



1 *Laboratory for in situ testing of fuel cell components.*

2 *Fully-automated screen printing lines in Fraunhofer ISE's Production Technology Evaluation Center PV-TEC.*

## PRODUCTION RESEARCH FOR FUEL CELL MEMBRANE ELECTRODE ASSEMBLY

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Fuel cells will play a significant role in the future energy system. They will be needed, for example, for storage and mobility solutions. Yet, so far, fuel cell production know-how and capacity are limited in Europe. Fraunhofer ISE has been conducting research in fuel cells and fuel cell production technology for almost three decades. The Institute has focused especially on the membrane electrode assembly (MEA) technology as the core of the proton exchange membrane (PEM) fuel cell.

With its pilot lines and Technology Evaluation Centers (TECs), Fraunhofer ISE offers technology development from basic proof of principles and concepts up to technology levels ready for transfer from "lab to fab". The offered services include studies on new concepts, development of processes and process sequences, formulation of active materials, adaption of machines and

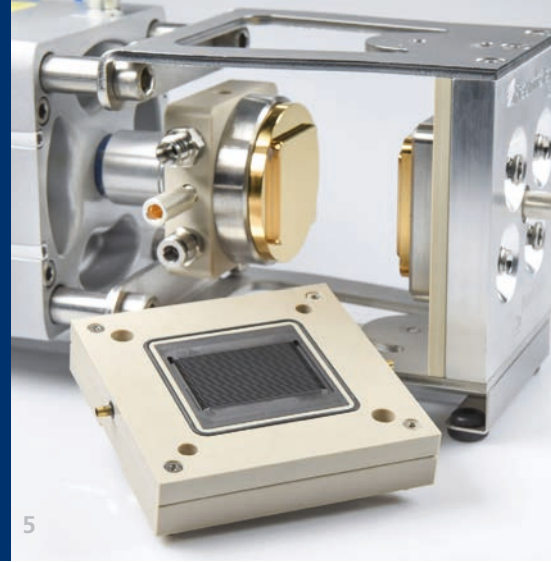
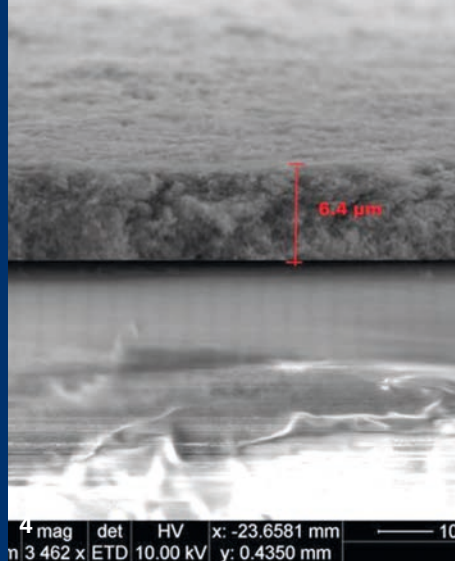
components, characterization, modelling and simulation as well as technology assessments including techno-economical and -ecological evaluation.

With our straight-forward MEA base-line process and various testing facilities, we offer customized services to partners, who want to evaluate and optimize their products for fuel cell application. Our partners are:

- equipment vendors:  
milling, mixing, printing, laser, thermal and (electro)chemical processing, automatization
- material suppliers:  
raw materials, catalysts, ionomers, membranes
- component manufacturers:  
catalyst-coated membrane (CCM), gas diffusion layers (GDL), MEA, bipolar plates



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### Technology Development

Development of technologies for the production of catalyst coated membranes ready for cell integration. Hereby, we follow several approaches, e.g. the printing on a decal foil with subsequent transfer onto the membrane by hot pressing or laser-processing. Our laboratory facilities offer technology development up to a technology readiness level (TRL) of 6 (technology demonstrated in relevant environment). Hereby, we make use of our pilot lines and Technology Evaluation Centers.

Our service areas are:

- design and development of advanced MEA architectures
- evaluation of materials (raw materials, pastes and inks, membranes), machines, processes, and process sequences for MEA processing in-line and off-line quality assurance
- technology transfer: individual transfer of single processes, process sequences, and complete technologies into industrial process lines of our customers. The transfers are accomplished by detailed process descriptions and customer site support during process implementation.

### Material Development

Fuel cell performance and costs strongly depend on the selection of raw materials and the formulation of those materials according to application-specific quality parameters. The focus is set on the development of pastes and inks for high-throughput printing techniques. For R&D activities in this field we offer:

- selection and validation of raw materials
- paste & ink formulation, homogenization and characterization
- selected characterization techniques: rheology, wetting, micro-structural analysis (ESEM/EDX)

### Process Development

Productivity (including throughput and yield) of single processes are of utmost importance for scaling innovative processes from "lab to fab". At Fraunhofer ISE, we offer a renowned competence towards the development of production processes – learned from PV:

- printing (slot-die, rotational and flat-bed screen printing, flexo-graphic printing, inkjet, dispensing, etc.)
- laser-processing
- roll-to-roll and sheet-to-sheet automatization

3 Application of paste on screen of semi-automated screen printing setup.

4 SEM cross-section of a catalyst layer applied by screen printing.

5 Test cell for electrochemical characterization of CCM and MEA components.

### MEA Characterization

Our experience in sophisticated cell characterization enables us to give valuable feedback for straightforward technology and material development. In this field we offer:

- electrochemical characterization on different levels of application: from differential cell testing up to spatially resolved characterization of full size cells
- analysis of material and operating condition dependent loss mechanisms
- durability testing using various accelerated stress tests

### Technology Assessment

To complete our service portfolio, we offer technology assessments. These include:

- total cost of ownership
- leveled cost of electricity
- sensitivity analysis
- exploration of business plans and technology roadmaps
- ecological assessment