Fraunhofer ISE

FRAUNHOFER INSTITUTE FOR SOLAR ENERGY SYSTEMS ISE

PRESS RELEASE

Fraunhofer ISE Demonstrates Ultrafine Transport Layers for Electrolyzers

Proton exchange membranes (PEM) are one of the most promising technologies for the production of green hydrogen by electrolysis. To reduce the material and manufacturing costs for PEM electrolyzers, the Fraunhofer Institute for Solar Energy Systems ISE is researching scalable production processes. Now, for the first time, it has succeeded in producing ultra-fine porous transport layers made of titanium using a screen printing process, thereby reducing the cost of catalyst materials. Industry-standard, scalable equipment was used. At the Hannover Messe (March 31 to April 4, Hall 13, C41), the institute will present samples of the optimized microporous transport layer, along with other innovations.

PEM electrolysis is a key technology for the market ramp-up of the green hydrogen economy because it can be operated at high power density and the flexible power supply from renewable energies. In addition to the catalyst-coated membrane, the porous transport layers (PTL) are central to its performance. "As the 'lungs' of the catalyst-coated membrane, the PTLs are responsible for transporting water and gases, among other things. Optimizing the PTL and its surface properties is a major lever for reducing costs and increasing performance in PEM electrolysis. This is why this layer is increasingly becoming the focus of our research," explains project manager Stefan Bercher of Fraunhofer ISE.

To improve the surface properties, microporous titanium layers (MPL) are applied between the PTL layer and the catalyst-coated membrane. Thanks to their low surface roughness, they allow the use of catalyst layers with significantly reduced iridium loading, as they significantly improve catalyst contacting and thus utilization. They also facilitate the use of thinner membranes, which reduces ohmic losses. The goal of the Fraunhofer ISE project group was to match the titanium-based MPLs optimally to the catalyst layer to be contacted and to make them as fine as possible, since these metals are among the main cost factors in electrolyzers.

"At Fraunhofer ISE, we have decades of experience in manufacturing and characterizing components for PEM electrolysis. We are using this know-how in interface engineering to optimize both layers together, rather than separately as in the past," explains Tom Smolinka, head of the Electrolysis and Hydrogen Infrastructure department at Fraunhofer ISE.

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Successful proof of concept with screen printing process

To print the ultra-fine MPL structures, Fraunhofer ISE is using the screen printing process, with which the institute has many years of production experience in the field of photovoltaics. Since screen printing allows precise control of the thickness and structure of the layers, the project team sees great potential in this technology.
In a series of tests, the researchers investigated whether PTLs coated with microporous transport layers achieve better results than commercially available PTLs. The individual production steps and parameters of the printing process were optimized, from mixing the ink with titanium particles to the actual screen printing process on standard industrial equipment and sintering. During the subsequent characterization of the MPL layer printed on a coarse PTL, the surface roughness and performance were measured in particular. "We were able to print very fine layers about 20 µm thick and reduce the surface roughness by 46 percent. This improves the contacting of the catalyst layer, in which the load of the expensive precious metal iridium is continuously reduced," says Stefan Bercher. This is the key to achieving the European targets for material savings and market launch despite limited resources. The research team is now looking for industrial partners to further optimize and adapt the microporous layer to customer-specific porous transport layers.

More innovations from Fraunhofer ISE at the Hannover Messe:

Further innovations will be presented at the Fraunhofer ISE booth at of the "Hydrogen+ Fuel Cells Europe" exhibition:
In addition to the production of PTL and MPL, Fraunhofer ISE is investigating further customer-specific processes for the production of membrane electrode assemblies (MEA) for electrolyzers and fuel cells from laboratory to industrial scale. The scientists have extensive expertise in process and ink development for screen printing and slot die coating. At the booth, they will present various MEA designs with reduced precious metal load, produced using commercially available materials.
The 3D exhibit "Hydrogen Infrastructure" shows a typical local, self-contained hydrogen infrastructure with regional production, distribution and storage, but also with connection points to national and international infrastructures. It thus represents the comprehensive expertise of Fraunhofer ISE along the entire hydrogen value chain.

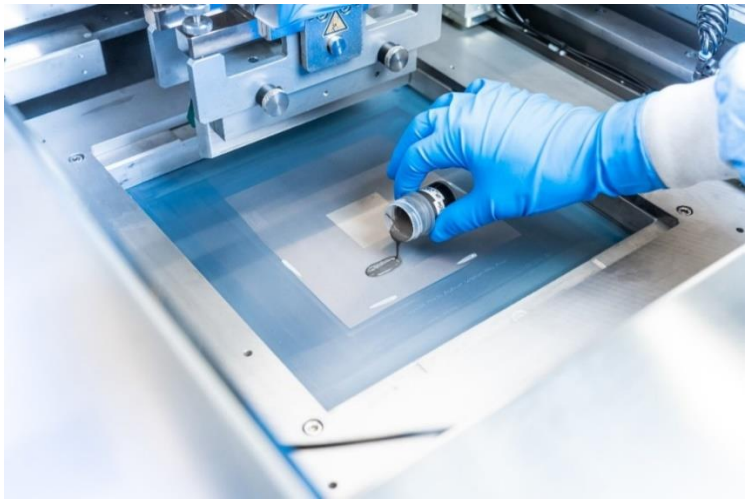
Fraunhofer ISE presentations at the Hannover Messe

March 31, 15:00-15:20, Public Forum, Hall 13: Prof. Dr. Christopher Hebling: "From barriers to bridges: Challenges and solutions of the global hydrogen market"

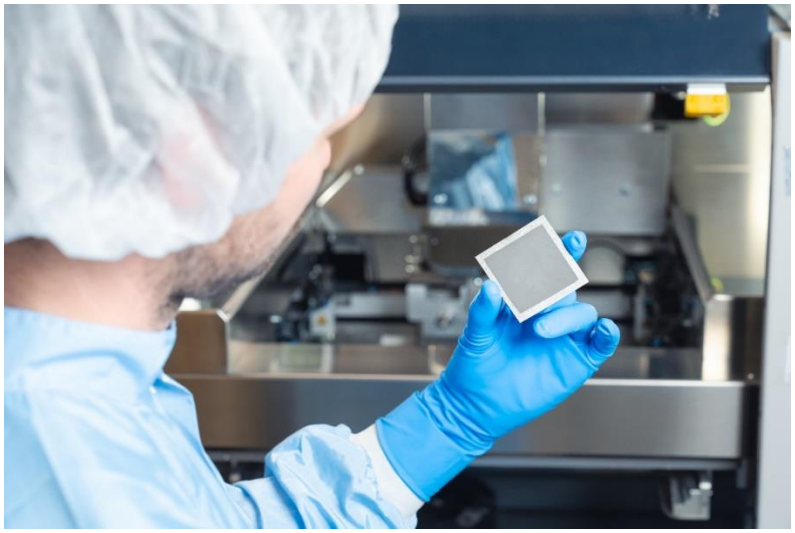
April 1, 11:00 a.m. - 12:30 p.m., Technical Forum, Hall 13: Lectures "Hydrogen at Fraunhofer"
Session 1: Hydrogen Production "Electrochemical Performance and Manufacturing"
Stefan Bercher: "Optimization of the interface between electrode and PTL to increase electro-chemical performance in PEM water electrolysis cells"

Links: MEA Production: https://www.ise.fraunhofer.de/en/business-areas/hydrogen-technologies/fuel-cell/mea-production.html

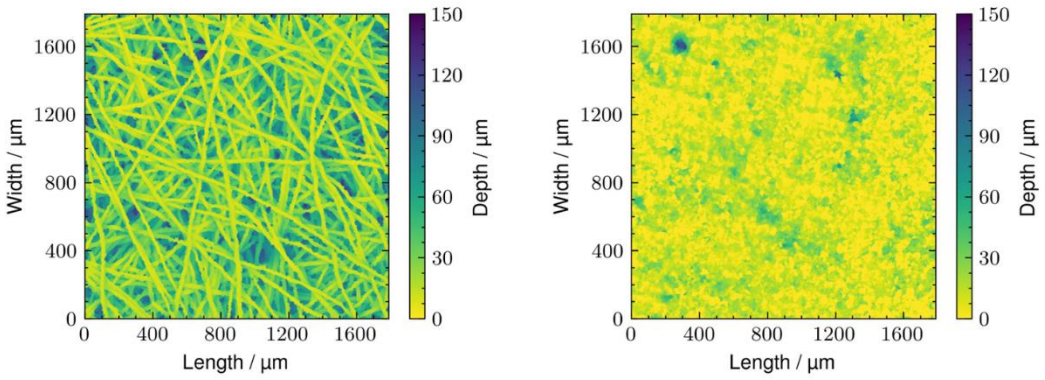
Virtual tour of the Fuel Cell Lab: https://www.ise.fraunhofer.de/en/rd-infrastructure/center/center-for-fuel-cells-electrolysis-and-synthetic-fuel.html



A paste consisting of titanium powder, solvent and additives is applied to the pressure screen. The paste is then applied through the screen as a thin microporous layer onto a titanium fibre substrate using a squeegee. © Fraunhofer ISE/Joscha Feuerstein



Final microporous layer on a titanium fibre substrate after the screen printing process. In a subsequent step, the two layers are sintered. The microporous layer with a reduced surface roughness allows an optimized interface to the catalyst layer. As a result, the catalyst loading with iridium can be reduced and thinner membranes are possible. © Fraunhofer ISE/Joscha Feuerstein



The laser scanning microscopy image shows the significant reduction in surface roughness. © Fraunhofer ISE