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Fraunhofer Institute for Solar Energy Systems ISE

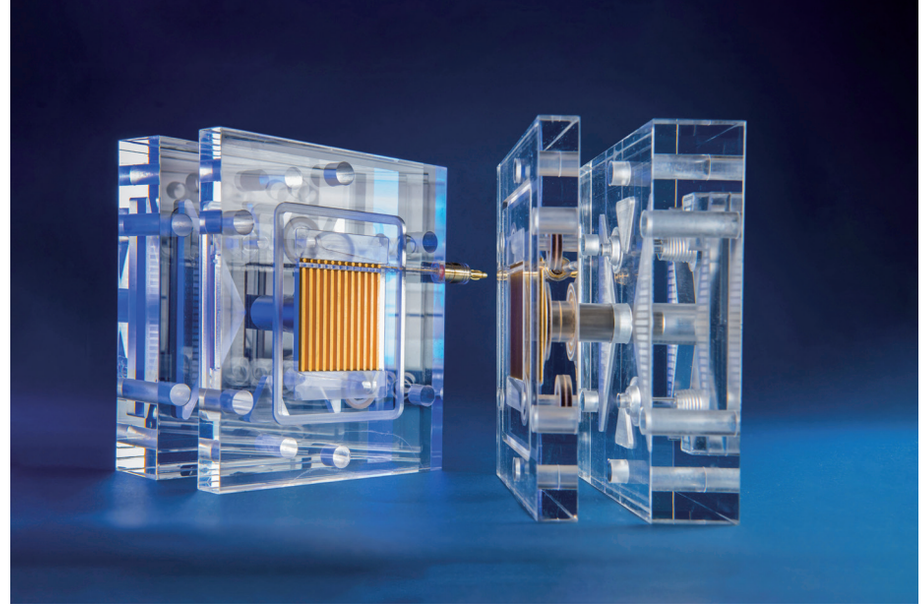
PEM Water Electrolysis

Green Hydrogen Production for a Sustainable Future

www.ise.fraunhofer.de/en/electrolysis

Green Hydrogen Production for a Sustainable Future

Electrolyzers cleanly and efficiently split water electrochemically to generate hydrogen and oxygen. In particular, proton exchange membrane (PEM) electrolysis is well-suited to produce green hydrogen from renewable energy sources, with good efficiency at high current densities and dynamic operation at high pressures within a broad operating range.



Laboratory test cell for water electrolysis used to screen cell components and carry out long-term measurements for life-time investigations. Anode and cathode are segmented to allow seperated measurement of the half-cell potentials.
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Our Offer

Extensive R&D services and international customer support in developing efficient, high-performing and durable PEM water electrolyzers:

- scientific characterization of new cell components and stacks for PEM water electrolysis
- investigation of degradation mechanisms and development of accelerated stress tests
- cell and stack development by means of fluidic and structural-mechanical calculations
- development of coating strategies for bipolar plates and porous transport layers
- system design and balance of plant (BOP) optimization
- development of operating controls and implementation on embedded systems
- technical assessment and cost analysis of different electrolysis technologies

Advanced Test Facilities For PEM Water Electrolysis

To meet the current R&D demand in upscaling stack size and capacity for PEM water electrolysis, the institute operates an advanced electrolysis test center in Freiburg combining different in situ and ex situ measurement techniques, with several test rigs for investigating single cells and stacks with electrical currents up to 2 000 amperes, operating pressures up to 50 bar and temperatures up to 120 °C. All test stations are equipped with script-based measuring programs and can be operated fully automated. Sophisticated measurement equipment and flexible process management enable the comprehensive characterization of PEM electrolysis cells and stacks for a wide range of applications, e.g. under highly dynamic and harsh conditions. There is also a test station for anion exchange membrane (AEM) water electrolysis. Diverse ex situ measurement analyses with 3D X-ray tomography, X-ray fluorescence, porometry, laser scanning and electron microscopy as well as interfacial contact resistance and corrosion measurements provide deep insights into multi-physical processes of electrolysis cells.

In situ Characterization of Components for PEM Water Electrolysis

- cell component screening over a broad operating window from ambient conditions up to 50 bar, 120 °C and 500 amperes in single cells and 2 000 amperes in short stacks
- electrochemical characterization techniques incl. polarization curves (performance and efficiency), electrochemical impedance spectroscopy (mass transport limitations) and cyclic voltammetry (electrochemically active surface area)
- evaluation of anodic and cathodic overpotentials in single cell measurements using segmented flow field with electrically insulated areas as reference electrodes
- long-term performance investigation and degradation analysis with combined in situ and ex situ measurements, e.g. high frequency impedance, gas cross-over and impurity measurements
- accelerated stress tests of membrane electrode assemblies and other cell components according to customer or international test protocols

Ex situ Characterization of Components for PEM and AEM Water Electrolysis

- corrosion current measurements to investigate oxide layer formation and passivation, using a 3-electrode setup with stressor test cells made in-house for this purpose
- electrical conductivity measurements to analyze interfacial contact resistance of bipolar plates and porous transport layers (PTL)
- laser scanning and environmental scanning electron microscopy (ESEM) to investigate surface characteristics, and energy dispersive X-ray spectroscopy (EDS) to determine surface composition and contaminants
- X-ray tomography to analyze 3D structures, porosity and pore size distribution of porous transport layers
- X-ray photoelectron spectroscopy (NAP-XPS) and X-ray fluorescence measurements to analyze catalyst layers of membrane electrode assemblies
- mass spectrometry using inductively coupled plasma (ICP-MS) to analyze water contaminants
- porometry and in- and through-plane permeability measurements of PTLs to determine fluid transport properties

For our customers and partners we offer our standard 4cm² electrolysis test cell. Worldwide it is already used by various working groups for numerous measurement tasks.
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For Further Information

Take a Virtual Tour Through our Labs

Contact

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02-252200-23