A009

Institute of
Engineering Thermodynamics

The Need of Uniform PEMFC Stack Test Procedures and their Validation

J. Mitzel[a], E. Gülzow[a], P. Piela[b], L. Jörissen[c]

[a]: Deutsches Zentrum für Luft- und Raumfahrt e.V., Pfaffenwaldring 38-40, D-70569 Stuttgart, Germany
[b]: Instytut Chemii Przemysłowej im. prof. Ignacego Mościckiego, Rydygiera 8, 01-793 Warsaw, Poland
[c]: Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg, Helmholtzstraße 8, D-89081 Ulm, Germany

STACK-TEST

New Energy World JU
fuel cells & hydrogen for sustainability

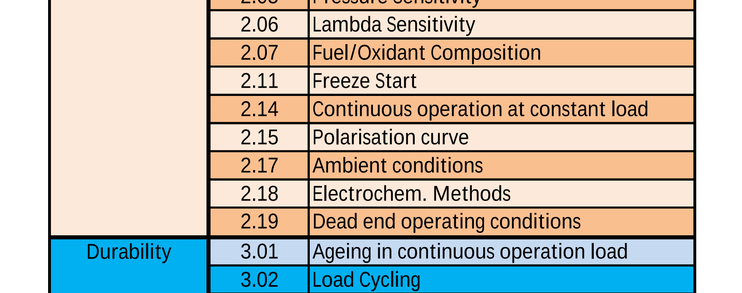
Objectives of the project Stack-Test:

- Consortium:

- Harmonization of PEMFC stack test procedures for industry (and academia).
- Development and validation of test modules with relevance to PEMFC stacks.
- Test scope of the project:
  - Ø function and performance
  - Ø endurance
  - Ø safety and environment

Scope	Test Module	
	Number	Name
Function and performance	2.00	StackTest master document
	2.03	Humidity Sensitivity
	2.04	Temperature Sensitivity
	2.05	Pressure Sensitivity
	2.06	Lambda Sensitivity
	2.07	Fuel/Oxidant Composition
	2.11	Freeze Start
	2.14	Continuous operation at constant load
	2.15	Polarisation curve
	2.17	Ambient conditions
	2.18	Electrochem. Methods
	2.19	Dead end operating conditions
Durability	3.01	Ageing in continuous operation load
	3.02	Load Cycling
	3.03	Start-Stop (200h)
Environment and safety	4.00	Safety test procedures
	4.01	Vibration
	4.02	Freeze-thaw-cycling
	4.04	Allowable working pressure
	4.05	Short-time-current
	4.06	Dielectric strength
	4.07	Short-circuit Test
	4.12	Excess temperature

- Defined in master document (TM2.00):
  - Ø testing methodology
  - Ø test bench requirements
  - Ø measurement uncertainties
  - Ø parameter sensor position
  - Ø parameter variation
- Test programs (TPs) assembled and validated as required:



- Interaction with industry.
- Review international activities and standards (FCH-JU projects, SAE, JIS, IEC…) and interact with SDO.

Control of the test input parameters

- Control position is defined.
- Direction of parameter changes is defined.
- Entire test procedure is defined.
- Critical conditions and parameters are pointed out.

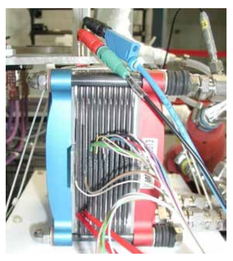
→ Assurance of comparable and reliable tests.

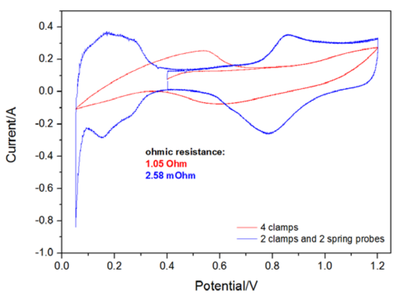
TIPs	Recommended direction of change	Critical direction of change	Parameter control
DP_{fuel}, DP_{ox}	low to high	high to low	reactant inlet
T_{stack}			coolant inlet
x_{imp}			reactant inlet
i_{stack}			load
x_{fuel}, x_{ox}	high to low	low to high	reactant inlet
p_{fuel}, p_{ox}			reactant outlet
I_{fuel}, I_{ox}			reactant inlet

Modification of setup for electrochemical methods

- CVM contacts not always suitable (R_{cont} > 1 Ohm).
- 4 wire potentiostat needed.
- Sense and current leading wires should be contacted separately.
- Spring probes can be used for contacting.

→ Assurance of comparable and reliable CV and H-crossover tests.

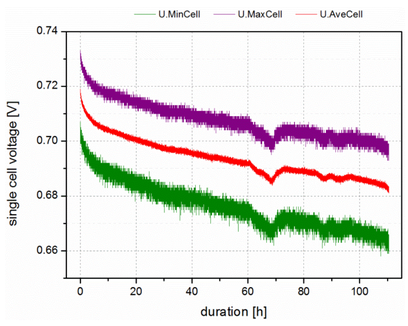


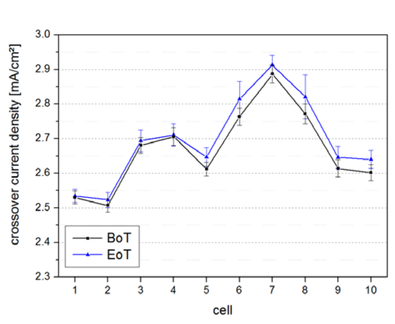


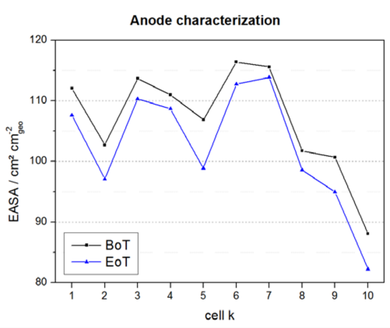
Electrochemical methods

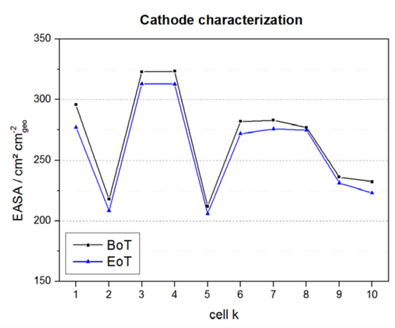
- EoT and BoT test during 110 h constant load (stable test input parameters).
- Linear degradation rate: -150 µV/h per cell
- Degradation during 110 h: -3,0 %
- Average EASA losses for anode (-3.3 %) and cathode (-4.2 %) side are significant.
- Minor increase in H-crossover (+1.0 %).

→ Identification of degradation phenomena in single cells via electrochemical methods.



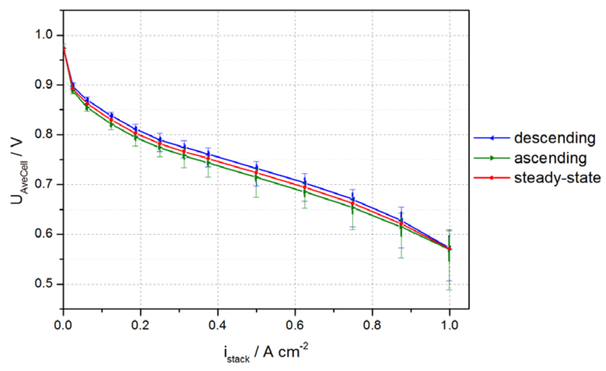




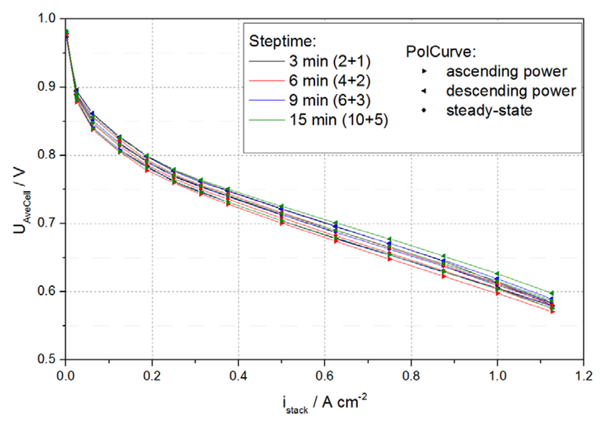


Steady state polarization curve

- Neither ascending nor descending polarization curve represents steady state polarization curve.
  → No final equilibrium of humidity level.
  → Dwell time depending hysteresis effect.
- Steady state polarization curve:
  Average of both curves



- Tested by dwell time variation: 3, 6, 9 and 15 min
  → Steady state polarization curve not affected by dwell time.
- Advantages:
  - Ø Test duration can be shortened by decreased dwell time.
  - Ø Comparable studies proven.
  - Ø Results independent of applied load changes.



Acknowledgement:

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Technology Initiative under grant n° 303445.
We gratefully acknowledge the members of the Stack-Test consortium who prepared, improved and validated the test procedures.

Test procedures acquirable:

stacktest.zsw-bw.de

DLR Deutsches Zentrum für Luft- und Raumfahrt
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Contact:

Jens.Mitzel@dlr.de