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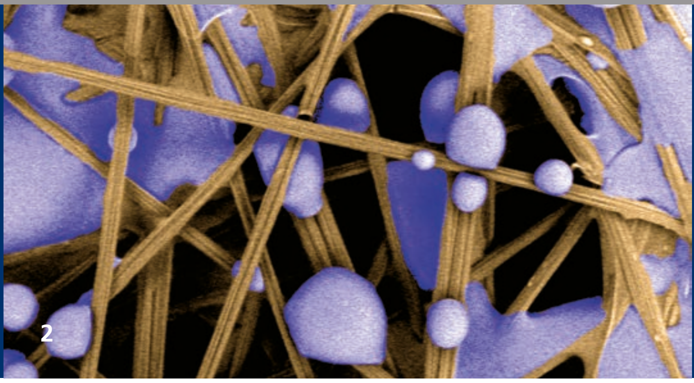

1 *Laboratory for in-situ testing of fuel cell components.*
2 *Image of a gas diffusion layer with water droplets using an environmental scanning electron microscope.*

# TESTING OF FUEL CELL COMPONENTS


**Fraunhofer Institute for Solar Energy Systems ISE**
Heidenhofstr. 2
79110 Freiburg, Germany

**Hydrogen Technologies – Fuel Cell Systems**
Ulf Groos
Phone +49 761 4588-5202

**Testing of Fuel Cell Components**
Dr. Robert Alink
Phone +49 761 4588-5184

**Testing of BoP Components**
Dr. Timo Kurz
Phone +49 761 4588-5205

h2fc.systems@ise.fraunhofer.de

www.h2-ise.com
www.ise.fraunhofer.de


Fuel cells are highly complex electrochemical systems. The conversion of chemical into electrical energy involves gas flow and diffusion, phase change processes, charge transport and heat transfer among others. To develop reliable fuel cells and operation strategies, a detailed understanding of these processes and behavior of the singular components is necessary.

Fraunhofer ISE's expertise is based on more than a decade of research. We support customers worldwide and offer a comprehensive range of services for an efficient, evidence-based product development. With our qualified know-how and professional service offers, you can base the marketing of your product on valuable experience, founded information and an internationally recognized name.

**In-situ characterization of fuel cell components**

- performance and degradation testing of membrane electrode assemblies and its components according to international or customized test protocols
- tests with standard or customer test cells
- performance and degradation analyses: polarization curves to characterize performance; electrochemical impedance spectroscopy to analyze the gas diffusion and electrical and proton conductivity; cyclic voltammetry to determine the electro-chemical active surface area; limited current measurement to evaluate the catalytic layer structure

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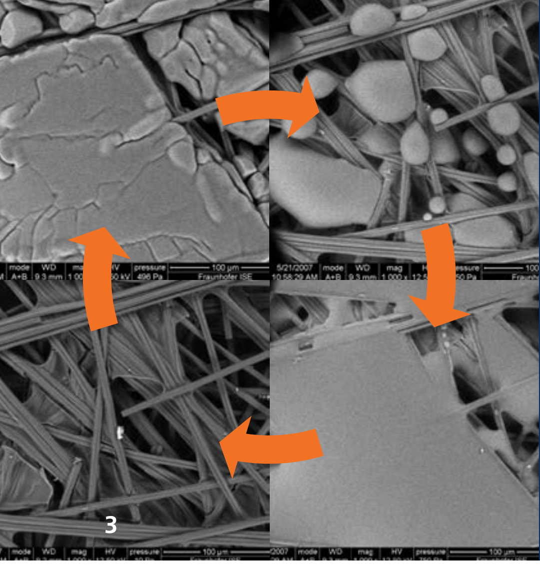

3 *Water phase change analysis of a gas diffusion layer in an environmental scanning electron microscope.*

4 *Corrosion testing of fuel cell system components.*

5 *Long-term valve test at freezing temperatures in the climate test chamber.*

**Measurement of contamination effects**

- in-situ testing of air pollution by mixing single gas or mixed contaminants to the cathode flow
- in-situ testing of hydrogen contamination by mixing single gas or contaminant mixtures to the anode flow
- investigation of fuel cell contamination due to corrosion by adding cations to either the cathode or anode flow

**Investigation of along-the-channel effects**

Many investigations to assess material properties rely on differential cells, which are used to assure minimized gradients of gas concentrations, humidity, and temperature. The behavior in real cells, however, is important and therefore we offer tests using real cells or stacks. To reduce testing costs due to high performance test stations and gas consumption, we have developed an along-the-channel test cell, optimized to study effects from gas inlet to outlet under realistic operation conditions. The cell can be manufactured according to the customers channel geometry with dimensions of the active cell area of 25 x 1 cm². To investigate the behavior along the length of the channel, a segmentation, e.g. into 25 electrically isolated segments with 1 cm² each, is possible.

**Model-based analysis of experimental results**

To extract and analyze material and component properties like membrane humidity or in-situ gas diffusion, which are difficult to measure directly, we have developed scientific and thoroughly validated models.

**Ex-situ characterization of fuel cell components**

- laboratory tests for chemical stability of components by exposure to DI water or acid solution under different temperature levels
- corrosion current measurement by applying potential using 3-electrode setup; also under high temperatures
- Fenton tests to investigate the chemical stability of membranes with varying cations, including their concentrations, and temperatures
- electrical conductivity measurements and contact resistance analysis of gas diffusion layers and bipolar plate
- Environmental Scanning Electron Microscope (ESEM) investigations to analyze surfaces and wetting characteristics
- Energy Dispersive X-ray spectroscopy (EDX) to determine the element composition in the surface of the material, e.g. by catalyst migration
- mass spectrometry of liquids with Inductively Coupled Plasma (ICP-MS) to analyze the product water as well as to determine the chemical stability of system components

**Testing of balance-of-plant components**

- cyclic load testing of valves, compressors, humidifiers, etc.
- leakage tests, also with pressurized hydrogen
- temperature stability tests from -40 °C up to +150 °C (300 l climate chamber and oven)
- climate tests from +5 °C up to +95 °C and relative humidities from 10 % up to 95 % (walk-in climate chamber)
- power consumption measurements under different operating modes or during cyclical operation
- tests also possible in conjunction with a fuel cell stack or system
- development of customized test rigs