

Experiences from AST in PEMFC

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2nd INTERNATIONAL WORKSHOP ON DEGRADATION ISSUES OF FUEL CELLS

21-23 SEPTEMBER, 2011

Thessaloniki, Greece

SINTEF background

- Non-profit research foundation
- Fourth largest in Europe, about 2100 employees
- Covers most technological aspects of modern society

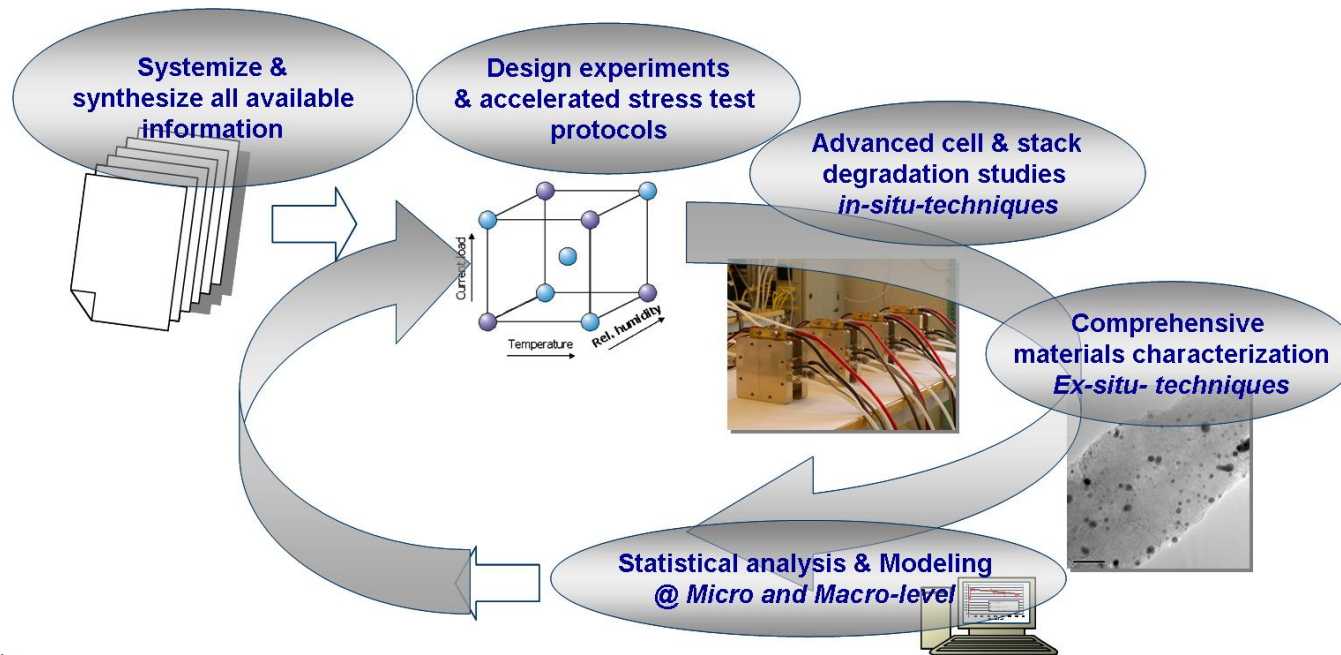
"Technology for a better society"

- International projects related to fuel cell degradation
 - **KEEPEMALIVE** (FCH JU, coord. SINTEF)
 - **STAYERS** (FCH JU, coord. Nedstack)
 - **RAMSES** (FCH JU, coord. CEA)
 - **HYLIFT** (FCH JU, coord. LBST)
 - **NORCOAT** (NICE/TEKES, coord. SINTEF)

KEEPEMALIVE

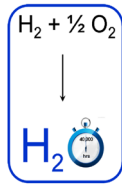
Aims to establish:

- Improved understanding of degradation and failure mechanisms for stationary PEM fuel cells
- Accelerated stress test protocols, sensitivity matrix and lifetime prediction models



- Funded by FCH JU

STAYERS



Main objective of the project is to:

- Materials research to improve longevity and reliability
- Lifetime of 40 000 hours for stationary applications
- Verify by real-life testing of stacks in the chlorine-alkali plant in Delfzijl vs. AST in lab

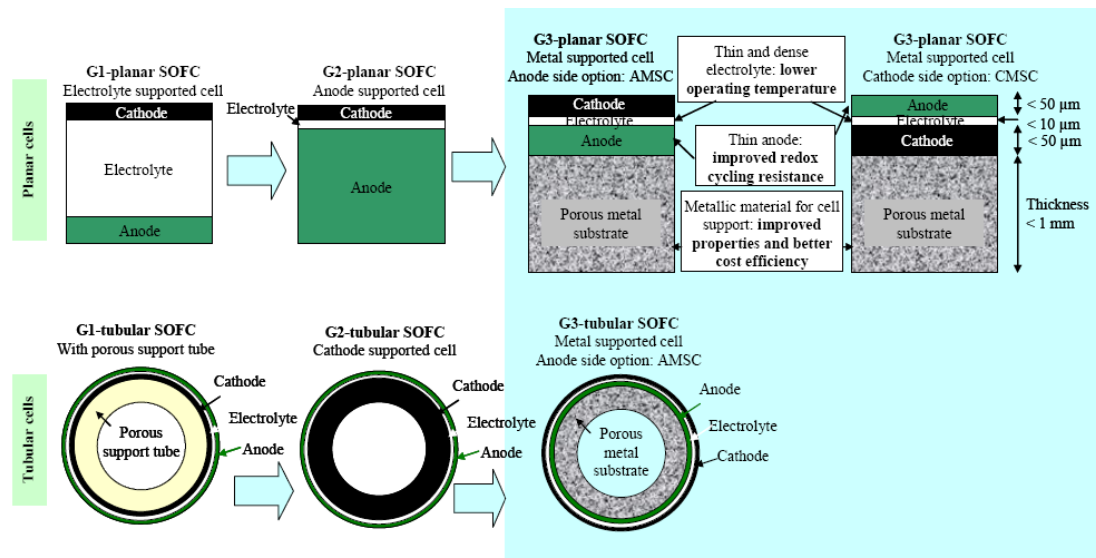


- Funded by FCH JU



Robust Advanced Materials for metal SupportEd SOFC

- Develop 3rd generation SOFC
 - Increased performance & durability
 - Reduced costs, based on metal supported cells



- Funded by FCH JU

Targeting: 10 000 hours lifetime for materials handling applications

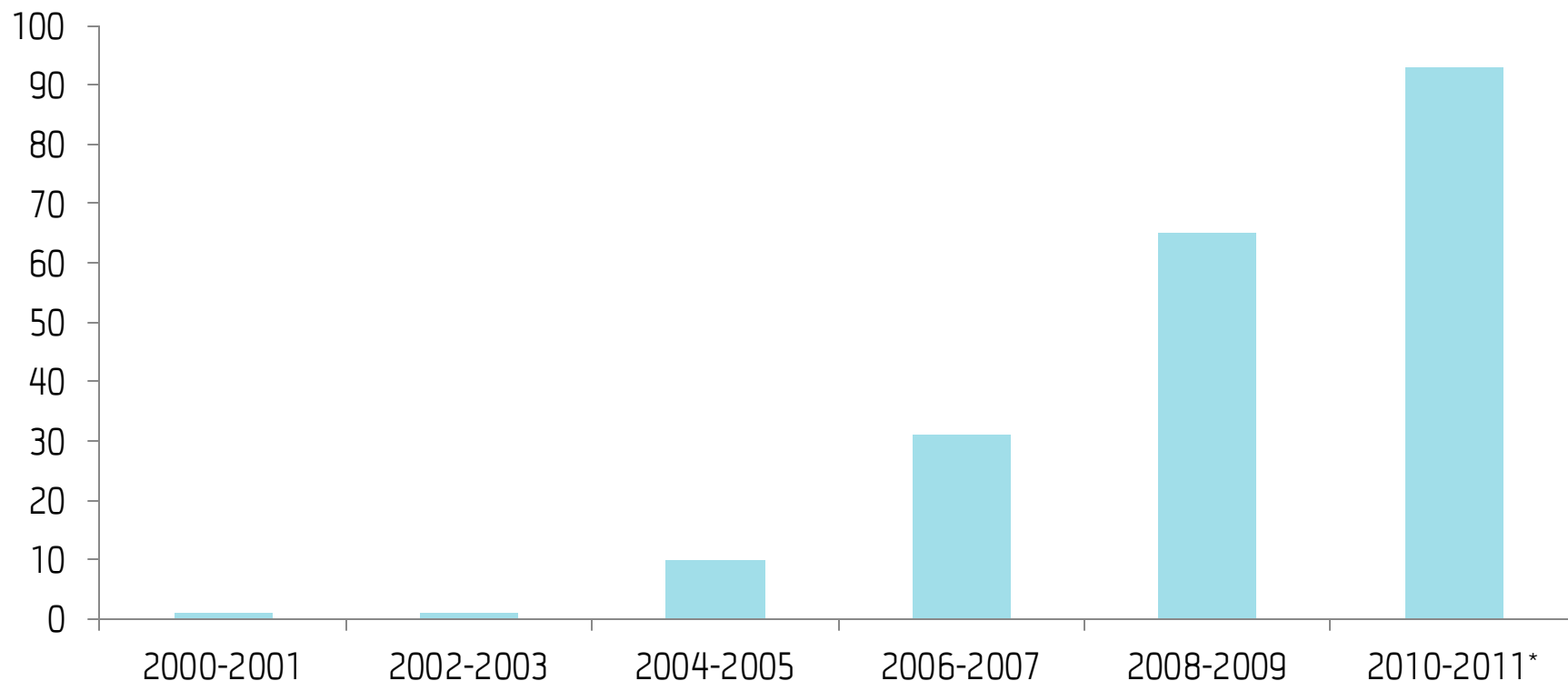
- Aiming at revealing critical parts in the operation profile causing degradation and component failure
 - Define mitigation strategies
 - Adapt control algorithm



- Funded by FCH JU

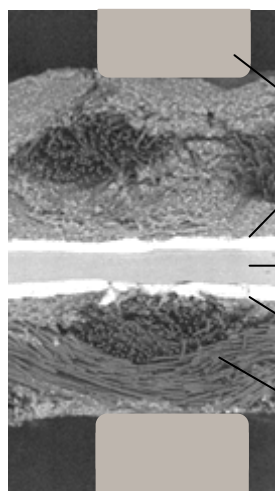
Literature search "Web of Knowledge"

publications, search terms: accelerated + PEM*



Approach to design accelerated degradation protocols

- **Accelerated stress tests** designed to investigate degradation :
 - of specific components (membrane, catalyst, GDL, BPP,...)
 - due to specific operating conditions/parameters
- **Accelerated life tests** designed to investigate real life operation
 - based on experience from real drive cycles



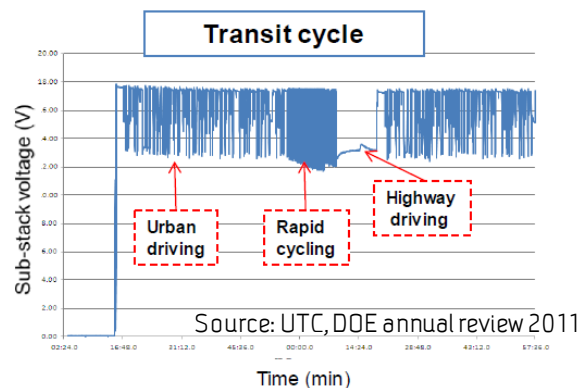
BPP (chemical and mechanical stability)

Catalyst support (electrochemical stability)

Membrane (chemical and mechanical stability)

Catalyst (electrochemical stability, poisoning)

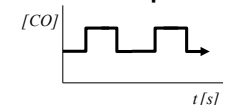
GDL (chemical stability)



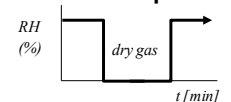
Continuous Operation



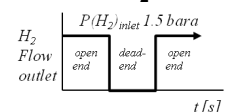
Reformate Operation



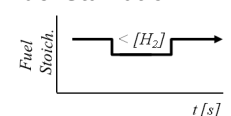
MEA drying / Stack 'Hot Spots'



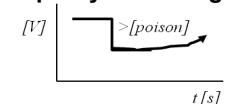
Dead-end H₂ mode



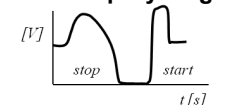
Fuel Starvation



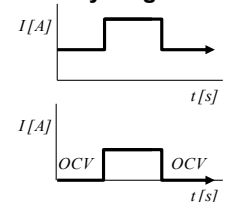
Impurity Poisoning



Start/Stop Cycling

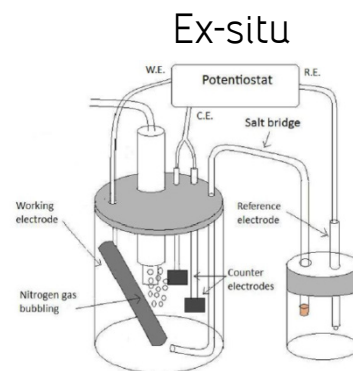
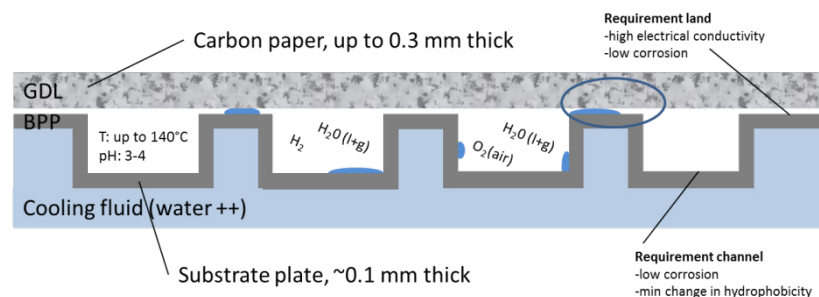


Load Cycling

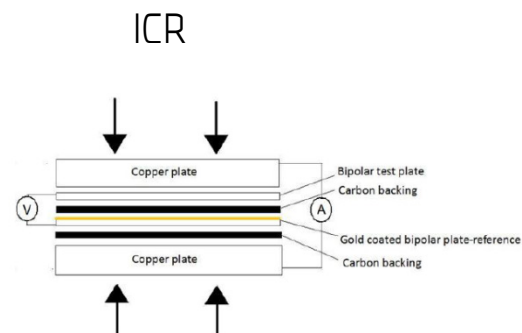
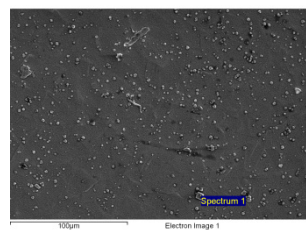


AST for investigation of bipolar plates/coatings

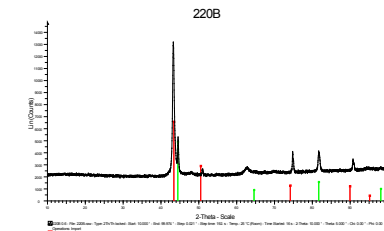
- Key issues are corrosion and interfacial contact resistance (ICR)
- Complex interaction with other components
- Required more than 5000 hours
- Time consuming and cost intensive testing of materials in fuel cells
- Simple and fast screening, preferably ex-situ in electrolyte, simulating fuel cell conditions and operating parameters



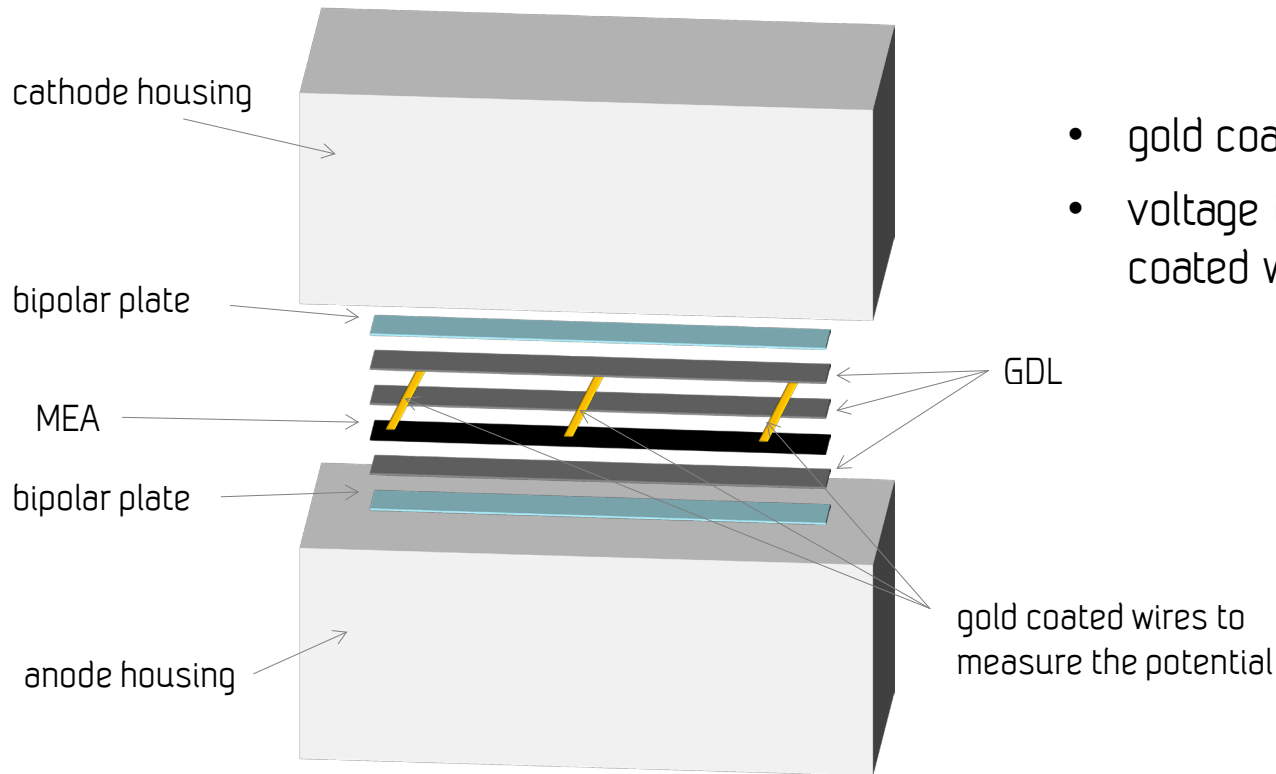
SEM



XRD



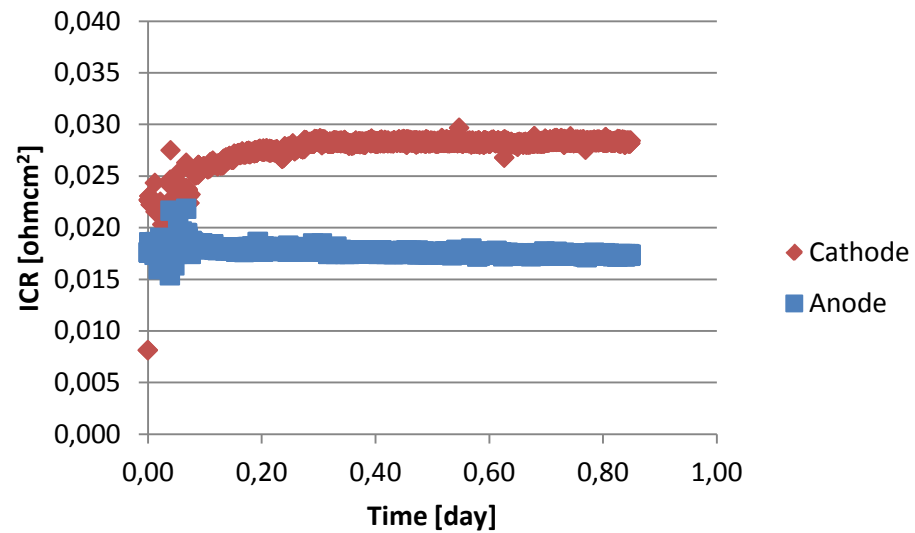
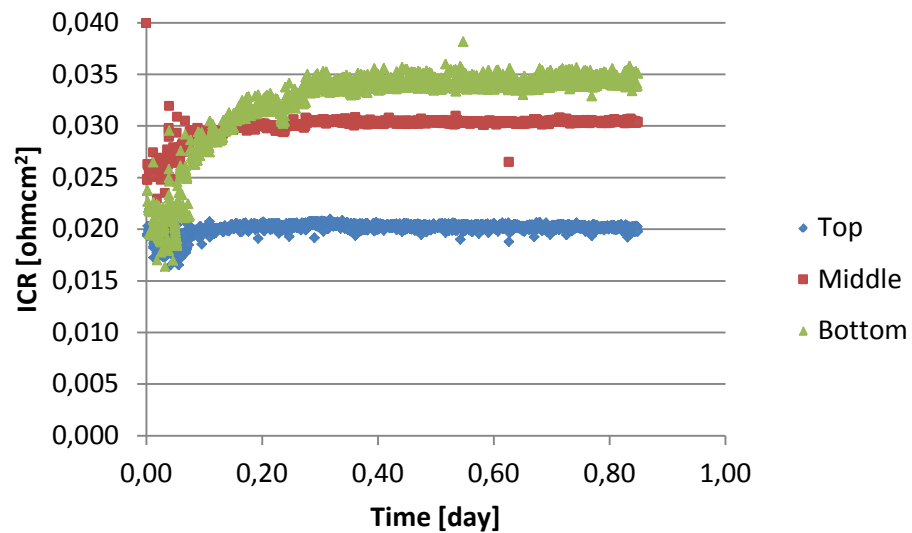
In-situ measurement of ICR



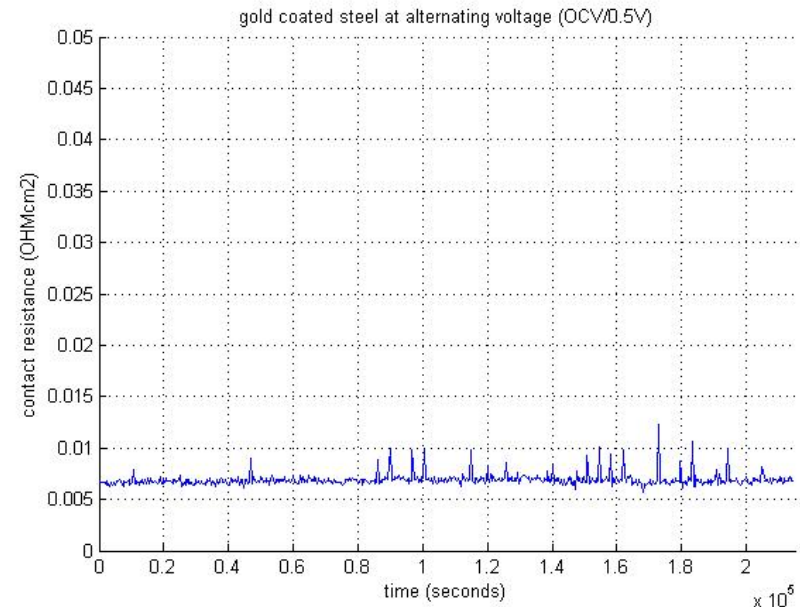
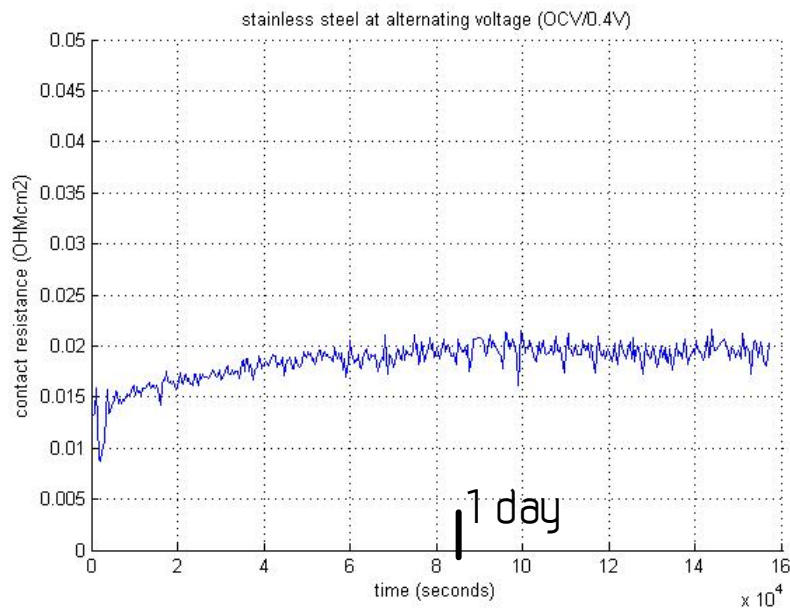
- gold coated wire between MEA and GDL
- voltage is measured between gold coated wire and bipolar plate

ICR measured in-situ, constant current 1 A/cm²

Cathode



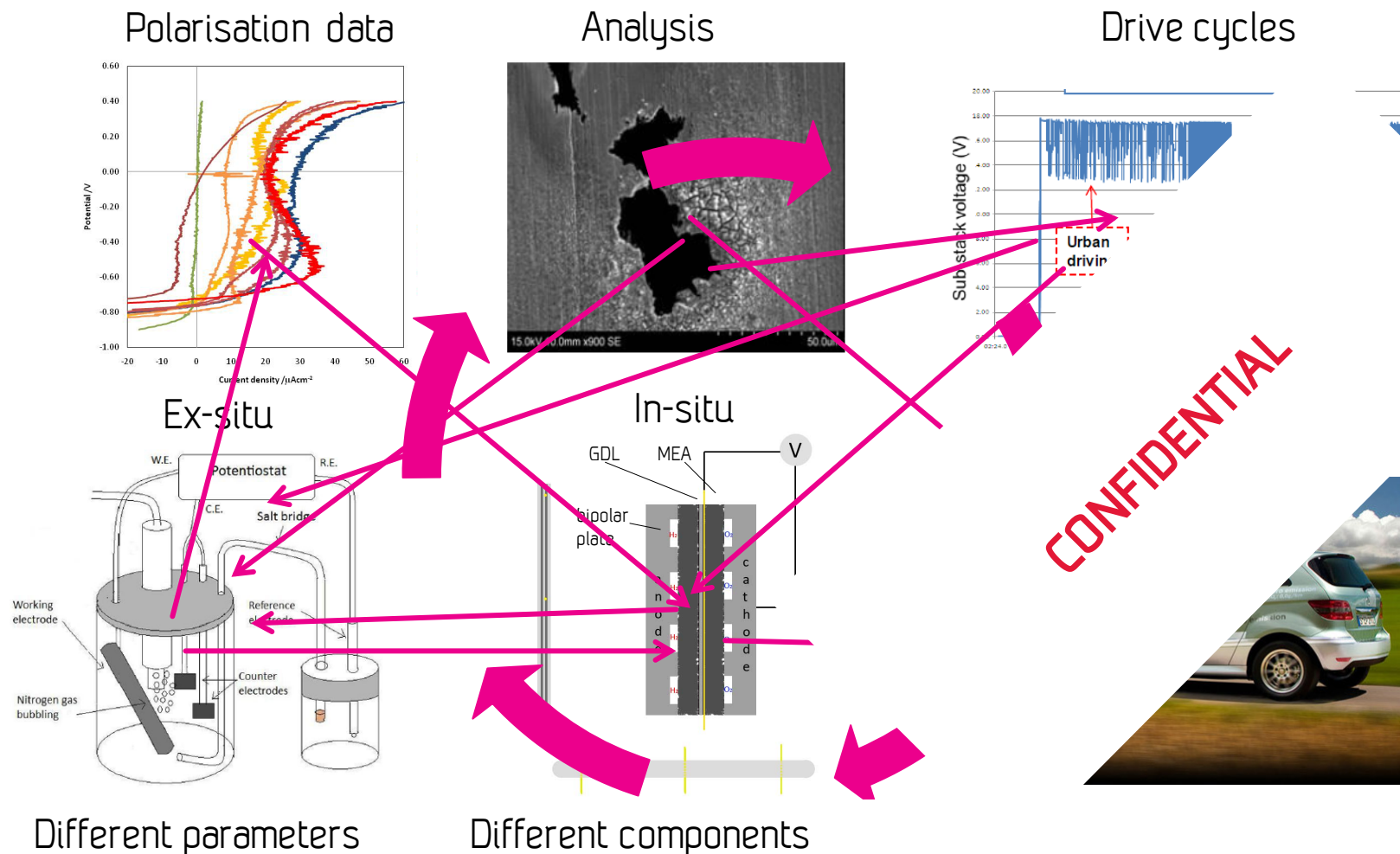
Stainless steel and gold at alternating voltage (OCV/0.4V) and 75°C; AST?



Aim for further work AST BPP

- Find accelerating parameters/conditions
- Optimise the ex-situ method and correlate this to the in-situ testing.
- But...

There are many aspects to consider...



Acknowledgements

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