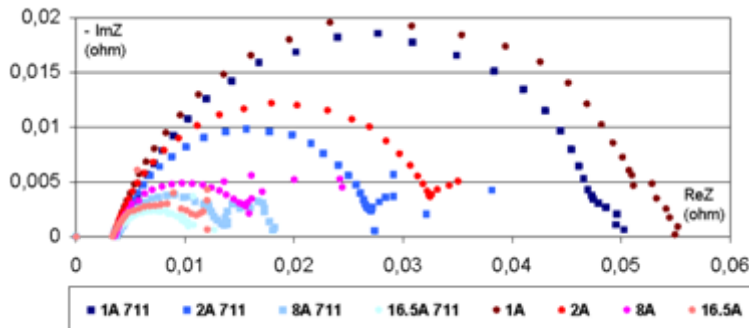
Cyclic voltammograms



- Stationary operation at $0.6\text{A}/\text{cm}^2$ - 80°C , 1.5 bars, 40/60%

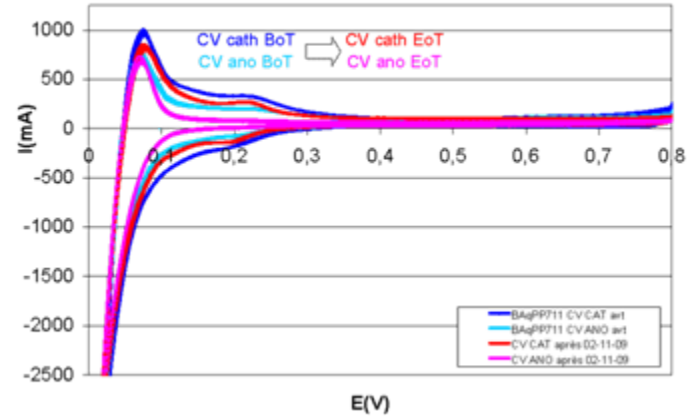
Electrochemical Impedance Spectra

BoT & EoT

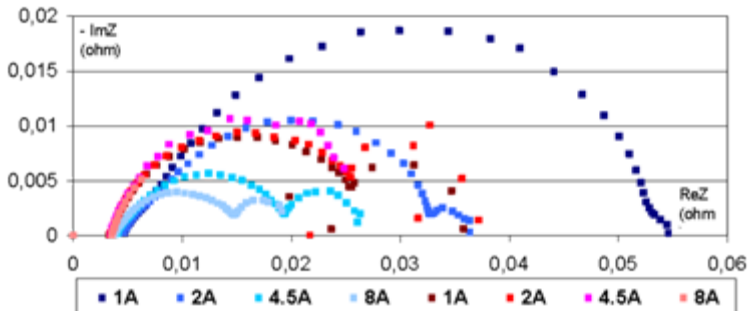


→ mainly electroactivity losses

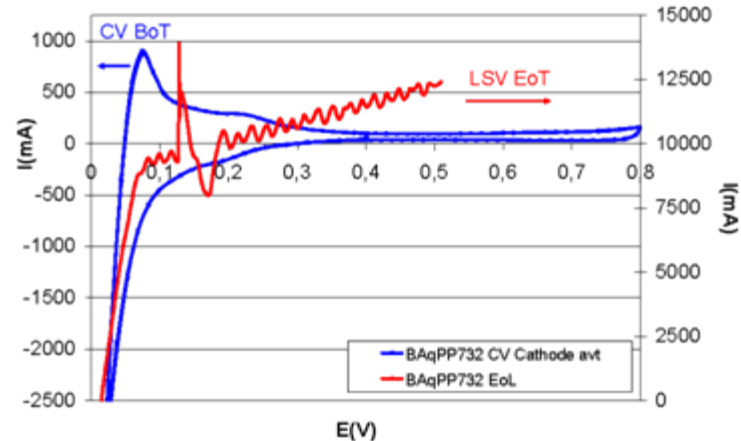
Cyclic voltammograms



- Load cycling operation at $0.12_0.6\text{A}/\text{cm}^2$ - 80°C , 1.5 bars, 40/60%



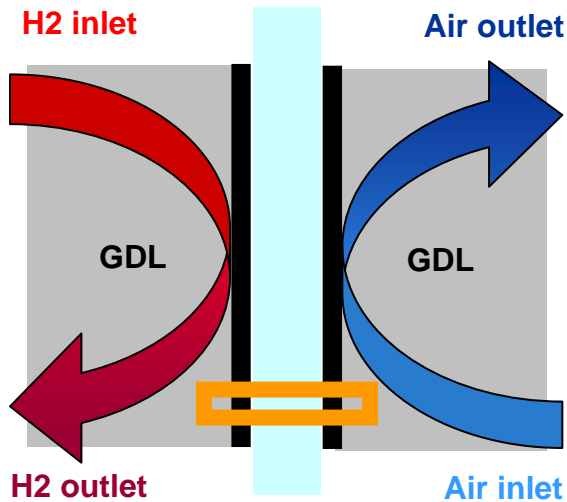
→ cross-over: membrane degradation
(no access to other information)



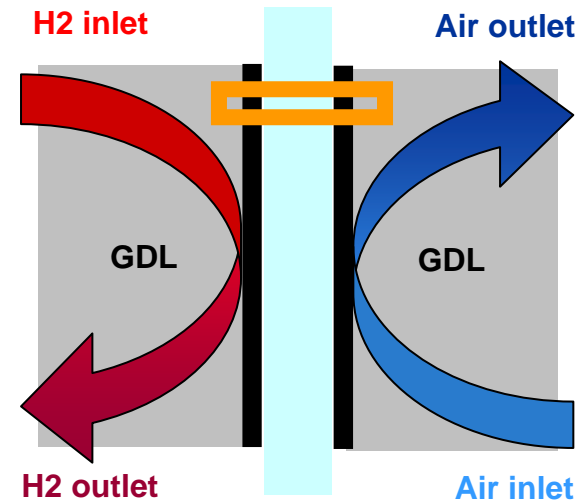
→ local analyses

- MEA observations by electron microscopy (SEM & TEM)

→ Identification of local modifications of the active layers & related degradation mechanisms



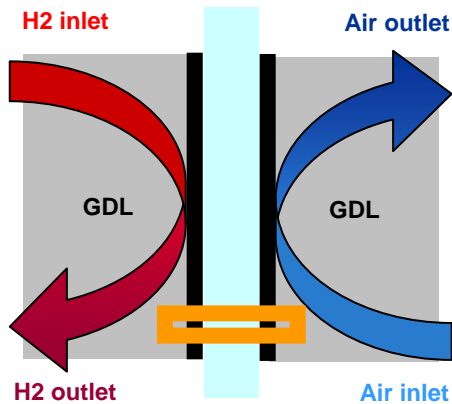
① MEA samples
at Air Inlet / H₂ Outlet



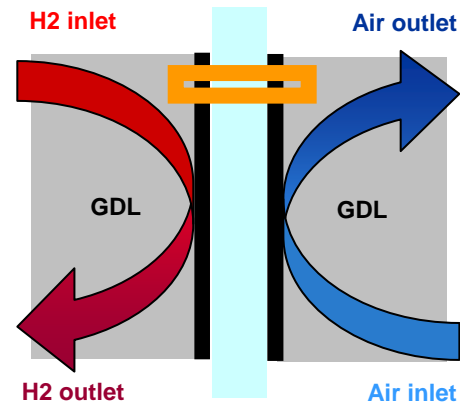
② MEA samples
at Air Outlet / H₂ Inlet

- MEA observations by electron microscopy (SEM & TEM)

→ Identification of local modifications of the active layers & related degradation mechanisms



① MEA samples
at Air Inlet / H₂ Outlet



② MEA samples
at Air Outlet / H₂ Inlet

→ 1st = observations after cycling operation