

PRESS RELEASE

PRESS RELEASEApril 28, 2025 || page 1 | 3

Fuel cell production

Digital holographic 3D sensor ensures quality of metal bipolar plates

A digital holographic sensor checks the quality of metal bipolar plates for fuel cells with an accuracy of a few micrometers, enabling complete inline quality control for the first time. The sensor data provides the basis for a digital twin of the entire forming process. The digital twin should help understand the causes of recurring errors and optimize the production process.

Bipolar plates are key components in fuel cells. With up to six hundred bipolar plates stacked in a cell, they provide the electrical connection as well as the distribution and discharge of reaction gases and water. Metal bipolar plates are embossed from metal foils on both sides that can be less than a tenth of a millimeter thick. Slight fluctuations in the process parameters during forming lead to typical defects such as tearing, wrinkling or bouncing effects, which impair the function and durability of the fuel cell. Until now, such defects could only be randomly detected by means of downstream quality control. As part of a cooperation between the Fraunhofer-Gesellschaft and the German Research Foundation, the Fraunhofer IPM, together with the University of Stuttgart and the industrial partners thyssenkrupp Automation Engineering and Chemische Werke Kluthe, has developed sensor technology and simulation methods that provide the basis for active process control and process optimization in the series production of formed bipolar plates.

Full surface measurement of large areas with micrometer accuracy

The digital holographic 3D sensor developed at Fraunhofer IPM records high-precision 3D data of the component surface and makes it available in real time for process control. To measure bipolar plates of different sizes, the researchers rely on a scalable system that can be expanded with additional measuring heads depending on the size of the component. Such a "matrix sensor" consisting of several sensor heads records the entire flux field of bipolar plates with a size of up to 400 mm × 150 mm in a single measurement pass. The process happens in less than a second and without moving the

Editorial notes

Holger Kock | Communications and Media | Fraunhofer Institute for Physical Measurement Techniques IPM | Georges-Köhler-Allee 301 | 79110 Freiburg, Germany | www.ipm.fraunhofer.de/en | Phone +49 761 8857-129 | holger.kock@ipm.fraunhofer.de

sensor. A Stitching algorithm combines the measurement data from the individual measuring fields into an overall image. The high-resolution measurement images show forming errors as small as a few micrometers. The system is currently being tested in a near-series environment at the Institute for Forming Technology IFU at the University of Stuttgart.

PRESS RELEASE

April 28, 2025 || page 2 | 3

Learning from mistakes: Valuable data for process optimization

The measurement data recorded by the digital holographic sensor is not only intended to differentiate between good and bad parts, but also to improve the production process in the long term. To this end, the University of Stuttgart has developed a comprehensive simulation toolchain for the forming process, which incorporates the 3D measurement data. The aim is to systematically record and analyze recurring error patterns so that process parameters can be adjusted.

Further information

Project AKS-Bipolar

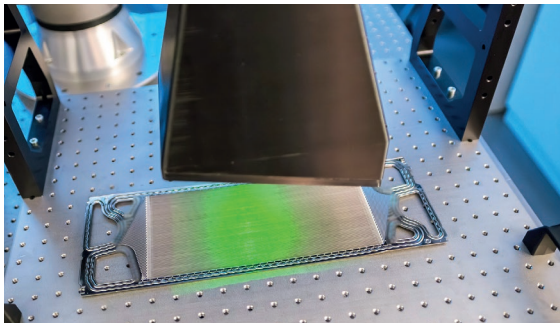
The AKS-Bipolar (Active Process Control in Series Production) project was funded by the Fraunhofer-Gesellschaft and the German Research Foundation as part of the "Trilateral Knowledge Transfer Projects" program. The aim of the project was to develop an overall system for active process control and quality assurance in the production of metal bipolar plates for fuel cells.

Project duration

07/01/2021 – 02/29/2025

Project partners

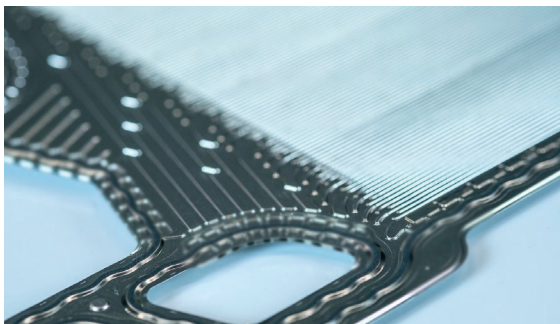
- Fraunhofer Institute for Physical Measurement Techniques IPM (project coordinator)
- University of Stuttgart, Institute for Forming Technology IFU
- thyssenkrupp Automation Engineering GmbH (application partner)
- Chemische Werke Kluthe GmbH (application partner)



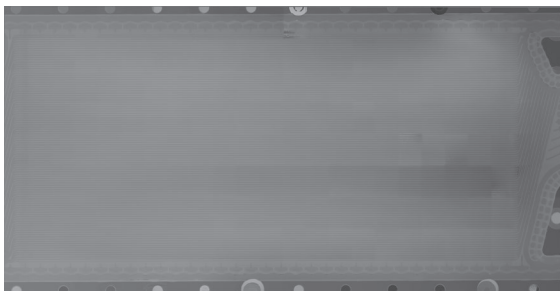
PRESS RELEASE

April 28, 2025 || page 3 | 3

A digital holographic inline sensor developed at Fraunhofer IPM ensures the quality of bipolar plates. The 3D sensor measures the component surface with micrometer precision and provides data for production control and optimization.



Hydrogen-powered fuel cells are an important component in the electrification of transportation. Due to their greater range, fuel cells are an exciting alternative to battery power, especially for heavy duty vehicles. The core elements of a fuel cell are bipolar plates with fine channels embossed on both sides.



Fully assembled measurement image of a bipolar plate with an area of $296 \times 152 \text{ mm}^2$. The measurement covers the entire flow field and includes approx. 512 million measurement points.

The **Fraunhofer-Gesellschaft**, based in Germany, is a leading applied research organization. It plays a crucial role in the innovation process by prioritizing research in key future technologies and transferring its research findings to industry in order to strengthen Germany as a hub of industrial activity as well as for the benefit of society. Founded in 1949, the Fraunhofer-Gesellschaft currently operates 75 institutes and research units throughout Germany. Its nearly 32,000 employees, predominantly scientists and engineers, work with an annual business volume of 3.6 billion euros; 3.1 billion euros of this stems from contract research.

Other contacts

Dr. Alexander Bertz | Group Manager Geometrical Inline Measurement Systems | Phone +49 761 8857-363
alexander.bertz@ipm.fraunhofer.de | Fraunhofer Institute for Physical Measurement Techniques IPM | www.ipm.fraunhofer.de/en