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AEM EL TEST PROTOCOLS



NEWELY

Next Generation Water Electrolyser



H₂

Next Generation Alkaline Membrane
Water Electrolyzers
with Improved Components
and Materials



This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No 875118. This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation program, Hydrogen Europe and Hydrogen Europe Research



F. FOU DA-ONANA
September 29th, 2023

Outlines

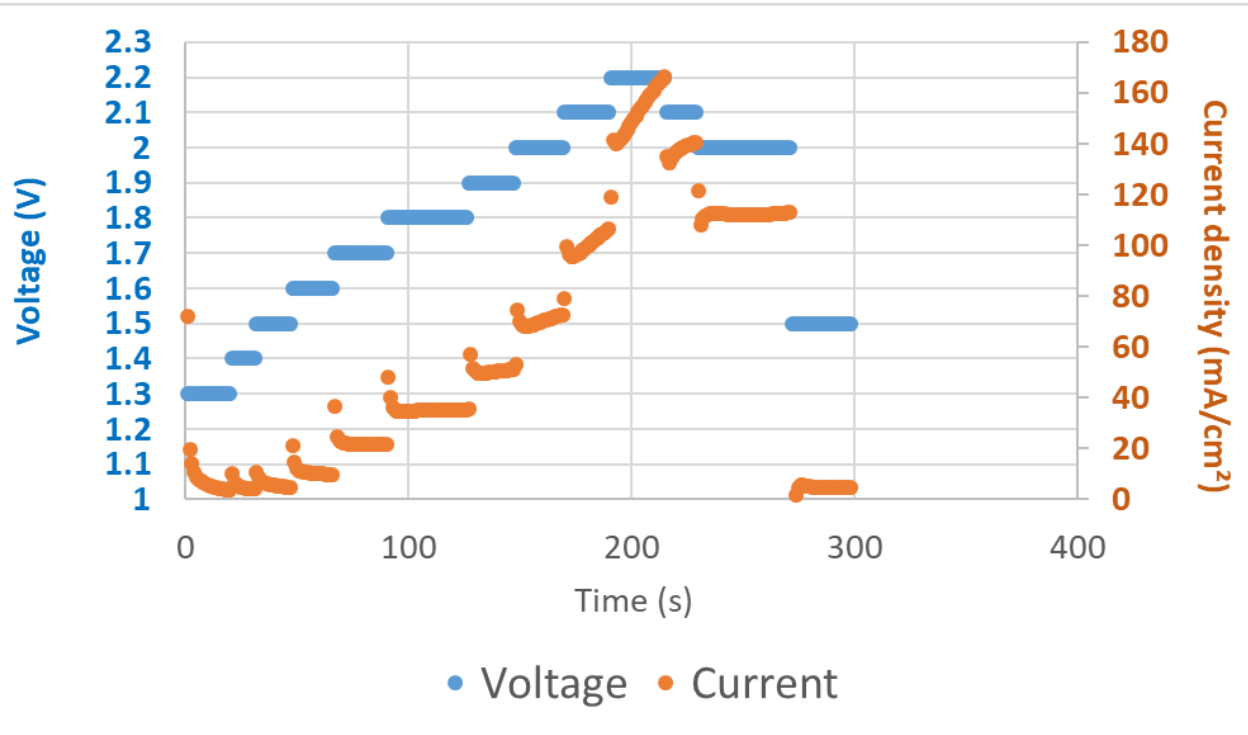
- Break In protocol
- IV curves measurements
- Influence of the flow rate
- Impact of the cell resistance
- Conclusion

**Only one testing condition
50°C – 0.1 M KOH – 1 bar – dry cathode mode**

Importance of the voltage

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Manual fast break-in period

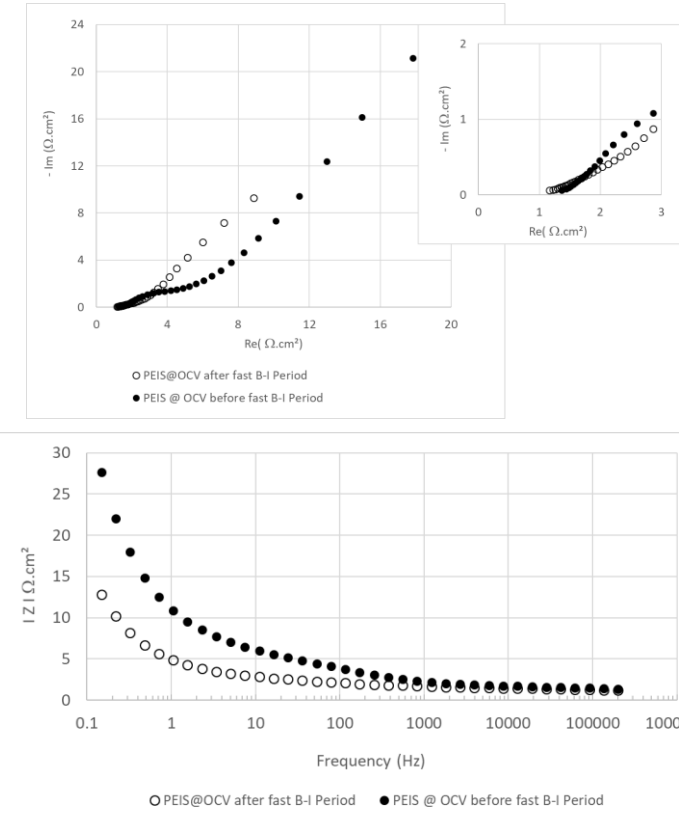


Non PGM catalysts from CENmat
 Membrane from IMC
 Ionomer from IMC
 2 cm² single cell



Below 2 V, no conditioning

PEIS @ OCV



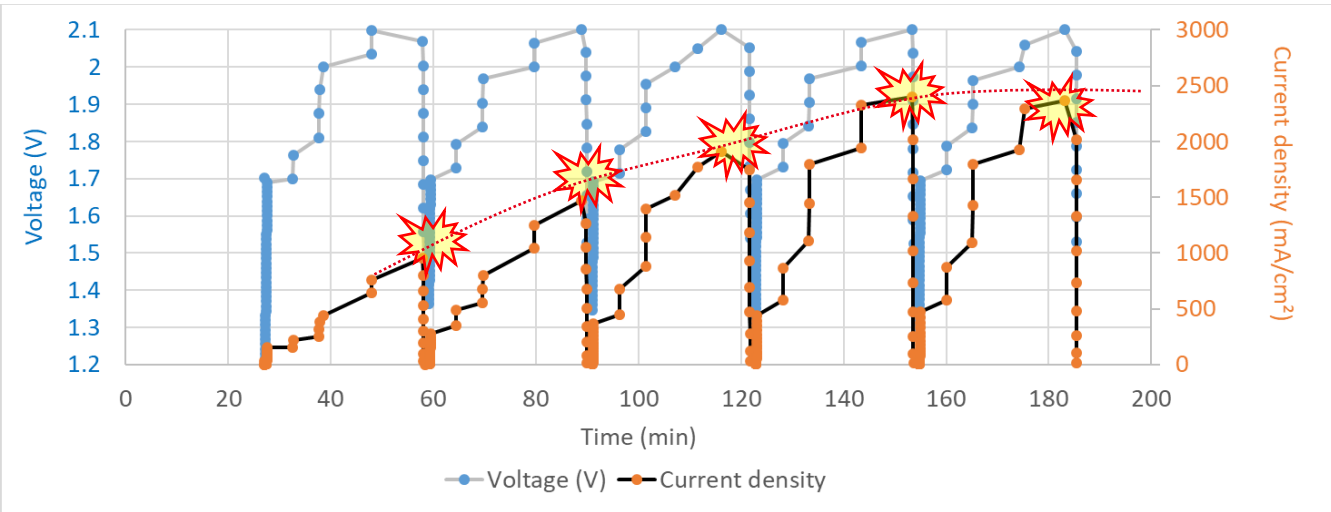
After fast B-I period

- Slightly lower HFR (improvement σ_{OH^-})
- Much lower LFR (better kinetics)

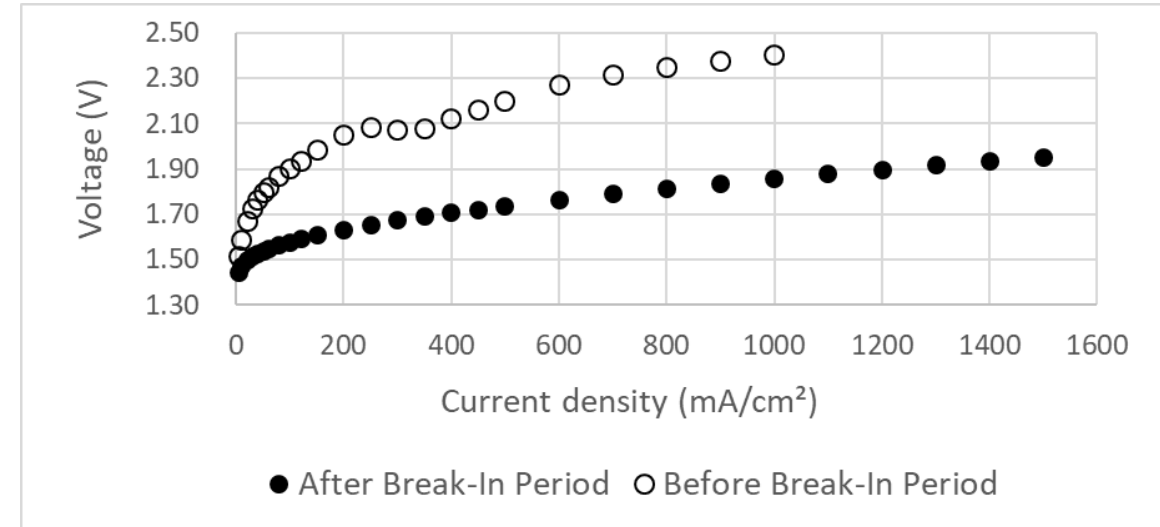


Break-In to be optimized for each system

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*Non PGM catalysts from CENmat
Membrane from IMC
Ionomer from IMC
2 cm² single cell*



➡ No more improvement after 5 cycles

➡ Impressive performance increase after B-I period
(about 400 mV improvement @ 1 A/cm²)

Is the IV curve affected by the measurement protocol ?

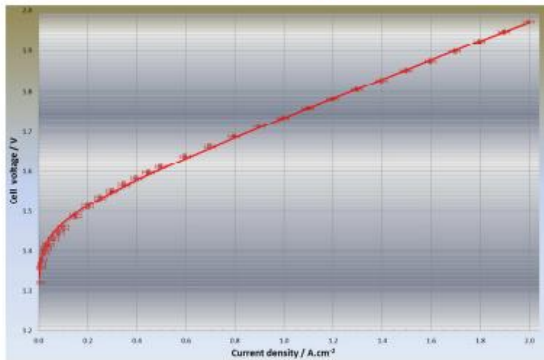


JRC VALIDATED METHODS, REFERENCE METHODS AND MEASUREMENTS REPORT

EU harmonised polarisation curve test method for low-temperature water electrolysis

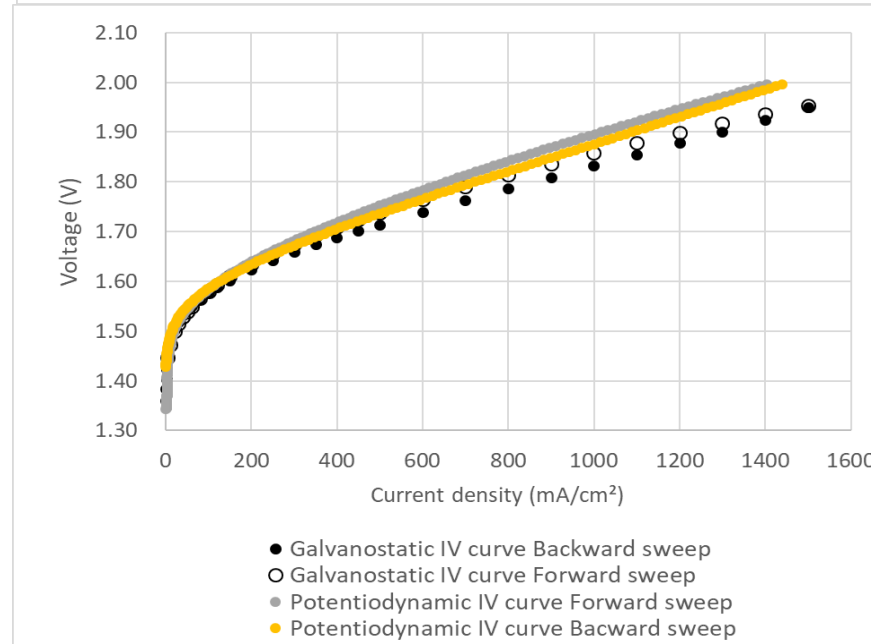
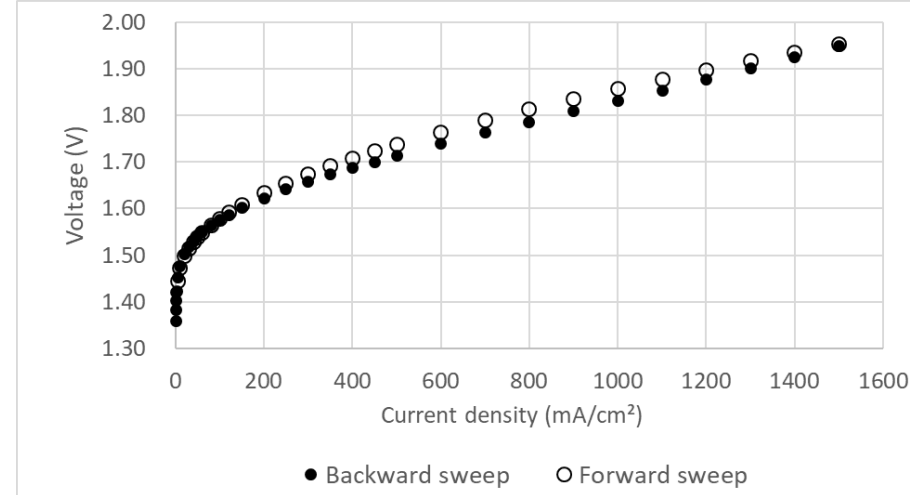
Malkow T., Pilenga A., Tsotridis G., De Marco G.

2018



EUR 29182 EN

doi:10.2760/179509 p25/48



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Few voltage difference between both forward and backward modes (30 mV @ 1A/cm²)

Non PGM catalysts from CENmat
Membrane from IMC
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2 cm² single cell



- Few voltage difference between both sweeps for both IV curves modes
- Galvanostatic mode gives higher performances above 600 mA/cm²

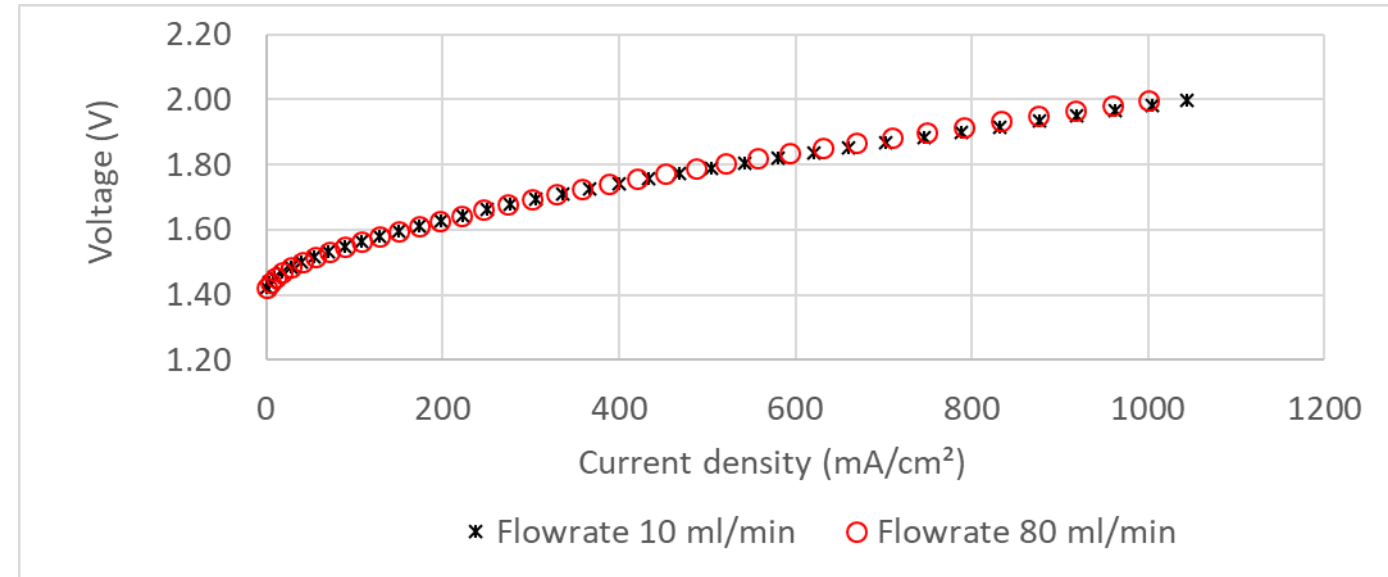
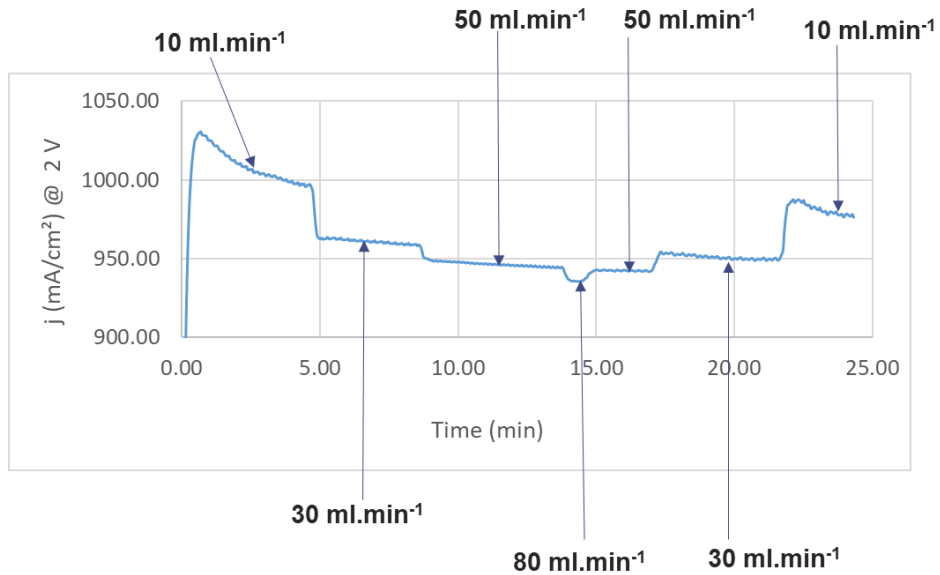
Main assumption :

Higher temperature during galvanostatic IV curve (σ_{OH^-} enhancement)

Flowrate: lower is better

- Break in protocol
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25 cm² single cell



Commercial PGM catalysts
Commercial membrane and ionomer
25 cm² single cell



Decrease the KOH flowrate even below 1 ml/min/cm² improves the performance



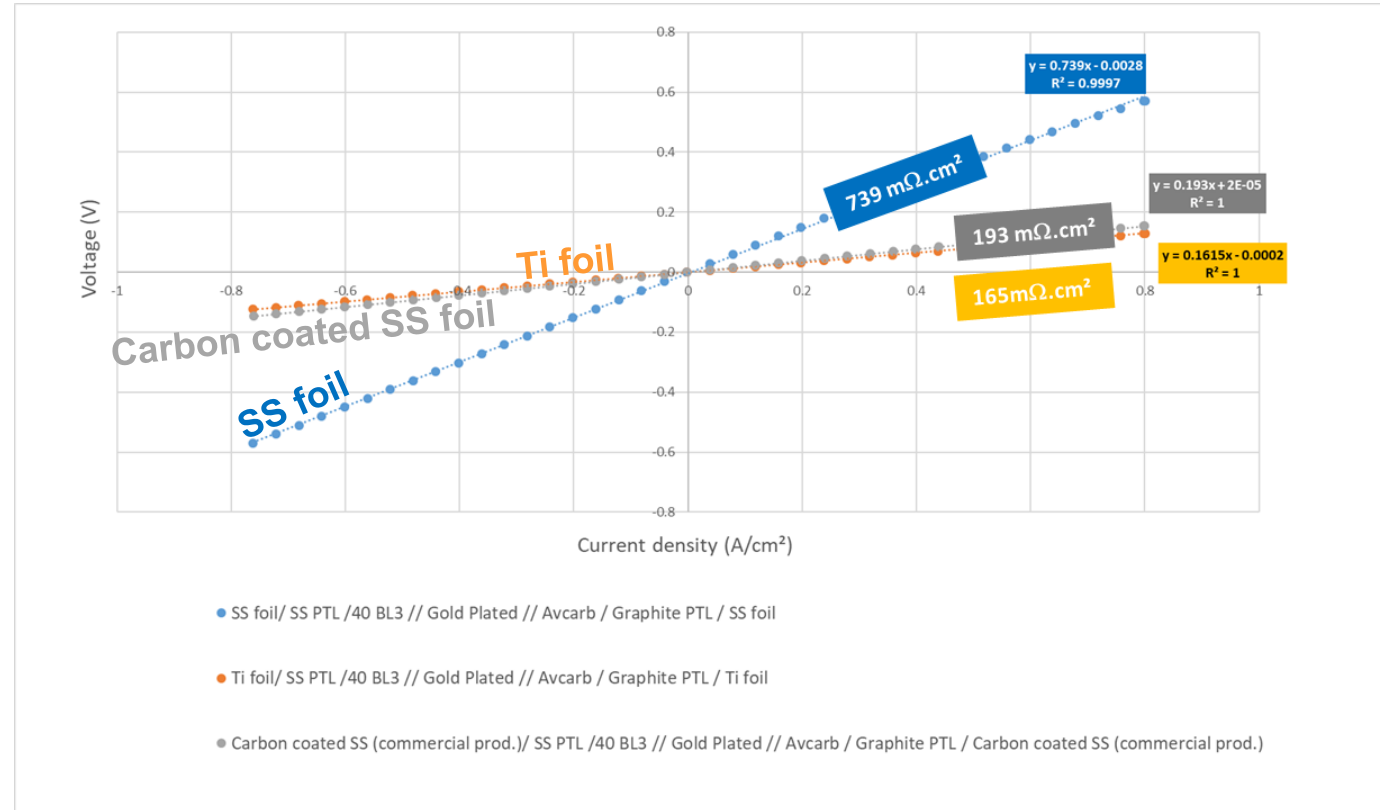
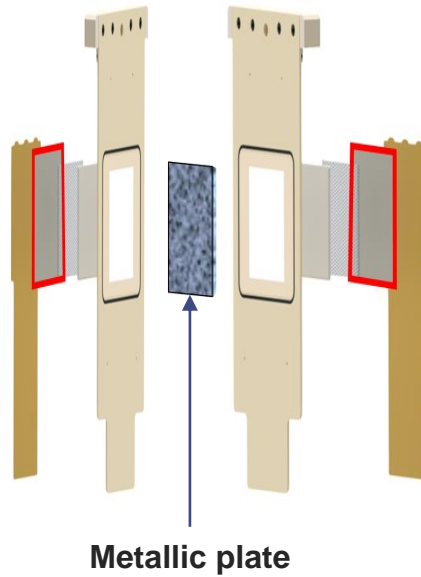
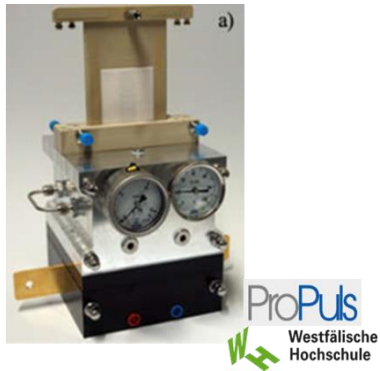
The influence of the flowrate was not observed on IV curves recorded in potentiodynamic mode

Main assumption :

The recording was too fast to observe the effect

High contact resistance, lower performances, obvious but ...

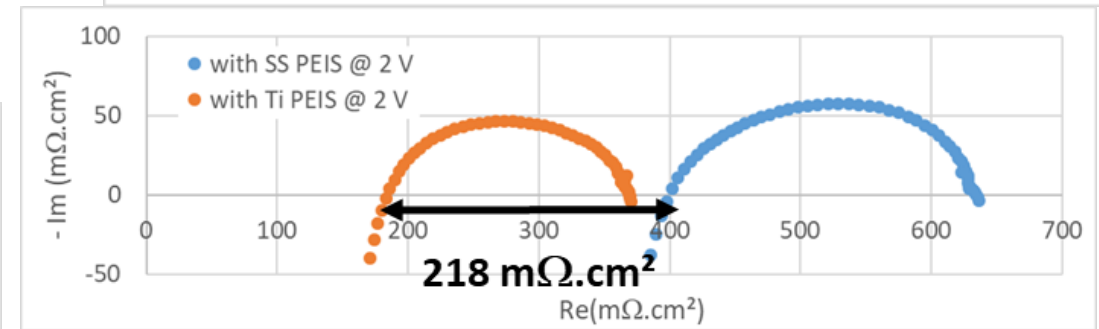
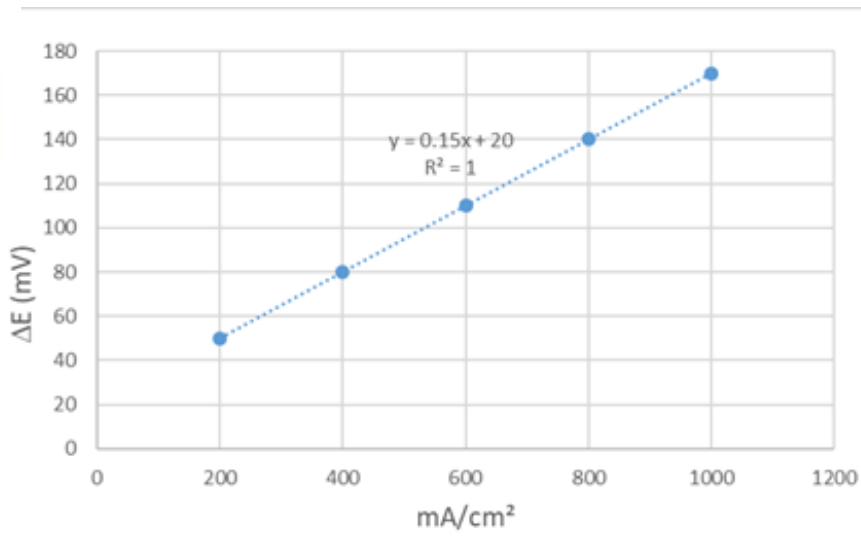
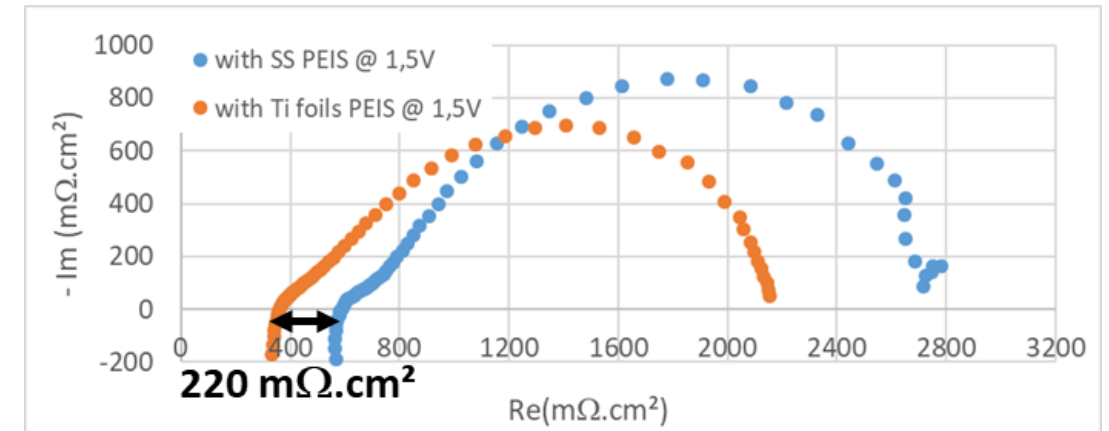
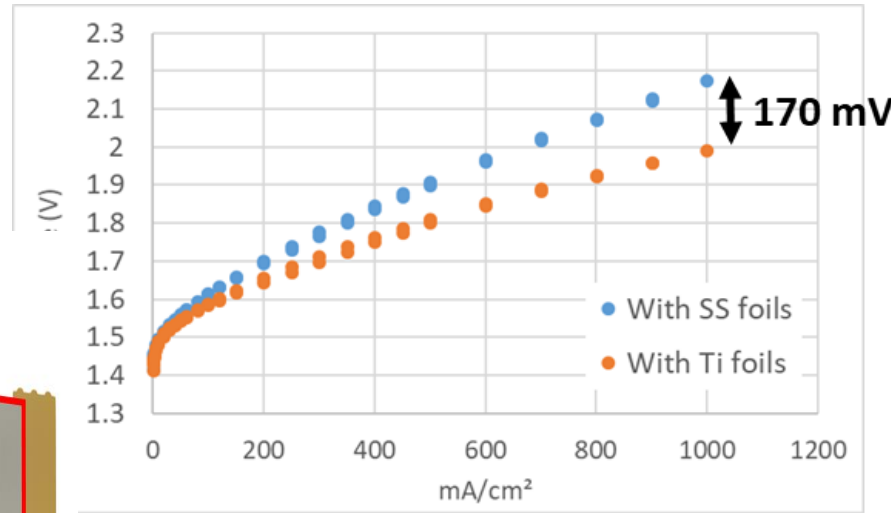
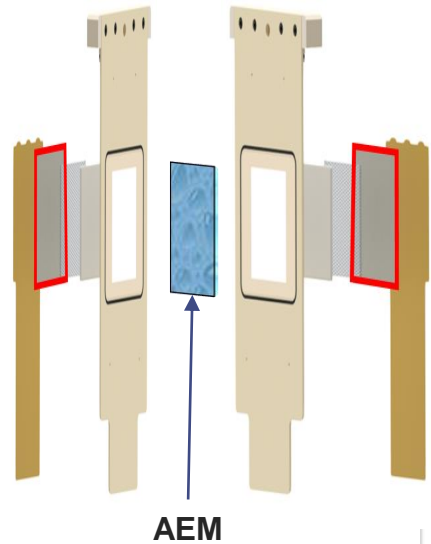
- Break in protocol
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The SS foil batch of this test was not suitable to be part of the cell

High contact resistance, lower performances, obvious but ...

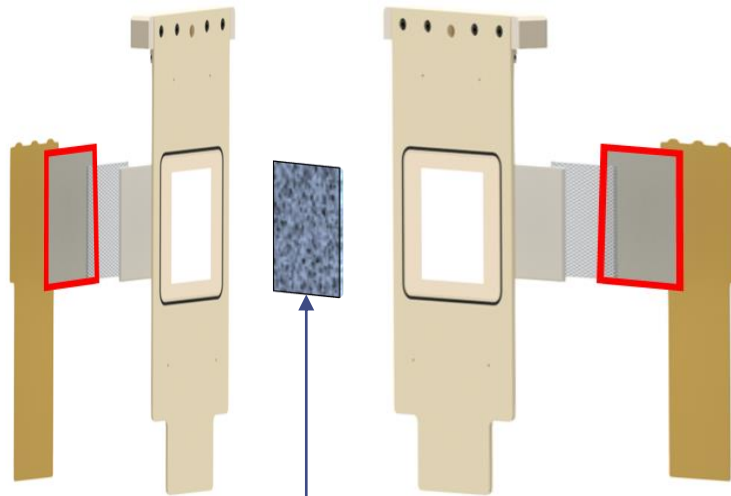
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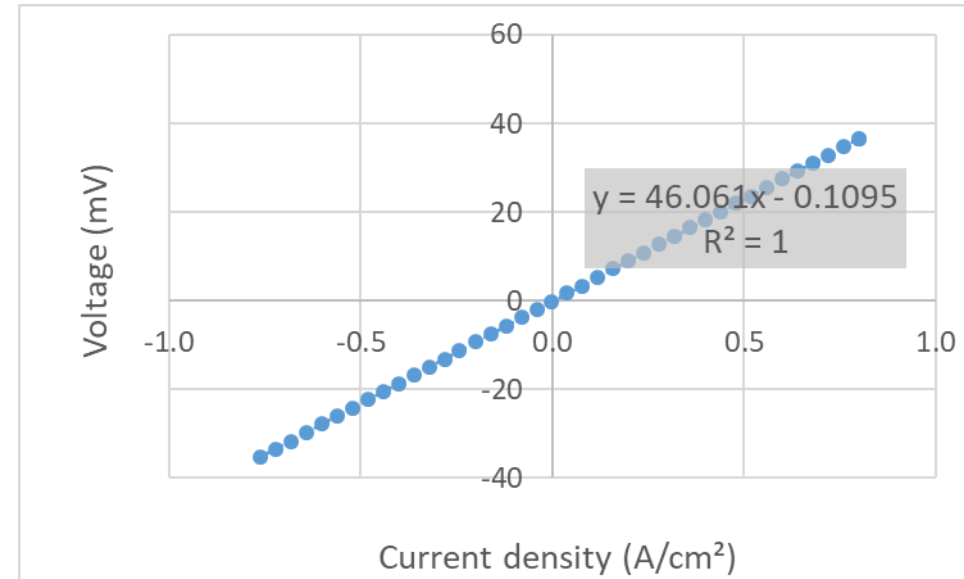
- The performance losses are caused only by poor contact resistance
- It is recommended to report the cell resistance when one provides IV curves.

High contact resistance, lower performances, obvious but ...

- Break in protocol
- IV curves measurements
- Influence of the flowrate
- **Influence of the cell resistance**
- Conclusion



Au coated SS plate



- The performance losses are caused only by poor contact resistance
- It is recommended to report the cell resistance when one provides IV curves (may ease comparisons).

$$0 < \text{Cell resistance} < 100 \text{ m}\Omega \cdot \text{cm}^2$$

Conclusion

▪ Break In protocol

- PGM or Non PGM electrodes, below 2 V no activation of the cell
- Break-In protocol could not be harmonized
- Good B-I protocol improves mainly the cell kinetics.

▪ IV curves measurements

- GalvanoStatic (GS) mode leads to higher performance than Potentiodynamic
- Slight difference between forward and backward sweep for both modes (GS and PD)

▪ Influence of the flow rate

- Lower flowrate seems to improve the cell performance
- It was not observed during PD mode IV measurements but maybe too fast dynamic to observe the flowrate influence

▪ Impact of the cell resistance

- High contact resistance, low performance
- Should be the first measurement before inserting the MEA
- Suitable value, cell resistance < 100 mΩ.cm²

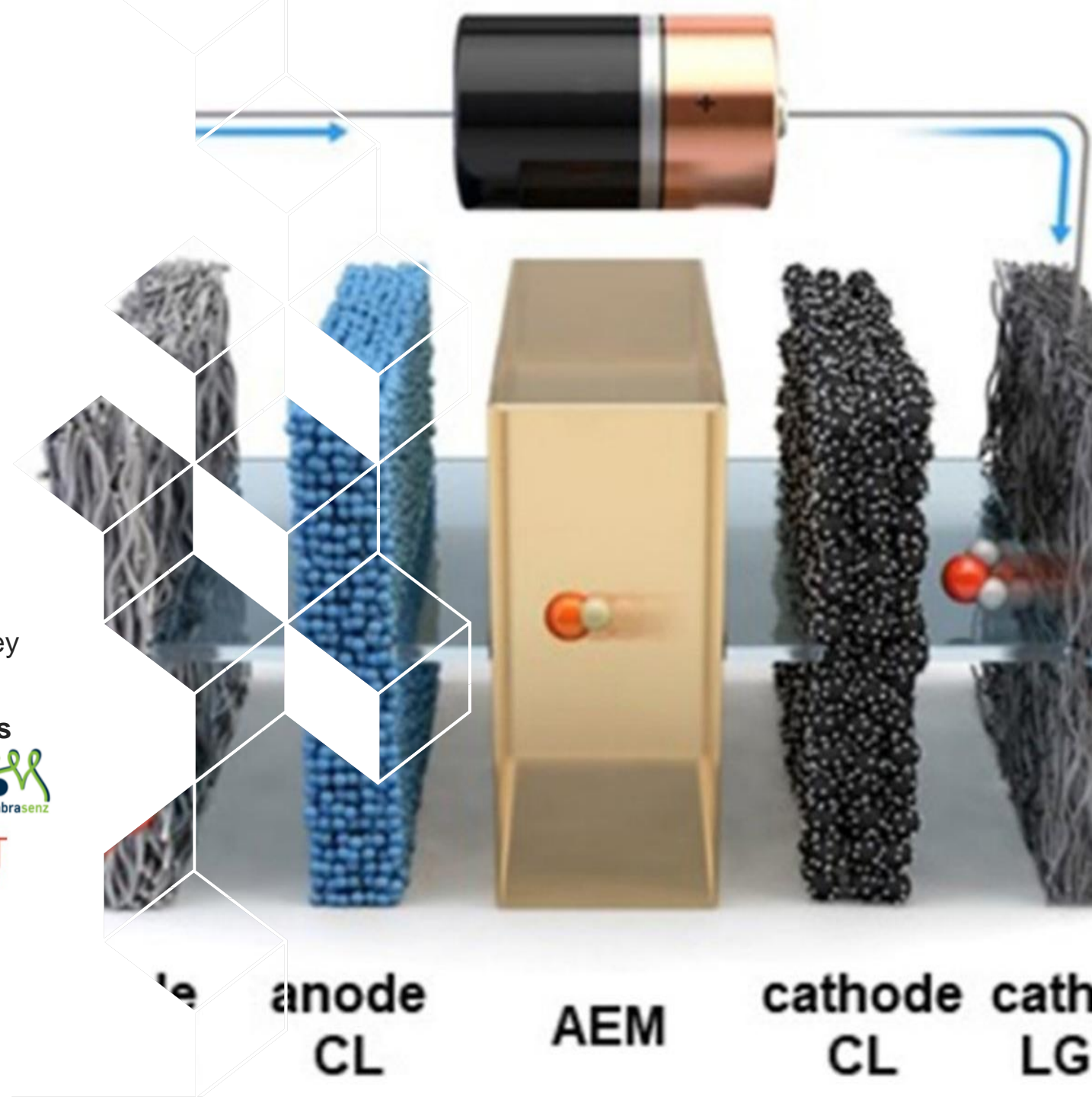


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Thanks to my colleagues
Samira Chelghoum, Gareth Keeley

Thanks to the NEWELY partners



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