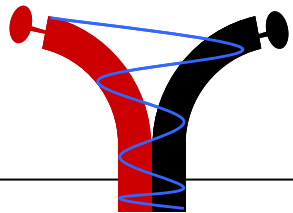


Electrodes ageing: local degradation insights

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

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A. Selimovic



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

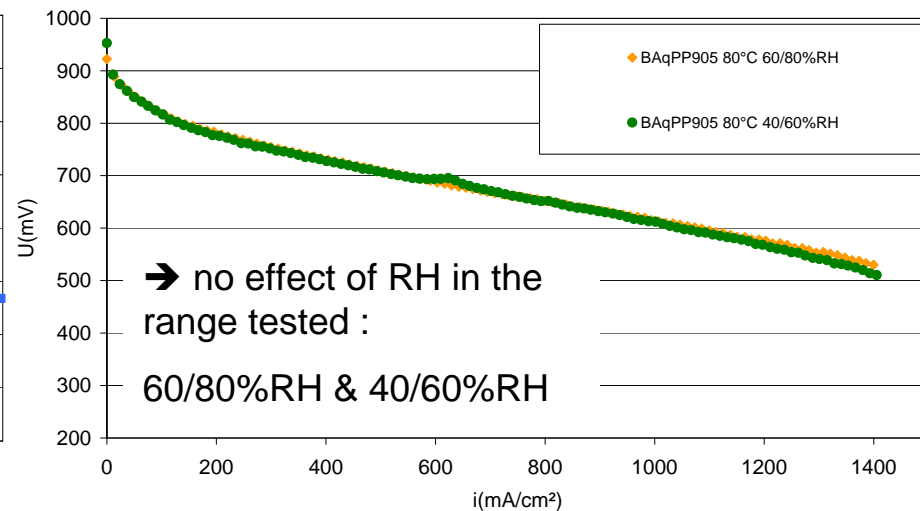
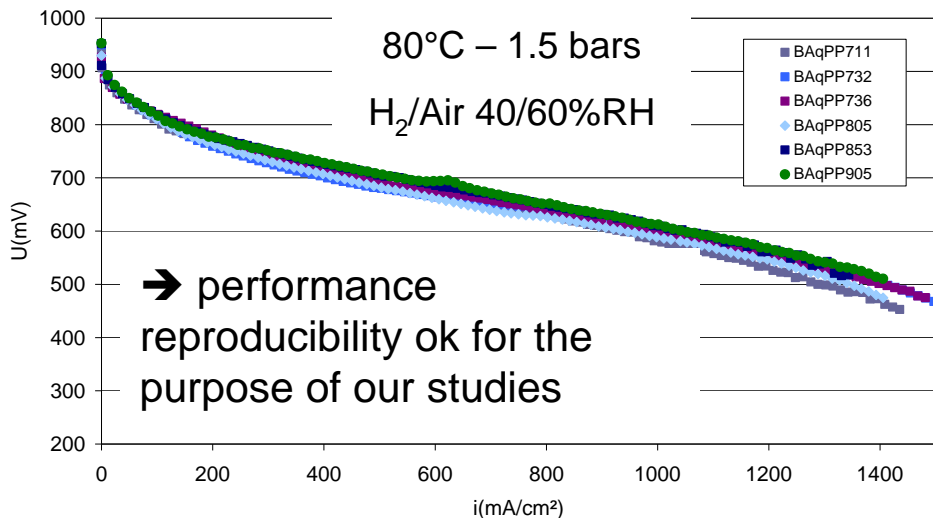
- MEA type : CCB (Catalyst Coated Backing)

- 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

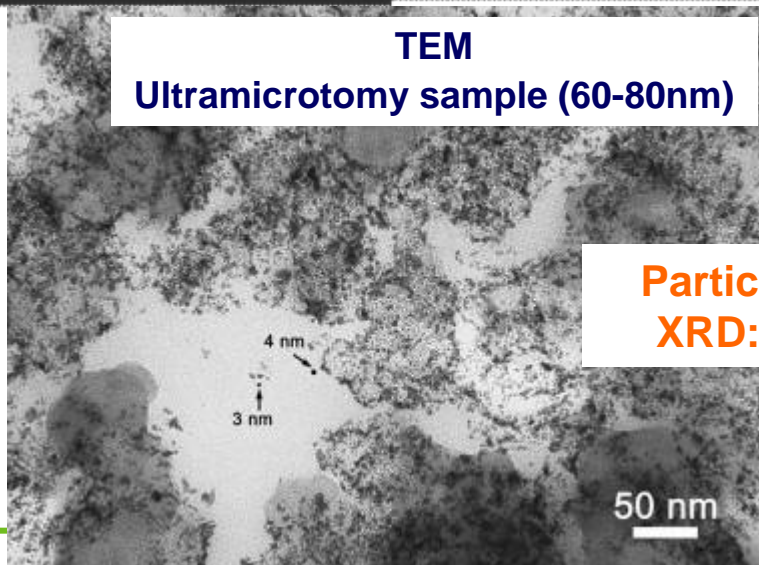
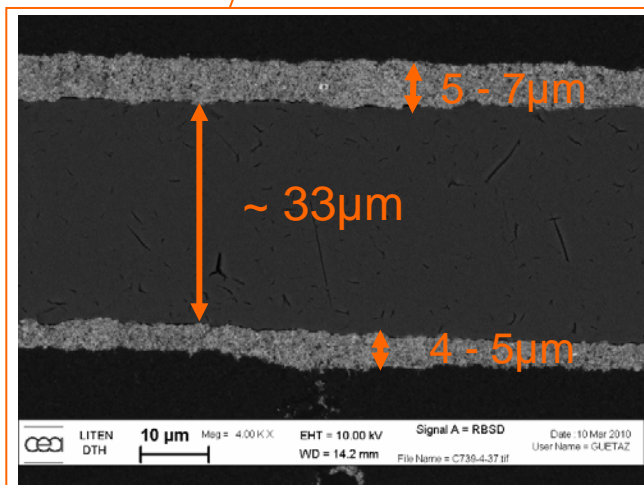
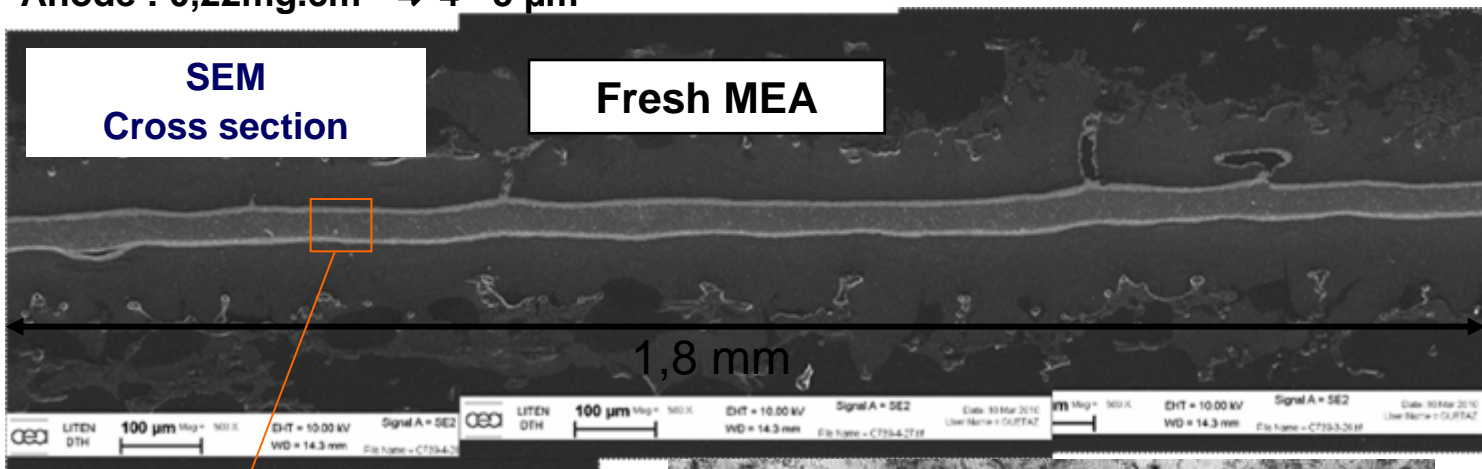


- MEA initial aspect & microstructure

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

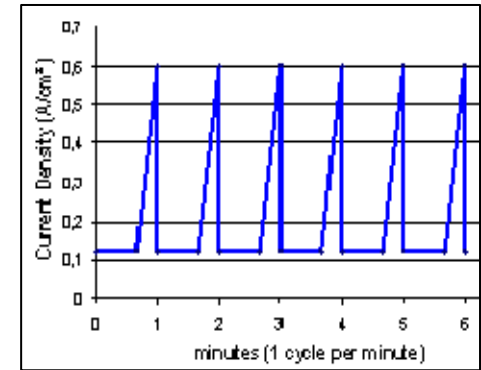
Membrane thickness : $32,5 - 34,5 \mu\text{m}$

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



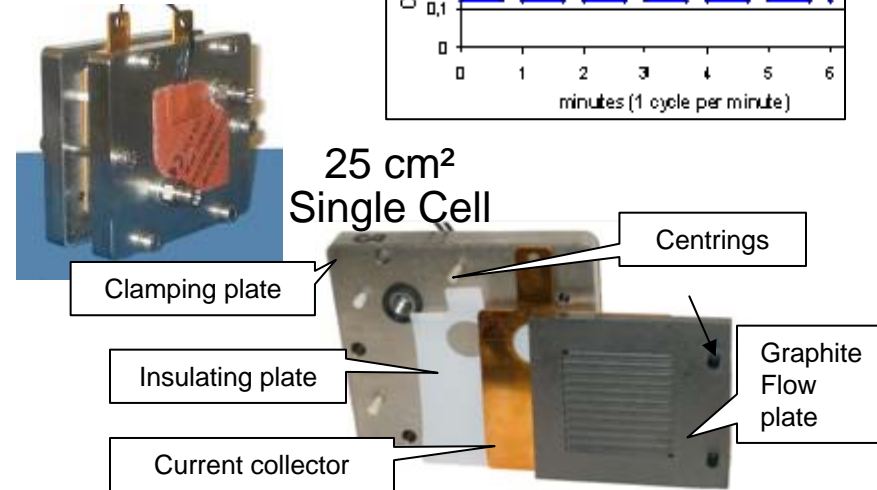
- Ageing test procedures

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

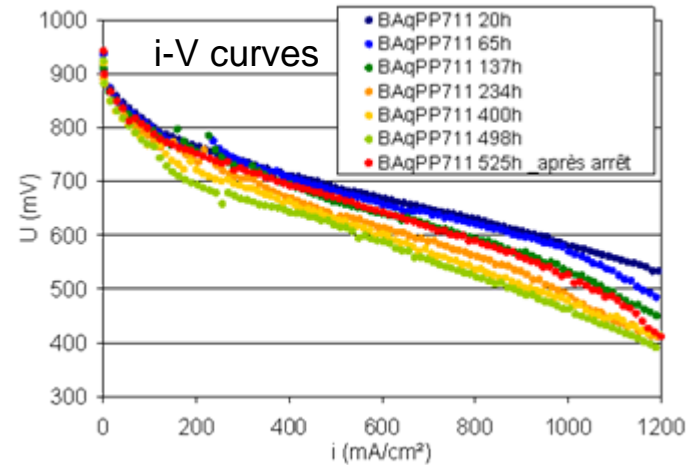
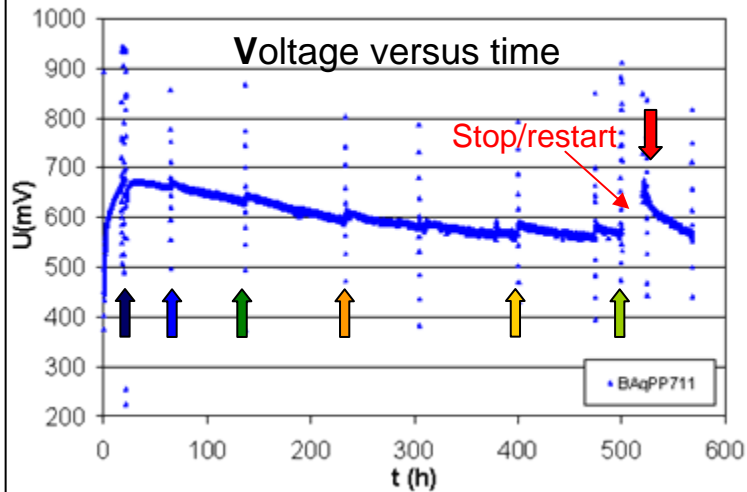
- T cell = 80°C
- P = 1,5 bars
- H₂ / Air: st 1,5/2 (i_{min} 0,1A/cm²)
- Gases humidification: H₂ 40% / Air 60%
- Counter-flow operation



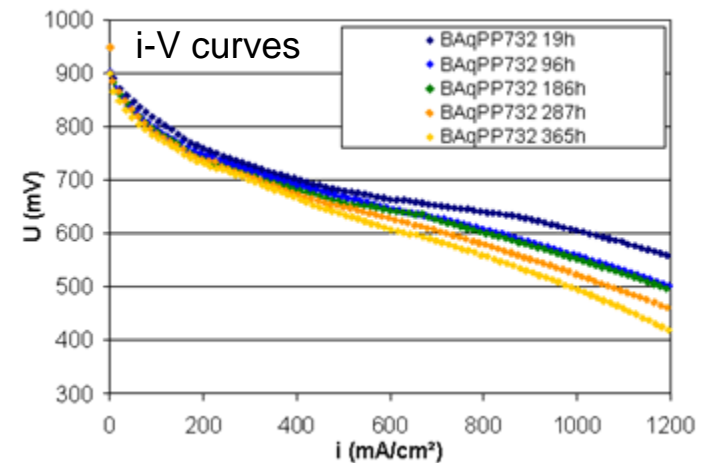
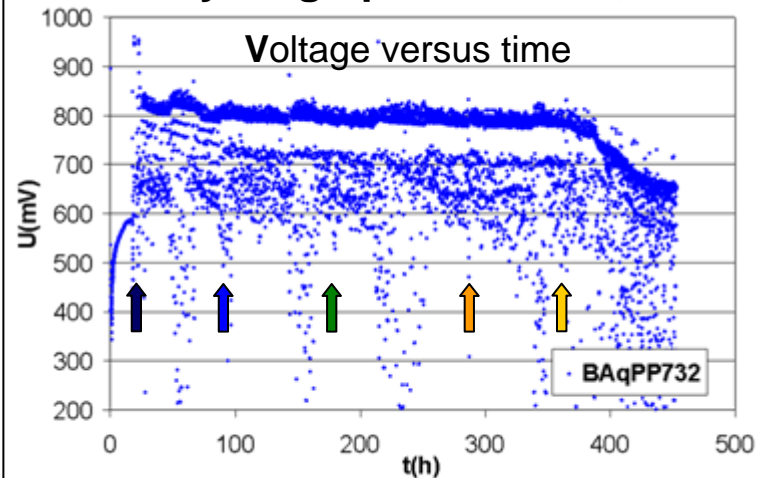
Test station

→ Comparison of two MEAs

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



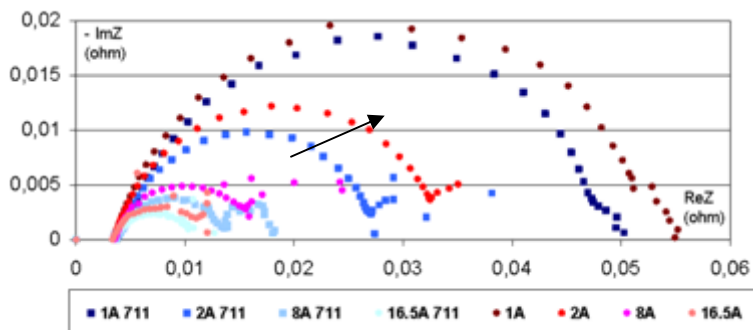
• Load cycling operation at 0,12_0.6A/cm² - 80°C, 1.5 bars, 40/60%



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

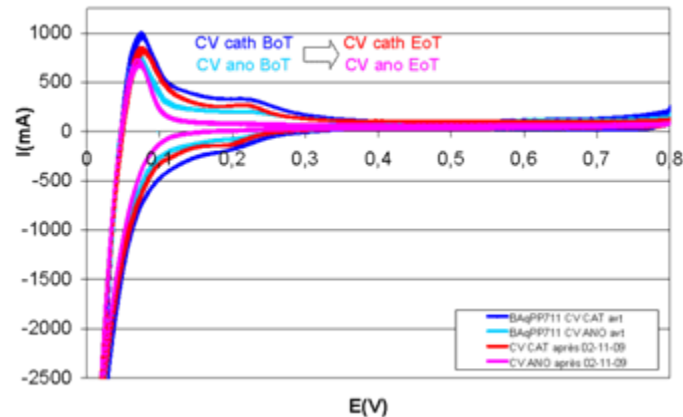
Electrochemical Impedance Spectra

BoT & EoT



→ mainly electroactivity losses

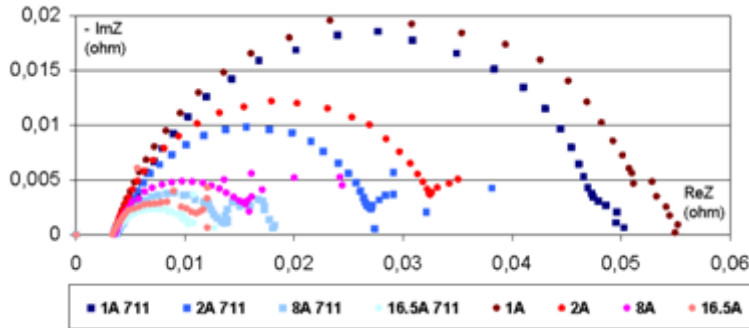
Cyclic voltammograms



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

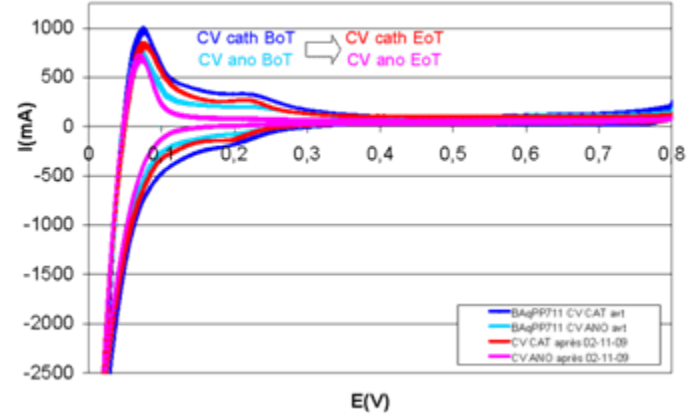
Electrochemical Impedance Spectra

BoT & EoT

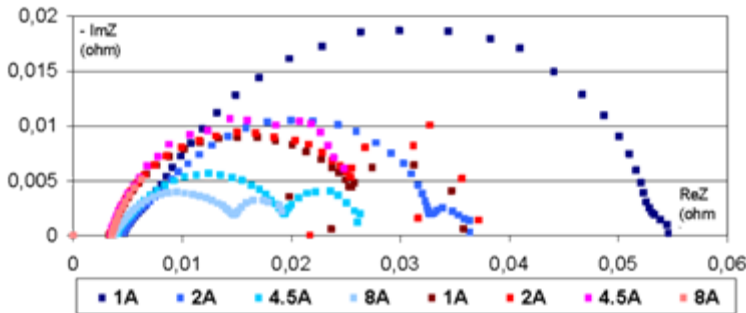


→ mainly electroactivity losses

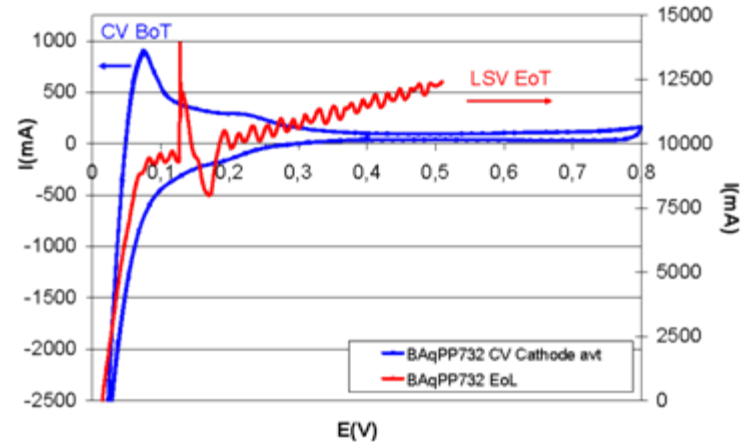
Cyclic voltammograms



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



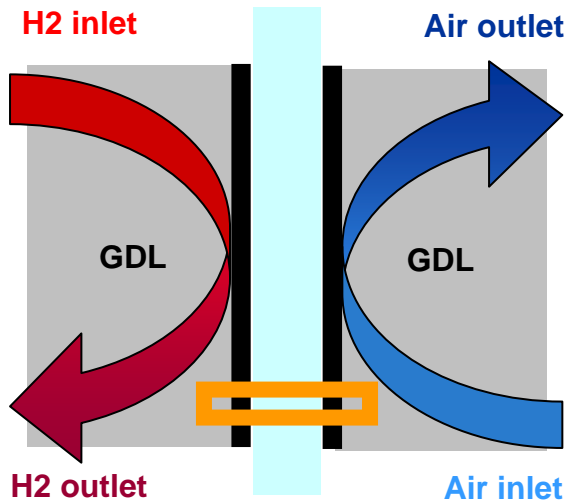
→ cross-over: membrane degradation
(no access to other information)



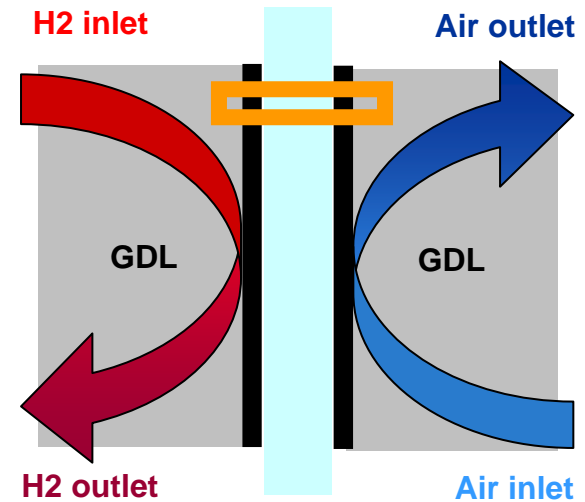
→ local analyses

- MEA observations by electron microscopy (SEM & TEM)

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



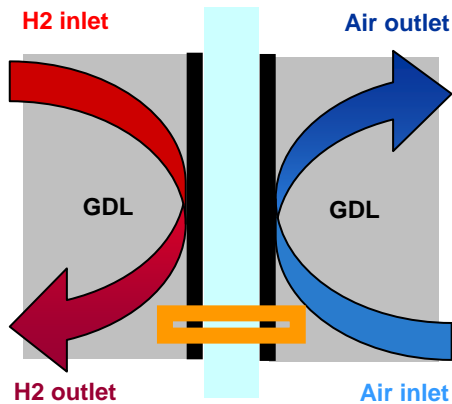
① MEA samples
at Air Inlet / H₂ Outlet



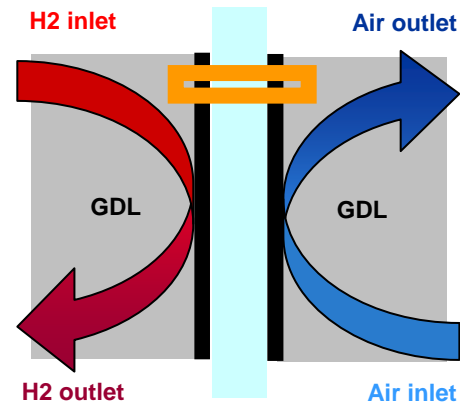
② MEA samples
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- MEA observations by electron microscopy (SEM & TEM)

→ 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