Fraunhofer ISE

Fraunhofer Institute for Solar Energy Systems ISE

Characterization and Development of Novel Components

Efficient Membrane Water Electrolysis

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Efficient Membrane Water Electrolysis

Electrolyzers are key to produce green hydrogen out of renewable energies. To support our customers in the industrialization of electrolyzers, we characterize and develop novel materials and components for membrane water electrolysis. In our projects we focus on membrane water electrolysis, either on the basis of proton exchange membranes (PEM) or on anion exchange membranes (AEM).

Our Offer

- Production research for membrane electrode assemblies (MEA) to optimize performance, materials and manufacturing processes
- Scientific characterization of new cell components and materials in electrolysis cells and stacks
- Investigation of degradation mechanism and development of accelerated stress test protocols
- 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 monitoring systems for scientific accompanying of electrolysis field tests
- Technical assessment and cost analysis of different electrolysis technologies

Microporous layer on a titanium fiber substrate after screen printing. The reduced surface roughness of the microporous layer allows for reduced catalyst loading with iridium, cost reduction and thinner membranes.

Development of Electrolysis Components

For our customers, we develop advanced cell components with the aim of increasing efficiency, reducing manufacturing costs and extending lifetime.

- **Comprehensive understanding of the optimal, efficient and sustainable production of MEAs:** In our production laboratory, we research the production processes from catalyst powder to MEA and support our customers in the implementation of industrial production.
- **Interface engineering for enhanced performance:** Using various printing processes, we develop novel micro porous layers (MPL) for porous transport layers (PTL) in order to reduce catalyst loading and increase current density.
- **Corrosion protection in electrolytic cells:** By means of physical vapor deposition (sputtering) we investigate and develop corrosion protection layers for bipolar plates and PTLs at low cost, thereby reducing the contact resistance in the cell.
- **Novel cell designs:** Based on our operational experience with new materials, we derive cost-optimized cell concepts for the upscaling of electrolysis.

In-situ Characterization of Electrolysis Components

A comprehensive in-situ characterization in terms of performance and degradation at different operation conditions provides the basis for our customers' decisions on suppliers, production processes and stack designs.

- **Optimize performance:** We conduct cell component characterization and screening over a broad operating window from ambient conditions up to 50 bar, 120 °C and 600 amperes in single cells and 2.000 amperes in short stacks.
- **Enhance operational efficiency:** Our electrochemical characterization techniques include polarization curves (performance and efficiency), electrochemical impedance spectroscopy (loss mechanisms) and cyclic voltammetry (electrochemically active surface area).
- **Understand degradation:** We evaluate anodic and cathodic overpotentials in single cell measurements using segmented flow fields with electrically insulated areas as reference electrodes.
- **Ensure long-term performance:** We combine in-situ and ex-situ measurements, e.g. high frequency impedance, gas cross-over and impurity measurements.
- **Guarantee compliance with standards:** We perform accelerated stress tests of MEAs and other cell components according to customer or international test protocols.

Ex-situ Characterization of Electrolysis Components

In addition to our measuring capacity of cells and stacks, we offer our customers a comprehensive range of equipment for ex-situ analysis of their materials and components.

- **Durability:** We provide corrosion current measurements to investigate oxide layer formation and passivation, using a 3-electrode setup with in-house stressor test cells.
- **Efficiency:** Our electrical conductivity measurements analyze interfacial contact resistance of bipolar plates and PTL.
- **Surface quality:** We utilize laser scanning and environmental scanning electron micro-scopy (ESEM) to investigate surface characteristics, along with energy dispersive X-ray spectroscopy (EDS) to determine surface composition and contaminants.
- **Material structure:** X-ray tomography is employed to analyze 3D structures, porosity and pore size distribution of PTL.
- **Catalyst composition:** We conduct X-ray photoelectron spectroscopy (NAP-XPS) and X-ray fluorescence measurements to analyze catalyst layers of MEAs.
- **Water purity:** Our mass spectrometry using inductively coupled plasma (ICP-MS) effectively analyzes water contaminants.
- **Fluid transport:** We perform porometry and in- and through-plane permeability measurements of PTLs to determine fluid transport properties.

Gold-coated PEM electrolysis test cell with temperature sensors and force sensor for adjusting the clamping pressure.

Further Information

Take a Virtual Tour Through our Lab

Contact

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