Horizon 2020
European Union funding
for Research & Innovation

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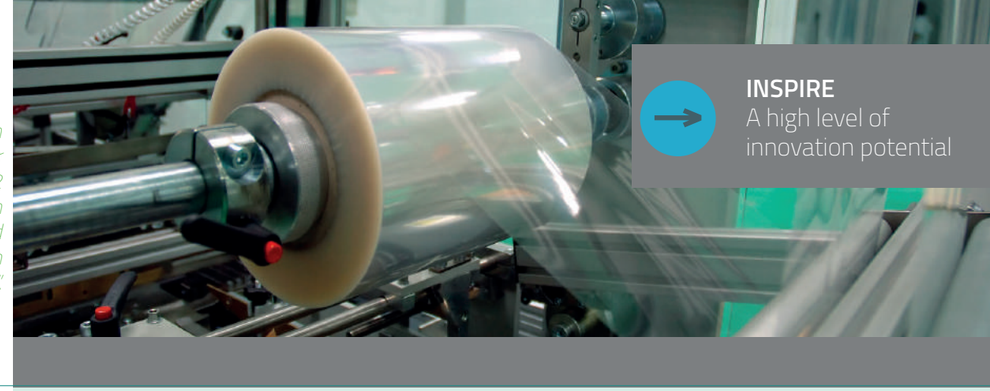

INSPIRE
A high level of innovation potential

How to Contact Us

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INSPIRE MEMBERS INCLUDE FUEL CELL COMPONENT SUPPLIERS, ACADEMIC INSTITUTIONS AND CAR MANUFACTURER BMW GROUP

This project is a close collaboration between industrial and academic partners to bring forward materials and components already showing considerable promise in current FCH JU projects, integrate them for enhanced performance and demonstrate their capability to be manufactured in volume

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Annual Newsletter

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INSPIRE

Integration of Novel Stack Components for Performance, Improved DuRability and LowEr Cost

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Integration of Novel Stack Components for Performance, Improved DuRability and LowEr Cost

www.inspire-fuelcell.eu

INSPIRE IS A THREE YEAR EU SUPPORTED PROGRAMME TO VALIDATE THE NEXT GENERATION OF AUTOMOTIVE FUEL CELL STACK TECHNOLOGY

INSPIRE is an industry-led three-year research and development project supported by a grant of €7.0 million from Europe's Fuel Cells and Hydrogen Joint Undertaking (FCH JU), under Grant Agreement Number 700127; this Joint Undertaking is a unique public-private partnership supporting research, technological development, supply chain and demonstration in the fuel cell and hydrogen energy sectors in Europe.

The **INSPIRE** project has reached its mid-point and has remarkably developed three catalyst supports and four catalysts already meeting the performance and stability targets set by the project stage-gate process, and three of those catalysts have now moved to full scale-up and evaluation in MEAs.

The development of components comprising the membrane electrode assembly, gas diffusion substrate, bipolar plates and stack housing have all been integrated into a first full-size stack generation achieving the interim performance milestone of 1.2 W/cm^2 and will now aim for the final project performance target of 1.5 W/cm^2.

June 2016
Sonning Common Primary School, UK

As part of the communication activities in the INSPIRE project, a team from Johnson Matthey Fuel Cells took part in **STEM (Science, Technology, Engineering and Math)** week in the UK.
This provided an opportunity for over **400 children from primary and secondary schools** to experience science and technology close up and see how important it is for our future well-being, particularly in the area of energy and fuel cells. It was also a chance to take JMFC's fuel cell car around the community, allowing children and parents to experience fuel cells in action.

Achievements & Outputs

Catalyst Achievements

A matrix of over 20 catalyst variants was created using three different synthesis routes that produced PtNi catalysts on two different carbon supports. The catalysts were incorporated into cathode catalyst layers and were evaluated as MEAs in single cells for stability and high current density performance. Two new PtNi catalysts had kinetic mass activities more than 50% higher than the benchmark catalyst, and also exceeded 0.44 A/mg Pt. After a voltage cycling AST the catalyst layers retained 25% more Pt surface area and 12% more mass activity compared to the WP3 benchmark catalyst layer. MEAs with two new cathode layers incorporating the best PtNi catalyst also exceeded the performance of the WP3 benchmark catalyst layer at high current density (1.5 A/cm^2) on H_2/Air by at least 7%, under a wide range of operating conditions, meeting the first project milestone as illustrated in Figure 1.

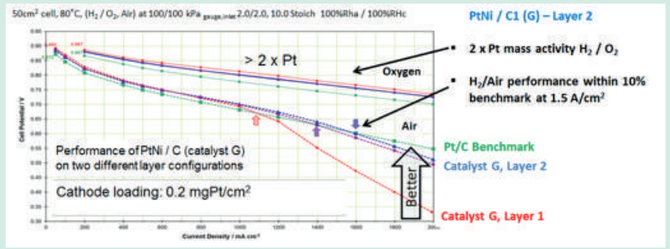


Figure 1. Performance in a 50 cm^2 single cell under H_2/O_2 and H_2/Air at 80°C, 100%RH and 100kPag, of PtNi/C catalyst, using two different catalyst layer configurations (red line) and (blue line). The green line shows the performance of the Pt/C benchmark catalyst layer. Cathode loadings are 0.20 mg Pt/cm^2.

Other approaches, including extended Pt layer/Ni nanofibre catalysts at CNRS, octahedral PtNi(Mo)/C nanoparticle catalysts at TUB, and hybrid Pt@Fe-NC catalysts at CNRS have shown sufficiently promising mass activities and stabilities by ASTs (meeting targets) to warrant continuing studies, including in full MEAs. In the longer term, high mass activity and high stability are expected from the complementary routes to Pt thin film deposition being developed on carbon fibre-carbon nanotube electrodes, transition metal doped carbons and NbTiOx-tie layer protected carbon fibres and particles, as well as from other alloys such as PtGd.

MEA Achievements

The aim of this work was to produce a higher performing GEN 1.5 MEA able to achieve the interim performance target of 1.2 W/cm^2 under the **INSPIRE** stack conditions. All components of the MEA were evaluated for performance and optimised for the **INSPIRE** stack conditions including new GDL, membrane, anode and cathode layers including the introduction of a cell reversal tolerant capable anode.
As shown in Figure 2, these materials were bought together as a new GEN 1.5 MEA with several options identified then down selected on the basis of an economic analysis. Although options were evaluated that did meet the interim performance target of 1.2 W/cm^2 the final option selected achieved 1.19 W/cm^2 but did so with a lower cost per kW in screener cell hardware. The final part had a thrifting of platinum group metals (PGM) from 0.45 mg PGM/cm^2 to 0.39 mg PGM/cm^2.

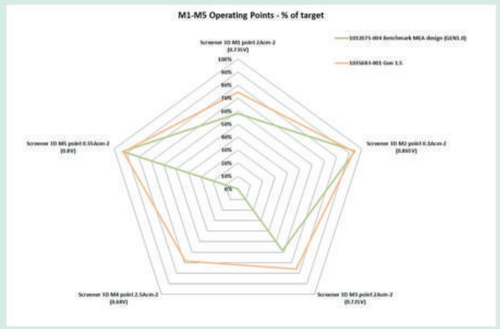
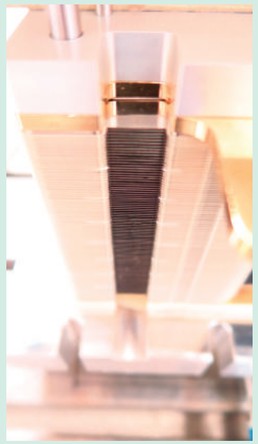


Figure 2: Performance achieved on the GEN 1.5 MEA compared to the GEN 1.0 benchmark MEA

Stack Design and Development

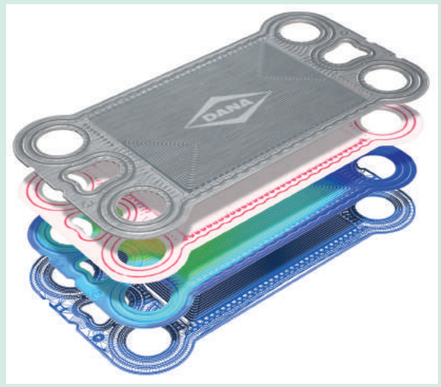
Two iterations of the stack assembly housing and compression will be delivered within INSPIRE. The housing and compression system for the **INSPIRE** stacks are required to provide uniform compression and homogeneous media distribution to the different stack components. The first iteration stack is intended for use in test station operation only. Therefore, the GEN1 stack case was designed as an open concept for easy dismantling and accessibility to sub-components.

Simulation tools were used to ensure adequate mechanical integrity of the pressure plates and tie-rods before the hardware was manufactured. The stack hardware is currently under test with GEN1.5 MEA and BPP components. Based on test and analysis results, BMW will design the next generation stack applying further weight and volume reduction measures. Additionally, the housing function will be enhanced to provide protection from environmental particles, high voltage safety, mounting points for possible vehicle integration and to fulfil crash requirements. All these requirements will be taken into account in order to provide a fully functional stack and meet the project targets.



BPP Design & Development

For GEN 1 of the **INSPIRE** project, DANA designed and manufactured an advanced state of the art bipolar plate. In cooperation with the project partners BMW, JM and SGL Carbon, the specification and design was defined. The plate design is based on several CFD and FEM simulation loops to define the final geometries for the chosen physical requirements.
The most challenging factors were the thin metal sheet as well as the very narrow channel geometries and small manifold area. An advanced tooling concept and precise welding technology enabled the manufacturing of the first plate generation in the **INSPIRE** project. The integrated bipolar plate concept including the bead seal technology and the high conductive carbon coating allows for the simplification of handling and assembly.



Conference Presentations

232nd ECS Meeting, 1-6 October 2017, National Harbor, MD, USA

68th Annual International Society of Electrochemistry Meeting, 27 August - 1 Sept. 2017, Providence, RI, USA

EFCF - 6th European PEFC & Electrolyser Forum, 04-07 July 2017, Lucerne, Switzerland

European Fuel Cell Car Workshop 1-3 March 2017, Orléans, France

Fundamentals and Development of Fuel Cells, 31/01-02/02 2017, Stuttgart, Germany

PRIME 2016, 2-7 October 2016, Honolulu, Hawai

Next Events

1. **24M progress meeting**
   15 -16 May 2018
   VTT
2. **FCH JU review days**
   November 2018
   Brussels, Belgium