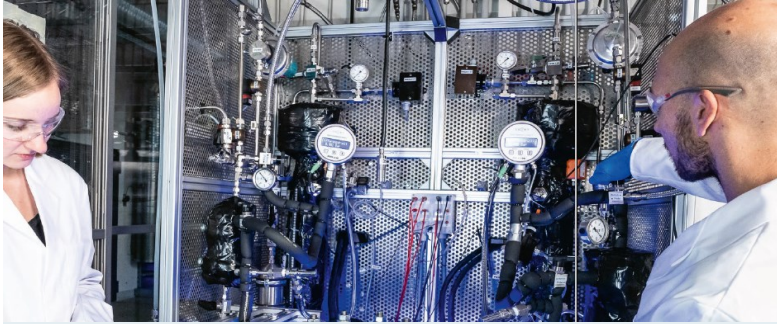


Understanding Fuel Cell Membrane Electrode Assemblies

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Division Hydrogen Technologies at Fraunhofer ISE

Green Hydrogen and Synthesis products for climate neutral industry, mobility and energy economy



Membrane-based Electrolyzers

Scalable production processes from catalyst powder to stack-level including *in-situ* & *ex-situ* characterization & analytics



ca. 170 Employees

Hydrogen System Analysis



Sustainable Synthesis Products

Synthesis, transport & usage of hydrogen-based chemicals, energy carriers & fuels for defossilization & emission reduction



ca. 23 Mio €/a Budget



Membrane-based Fuel Cells

Scalable production processes from catalyst powder to stack-level incl. *in-situ* & *ex-situ* characterization, analytics & modelling



>30 Years H₂ Experience

Site specific simulations & optimization of regional & global H₂- & PtX-supply chains, from a technologic, economic & ecologic perspective

Electrolysis and Hydrogen Infrastructure

More than 30 years experience

Key Performance Indicators 2025:

- 19 FTE researchers plus students
- 4.8 Mio € annual budget (w/o investments)
- > 850 m² laboratory area with several test rigs in 24/7 mode
- Focus on electrochemical production of green hydrogen
- Institute's hydrogen refueling and injection stations with on-site electrolysis



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Department Sustainable Synthesis Products

PtX Products - Production, Transport and Utilization

From Catalyst to Industrial Reactors & Processes

Key Performance Indicators 2025

- 26.5 FTE researchers plus students
- 7 Mio € annual budget (w/o investments)
- Techno-economic analysis of PtL processes
- Life-Cycle-Assessment of PtX processes
- Design, test and characterization of tailor-made catalysts (e.g. HT-NAP-XPS)
- Process development of efficient, cost optimised processes using CO₂/CO or N₂ & H₂ as feeds
- In-house development & operation of miniplants
- Unique selling points: π -COMET®, CatVap®, etc.



Power-to-Methanol



DAC Material & Process



INDIGO DME Technology



PICASO NH₃ Technology



π -COMET® – OME Techn.



Thermochem. H₂ Production



Methanol to Jet fuel (SAF)



LOHC as H₂-carrier

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Our Mission in Our Department Fuel Cell

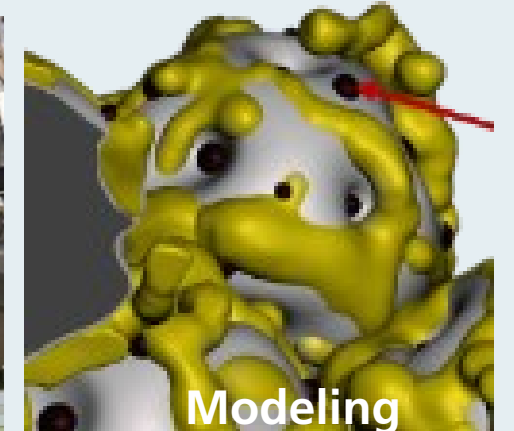
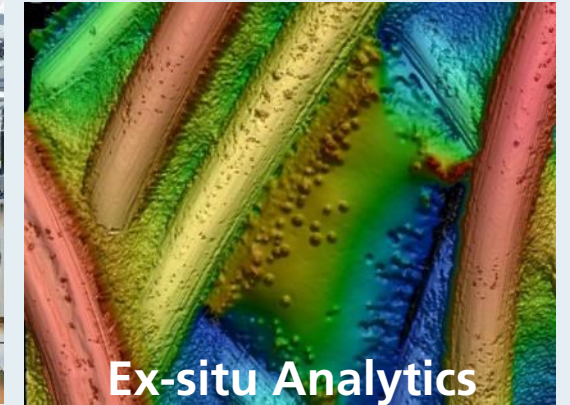
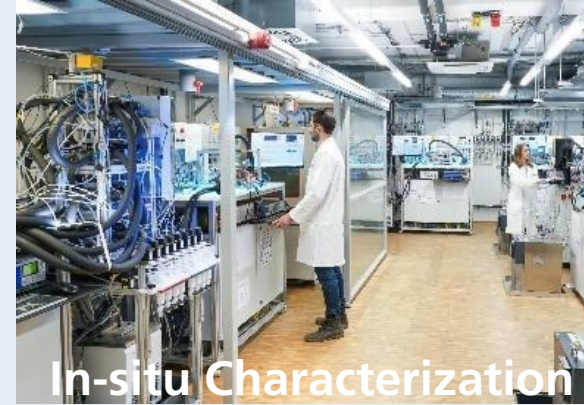
Assisting Global Industry with Scientifically Sound Services

Understanding Fuel Cell Membrane Electrode Assemblies (MEAs)

Key Performance Indicators 2025:

- 35 FTE researchers plus students
- 6.8 Mio. € annual budget (w/o investments)
- 26% direct revenue by industry contract research
- 900 m² laboratory area with 13 single cell test stations, 7 stack test stations, analytic equipment, machinery for MEA production research
- Focus on transport application

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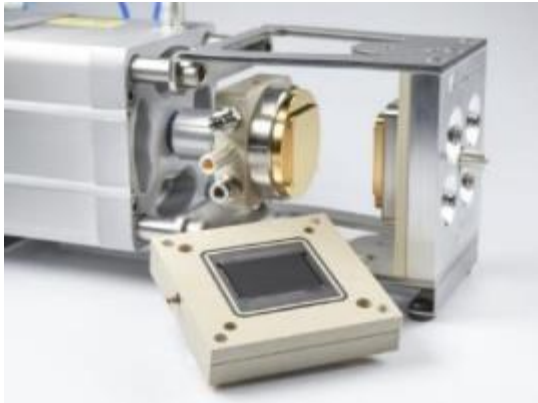
R2R MEA Production at Fraunhofer ISE

From Catalyst Powder to Full Scale MEA



In-situ Characterization of MEAs and Its Layers

From Lab Scale Test Cells to Stacks



Differential Cell

- 12 cm² active area
- No gradients (c, RH, T)



(Segmented) Along-the-Channel Cell

- Automotive cell design
- 1D gradients from gas inlet to outlet (c, RH, T, p)



(Segmented) Full Size Cell

- Automotive cell design
- 2D gradients from gas inlet to outlet (c, RH, T, p)



Short Stack

- Automotive cell design



Stack Testing

Evaluating Stack Design and Operation Strategies

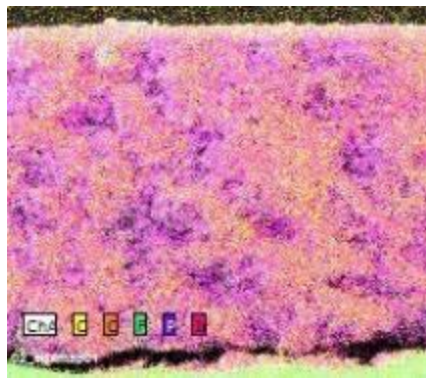
Technical Highlights

- 1 x 4 kW stack test station
 - 3 x 10 kW stack test station
 - 2 x 20 kW stack test station
 - 1 x 200 kW stack test station
-
- Fully automated for long-term testing
 - Temperature range – 32 °C up to 130 °C
 - High gas purity due to filtration
 - Cell voltage monitoring at inlet and outlet
 - Special characterization methods
 - Investigation of gaseous contaminants



Understanding the Process – Microstructure – Operation Behavior Relationship is Key to Improve Architectures of Membrane Electrode Assemblies

- Understanding MEA production processes and quality control for up-scaling
- Investigating component performance and degradation by in-situ characterization together with ex-situ analytics
- Spatial resolved measurements to evaluate in-plane effects
- Morphology modelling to prove the understanding of fuel cell physics
- Fraunhofer ISE emphasizes for understanding MEAs on the 4 perspectives of **manufacturing, ex-situ analytics, in-situ characterization & modelling**





Contact

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