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Research Project

Surface Quality

Mass Manufacturing of MEAs Using High Speed Deposition

The failure of a single component can bring down the entire system, so we will have to employ some unprecedented techniques to make every cell work at maximum efficiency. Only then can we reach true mass manufacturing of fuel cells, ensuring their supply for an increasingly demanding market.

— Aleksander Preglej, Managing Director, INEA UK

The project.

The MAMA-MEA (MAss MAnufacturing of Membrane Electrode Assemblies) Horizon 2020 project aims to develop a mass manufacturing process for Membrane Electrode Assemblies (MEAs). MEAs are a crucial part of a fuel cell, helping to create the electrochemical reaction needed to separate electrons and generate usable current.

The developed technologies are expected to increase material utilisation to 99% and the total yield to over 95% of the source material. The manufacturing rate should increase tenfold compared to the current state-of-the-art processes while reducing total manufacturing costs by up to 58%.

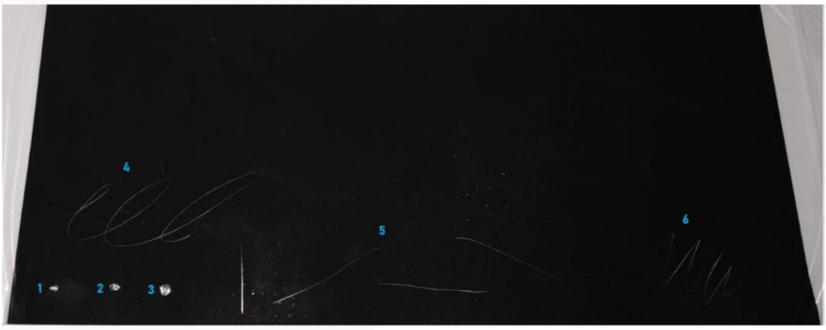
The project will be implemented at a Johnson Matthey Fuel Cells Ltd. (JMFC) manufacturing plant in Swindon, UK. JMFC is a subsidiary of Johnson Matthey, a global leader in chemical engineering and catalyst development.

INEA's focus in the project is the development of a quality control (QC) system that will satisfy the high-precision and high-speed demand of the planned production process.

The project is expected to be completed by early 2021.

Our challenge.

MEAs are constructed by applying layers of catalysts on a carrier foil. It is crucial that the resulting membrane only lets through the protons needed for the reaction, while keeping the residual gases separate. Any imperfections in the catalyst layers must be detected in the quality control stage, because a single faulty component can drastically reduce the efficiency of the entire fuel cell.



The layers of are about 10 microns thick and are applied on top of each other on a carrier foil of about 30 centimetres wide in a continuous roll-to-roll process, moving the foil at speeds up to 1 m/s. To ensure proper application, possible imperfections like variations in thickness and the absence of holes in the membrane and catalyst layers must be correctly detected and measured.

The optimal solution will have a sufficient resolution, measuring frequency, and processing speed to be able to detect micron-wide imperfections on a continuous roll of material, moving at up to 1m/s.

The approach.

Current vision systems detect imperfections by shining a light on one side of the material, with a high-resolution camera on the other side, capturing an image that highlights light leaks, resulting from holes in the otherwise opaque material. Different imaging techniques and additional sensorics might be needed to achieve reliable readings in such specific conditions.

A conventional approach would include a regular vision system with line and area scanners, which have improved significantly. However, due to the required high speed and micron-level precision that can ensure exact measurements, we may need to expand how we think about visual inspection systems. Alternative approaches that are being researched to bring additional benefits include:

- Confocal thickness measurement, for its unrivalled reliability in measuring the thickness of materials using light refraction;
- 3D laser triangulation, an industry-standard solution for high-speed measurements;
- Hyperspectral imaging, for its ability to clearly distinguish different materials by measuring their reflection in the invisible spectrum;
- Terahertz imaging, the fastest imaging solution on the marketwith a downside of low-resolution;
- X-ray imaging, which allows for subsurface vision through non-transparent layers.