FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

STACK-TEST

Stack-Test – Development of EU-wide uniform performance test schemes for PEM fuel cell stacks
Work package 2: Summary of functional and performance test procedures

J. Mitzel, **E. Gülzow** , **A. K. Friedrich**
German Aerospace Center, Pfaffenwaldring 38-40, 70569 Stuttgart, Germany
E-Mail: Jens.Mitzel@dlr.de; Phone: +49 711 6862 8063
S. S. Araya, S. K. Kær
Aalborg University, Department of Energy Technology, Pontoppidanstraede 101, DK-9220 Aalborg East, Denmark
E-Mail: ssa@et.aau.dk; Phone: +45 9940 9253

Key project activities:

- Ø Functional / Performance Testing
- Ø Durability Output Testing
- Ø Environmental / Safety Output Testing
- Ø Liaison to Standard Developing Organizations and Industry

11 participating institutions based in 6 European countries
Total cost 5.64 Mio € / FCH-JU contribution 2.91 Mio €

Project Objectives

- Industry wide harmonized test procedures for PEMFC stacks developed and validated.
- The work is based on the FCTESTNET, FCTES^{QA} series.
- Performance / functional, durability and safety outputs for vehicle propulsion, stationary and portable applications.
- Generic test modules defined and validated.
- Application specific test programs derived and validated.
- Industrial practice established by the implementation of an industrial advisory group consisting of selected key stakeholders along the value chain of the fuel cell industry.
- The consortium liaise with international standardization activities and contribute to the improvement of existing standards by pre-normative research and – if deemed necessary – initiate new work item proposals.

Development of Generic Test Modules

Different Test Modules (TM) are defined for the functional and performance characterization of a PEMFC stack. The master document TM2.00 defines requirements and methodology for parameter variation, stability and data acquisition.

#	TM name	Applications					
		Automotive			Stationary		Portable Generators
		Propulsion	Range extender	APU	residential CHP	Backup power	
2.00	Master document	x	x	x	x	x	x
2.03	Humidity Sensitivity	x	x	x	x	x	x
2.04	Temperature Sensitivity	x	x/-	x	x/-	x/-	x
2.05	Pressure Sensitivity	x	x	x	x	x	x
2.06	Lambda Sensitivity	x	x	x	x	x	x
2.07	Fuel/Oxidant Composition	x	x	x	x	x	x
2.11	Low Temperature Test	x	x	x	-	x	x
2.14	Continuous operation at constant load	x	x	x	x	x	x
2.15	Polarisation Curve	x	x	x	x	x	x
2.17	Stack tilt	x	x	x	-	-	x
2.18	Electrochem. Methods *	x	x	x	x	x	x
2.19	Dead end operating conditions	x	x	x	-	-	x

***** Separate documents for different electrochemical methods:

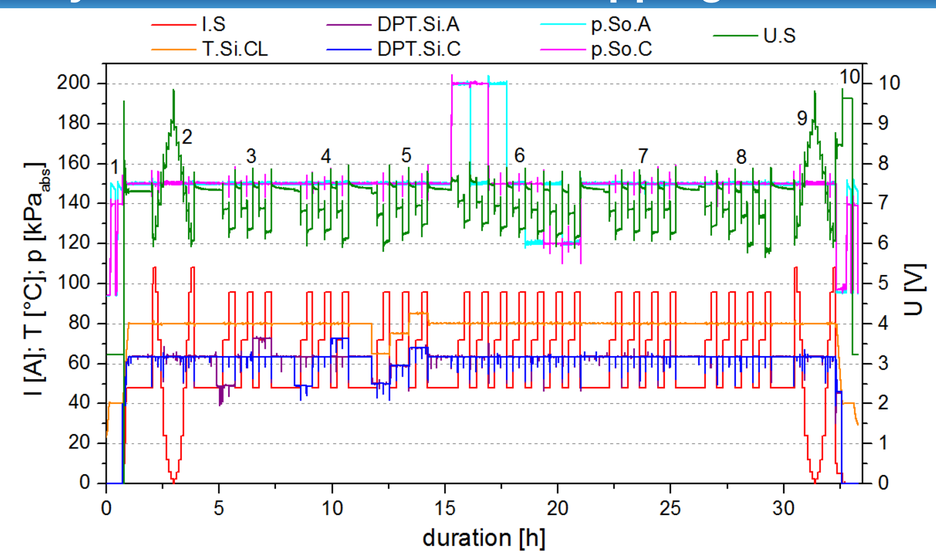
- TM2.18a: In-Stack Electrode Voltammetry
- TM2.18b: In-Stack Electrode Potentiometry
- TM2.18c: Stack Electrochemical Impedance Spectroscopy
- TM2.18d: H_2 Crossover in H_2-PEMFC Stack
- TM2.18e: Methanol Crossover in DMFC Stack
- TM2.18f: Anode's Steady-State Polarization Curves in DMFC Stack

Prepared Test Programs

The Test Programs (TP) are prepared specific to different applications. 5 exemplary TP were prepared. Additional TPs can be created by combination of the different TMs of interest for a given test objective.

#	TP name	Comprised Test Modules	Applications					
			Automotive			Stationary		Portable Generators
			Propulsion	Range extender	APU	Residential CHP	Backup power	
2.01	Performance Assessment	2.14, 2.18	x	x	x	x	x	x
2.02	Performance Mapping	2.03-2.06, 2.15, 2.18	x	x	x	x	x	x
2.03	Deviant Stack Performance	2.07, 2.11, 2.15 2.17, 2.18	x	x	x	-	x	x
2.04	Dead end performance	2.03-2.06, 2.15, 2.18, 2.19	x	x	x	-	x	x
2.05	Optimization of Operating Parameters	2.14, 2.18	x	x	x	x	x	x

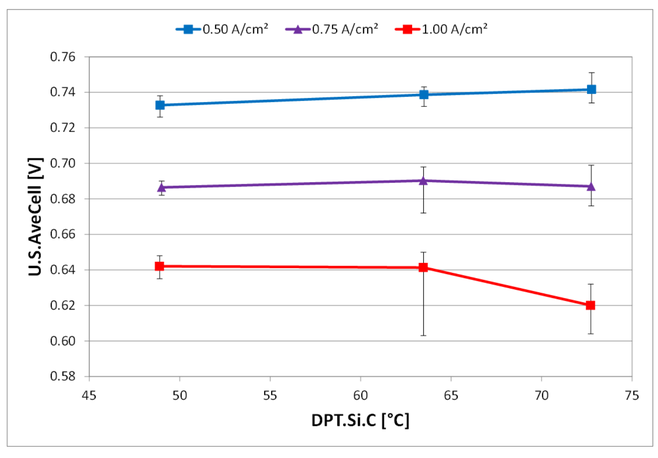
Exemplary TP2.02: Performance Mapping



1: Leakage BoT
2: PolCurve BoT
3: TM2.03a-Anode Hum.
4: TM2.03b - Cathode Hum.
5: TM2.04 - Temperature
6: TM2.05 - Pressure
7: TM2.06a - Anode Lambda
8: TM2.06b - Cathode Lambda
9: PolCurve EoT
10: Leakage EoT

Methodology:
Map the performance of a stack against the operating parameters. The performance fingerprint can be determined by polarisation curves. Sensitivity test regarding the different operation parameters can be used optimise stack operation.

Test results:
Can visualize operating windows regarding different parameters, e.g. the humidity of the air feed to the stack.



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.
Test procedures acquirable: **stacktest.zsw-bw.de**