



## **Solving fuel cell quality assurance challenges using non-contact measurement**

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# HEXAGON - Empowering an autonomous, sustainable future

## Manufacturing Intelligence

Converging design and engineering, production and metrology solutions to enable smart factories for digital transformation.



## Asset Lifecycle Intelligence

Transforming unorganised information into smart digital assets to visualise, build and manage structures and facilities.



## Mining

Solving the toughest surface and underground challenges with proven technologies for planning, operations and safety.



## Agriculture

Enabling better planning, efficient execution, precise machine controls and automated workflows with advanced technologies.



## Autonomy & Positioning

Pioneering end-to-end solutions for assured positioning and correction for land, sea and air.



## Geospatial

Delivering 5D smart digital worlds with location intelligence that conveys what was, is, could be, should be and will be.



## Safety & Infrastructure

Improving the performance, efficiency and resilience of vital services with software solutions for smart and safe cities.



## Geosystems

Creating smart digital realities from different views with powerful technologies that capture, measure and visualise data.



## Xalt Solutions

Accelerating digital transformation by solving workplace challenges with the industry's most agile framework.





# Manufacturing ecosystem

Digital reality solutions for the complete lifecycle of discrete manufacturing, enabling asset owners to:

- learn and adapt quickly to changing conditions in real time
- pursue perfect quality with optimised design, requiring fewer inputs and producing less waste

Did you know?



**Hexagon's manufacturing technologies are used in:**

**95% of cars produced worldwide**

**90% of aircraft produced worldwide**

**80% of orthopaedic implants produced**

**75% of smartphones produced worldwide**

**98% of manufacturing organisations**—report that a single hour of downtime costs over €100,000

**Global CO<sub>2</sub> emissions**—were a result of 17% of manufacturing in 2019

# Manufacturing

Connect the vast manufacturing ecosystem via a Smart Digital Reality—a real-time 3D replica connecting product requirements with outcomes and enabling proactive corrective actions and maintenance while reducing waste and increasing productivity sustainably.

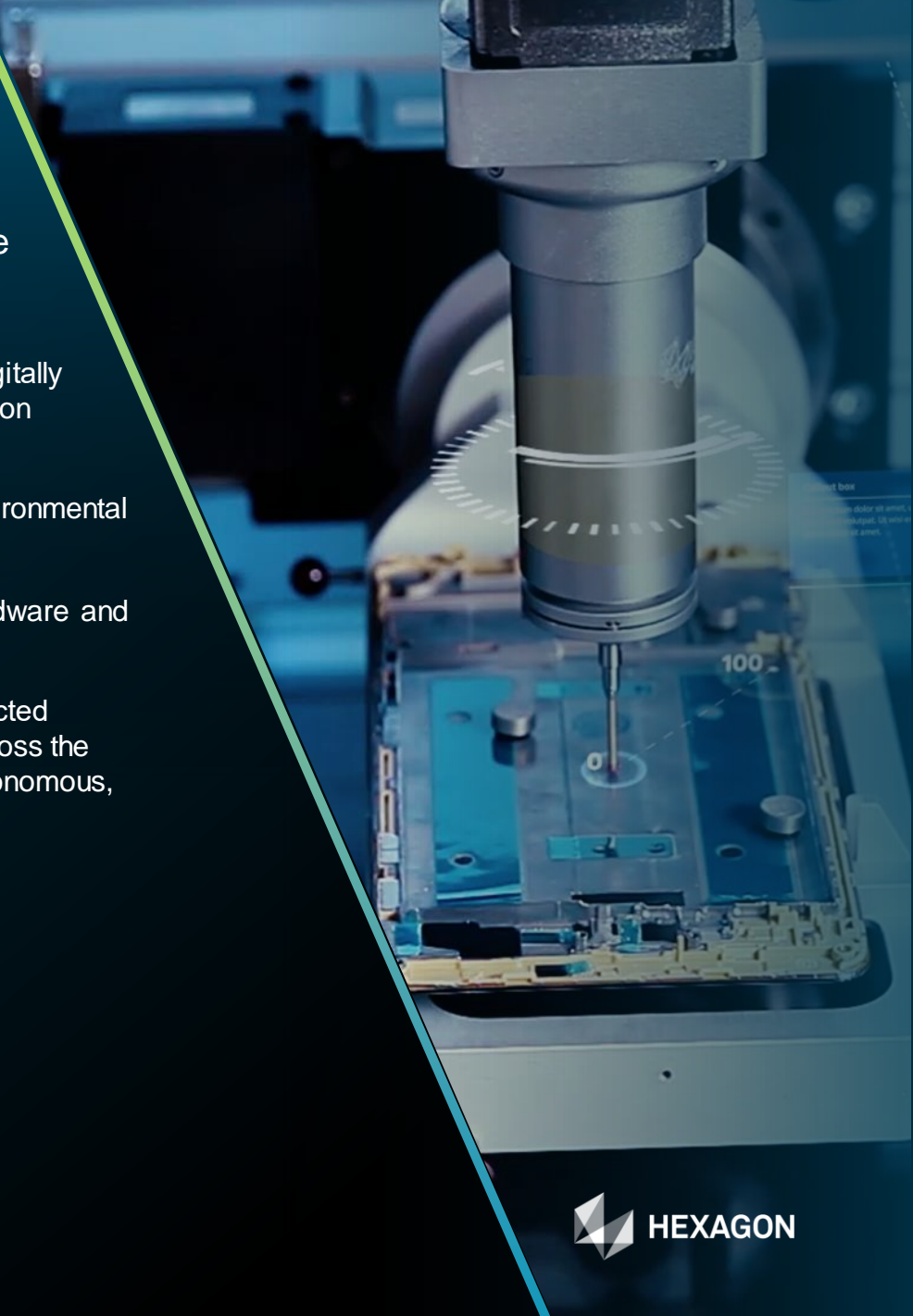
**Design & engineering phase**—With Hexagon’s innovations in manufacturing technology, users can digitally simulate and optimize product design and engineering to ensure component manufacturability, production productivity and output quality.

**Production phase**—Maintain a digital thread through production, optimise machine tools, measure environmental variances and prevent downtime with predictive data analyses.

**Inspection phase**—Automate and digitalise quality measurement with our world-leading metrology hardware and software, creating a bridge between the real and digital worlds.

**Digital transformation**—Deploy Hexagon’s sensor software systems to transform siloed and disconnected processes into an integrated, data-driven manufacturing ecosystem that captures and creates value across the product lifecycle, enabling new business models and automating workflows to become increasingly autonomous, efficient and sustainable.

Hexagon’s  
sustainable  
value  
creation





# Hydrogen is a key component for the way to net zero

- Hydrogen is a key component for achieving the goal of global carbon neutrality by 2050
- It has the potential to be the mainstream green alternative to fossil fuels
- Hydrogen will be needed across several sectors to achieve carbon neutrality, with an expected demand exceeding 660 million tons (MT) by 2050
- The key driver in achieving the goal is to ensure hydrogen is a cost-efficient alternative to other fuels

# Fuel cell stack



Source:  
Fraunhofer IPT

# Bipolar plate

## Key applications

- High-accuracy non-contact measurement of the bipolar plate flow field microstructure channels
- Capture flow field profile in multiple sections
- Material thickness measurement requires measurement from both sides
- Complete 3D nominal-to-actual comparison

## Challenges of measuring bipolar plates

- Measuring on demanding materials and surface finishes, for example metal-based coatings or graphite.
- Thin, easy-to-bend material with filigree structures.

## Measurement solutions



OPTIV M



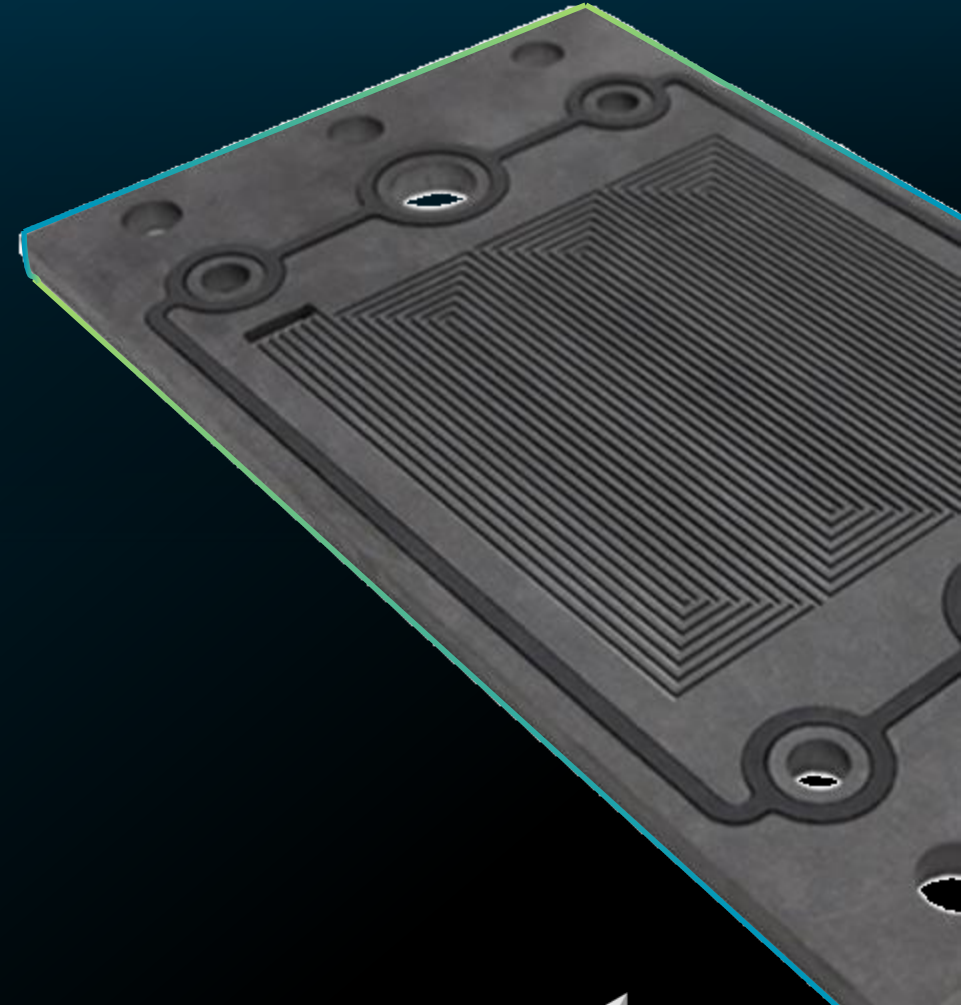
GLOBAL S  
with HP-OW



Leitz Reference  
with HP-OW

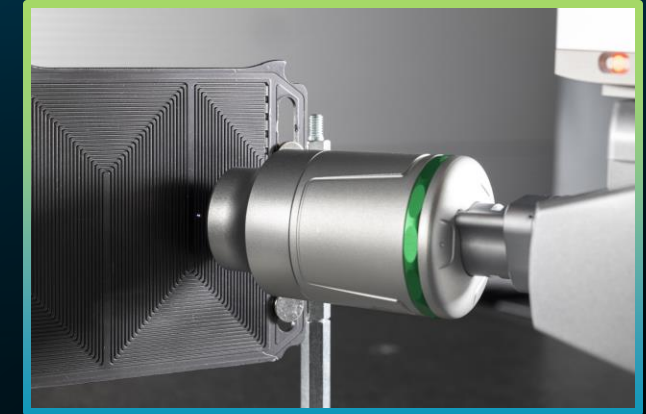
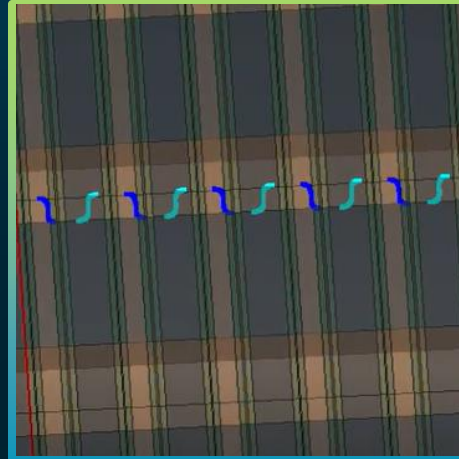
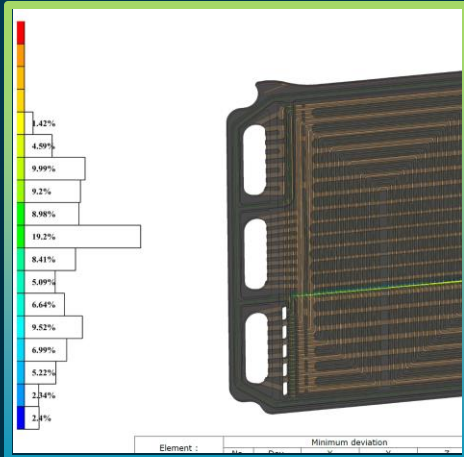


StereoScan neo





# Bipolar plate | GD&T measurement



- Using a non-contact sensor, such as the HP-OW, a cross section of the flow field is scanned
- Due to inclination angle of the grooves, it can be necessary to scan the profile twice
- Each time the sensor is positioned according to the direction of the groove's flanks

- Scans of the two sensor orientations, one in light and the other one in dark blue
- This ensures that every section of the profile is ideally captured
- The single scans are then merged into one profile

- Length and width need to be evaluated
- The edges are captured with a tactile probe
- The same procedure can be applied for ports, holes and slots and the edges are captured with a tactile probe or a camera sensor

# Bipolar plate | GD&T measurement

Non-Contact measurement with chromatic white light sensors HP-OW





# Membrane electrode assembly (MEA)

Accurate dimensions are critical for the stacking process and the fit of the complete stack. Deviations can cause misalignments, slow down the stacking process or limit performance.

## Key applications

- The measurement of 2D geometries:
  - length and width of the foils
  - parallelism of coating area to sheet edges

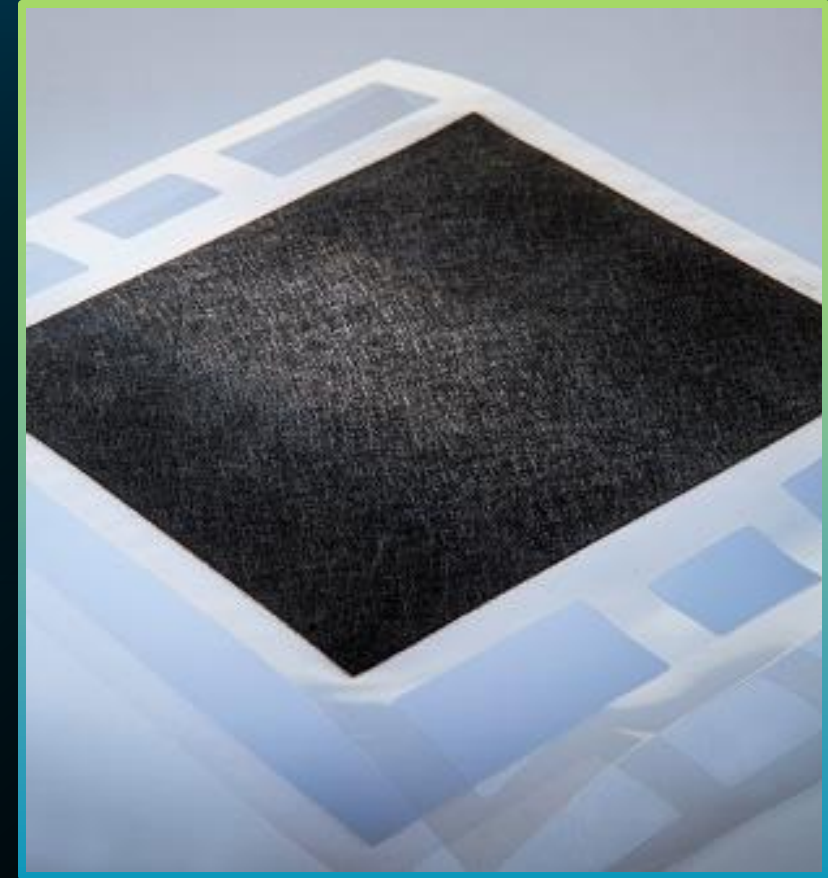
## Challenges of measuring the membrane electrode assembly

- The foils are very thin and sensitive (about 0.1 -0.3 mm thickness)
- Different coatings on the part

## Measurement solutions



OPTIV M



# Bipolar plate | Membrane electrode assembly (MEA)



- Dimensions of the MEA – lengths and widths of the different layers – are to be measured
- With the camera sensors of an OPTIV CMM the edges are quickly detected



- Evaluation of positioning and diameter of the glue point
- Topographic detection with non-contact point sensor (e.g. HP-OW)



- Profile form of cut outs can be compared to CAD data for evaluation
- Profile is captured with camera sensor



# Bipolar plate | Membrane electrode assembly (MEA)

Non-contact measurement of geometrical dimensions with multisensor CMM OPTIV M



# Fuel cell stack end plates

## Key applications

- Measurement and evaluation of length and width of the plate or inner diameter of the boreholes
- Measurement of form features, such as cylindricity of fits or concentricity of undercuts
- Position features are to be measured and evaluated
- Deformation analysis before and after assembly

## Challenges of measuring end plates

- The larger-sized components require adequate measurement volume
- Feature accessibility and tight tolerancing often require a tactile measurement solution
- Full scan data capture requires measurement solution with area data acquisition capabilities

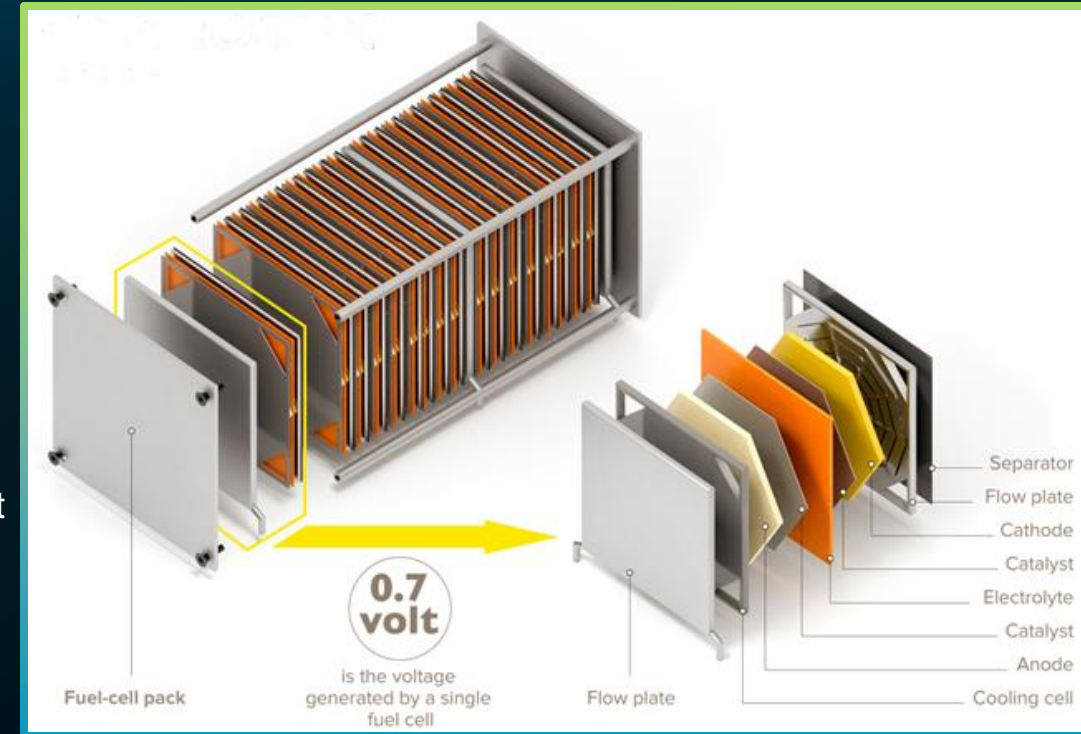
## Measurement solutions



Leitz  
Reference

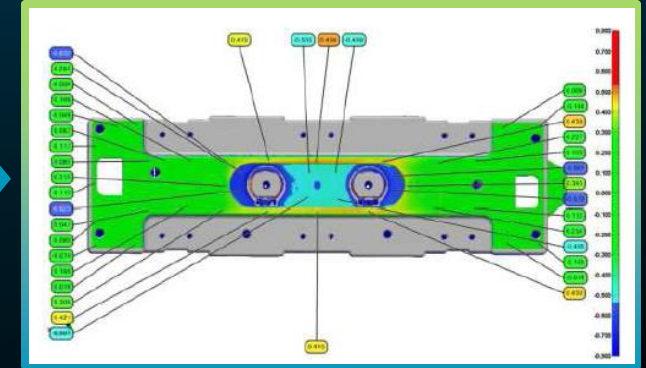
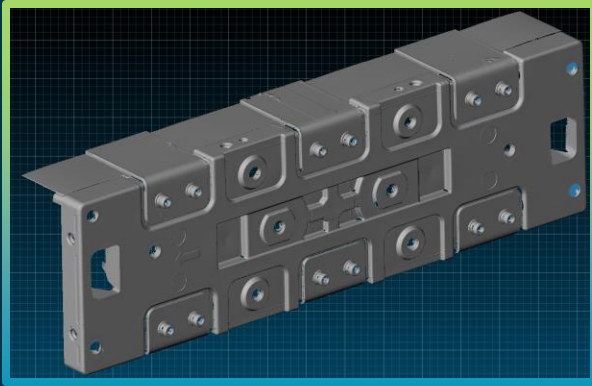


StereoScan  
neo





# Fuel cell stack end plates | Deformation analysis



- In a first step the end plate is scanned in an unclamped condition

- StereoScan neo FOV 550 – larger FOV for quicker capturing
- The data is processed in OptoCat software
- After the gas tight assembly of the fuel cell stack, the measurement of the endplate is repeated

- The captured data is converted to STL and based on a nominal-to-actual comparison the deviations between the unassembled and assembled endplate are shown in a 3D colour map
- This comparison gives information on the pressure distribution on the end plate for validation of the assembly process

# Solving fuel cell quality assurance challenges using non-contact measurement

- High variety of challenges in quality assurance of fuel cell components
- Materials, surface characteristics and geometries require non-contact measurement solutions
- HEXAGON offers the ideal measurement solution for fuel cell components

Visit us in **Hall 6 Booth B65**



# THANK YOU



## HEXAGON

empowering an autonomous future

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