FCH JU AWARDS 2019, BRUSSELS, BELGIUM - GAIA BEST SUCCESS STORY

This year's Best Success Story winner: '*Driving forward fuel cell technologies*', involves 5 projects, GAIA , CRESCENDO, VOLUMETRIQ, INSPIRE and PEGASUS, which are making fuel cells more affordable and competitive.

The successful projects reduce fuel-cell technology production costs, speed up manufacturing, develop new materials to increase fuel-cell performance and demonstrate how people can rely on hydrogen energy. Overall, they pave the way for a world-class European fuel-cell industry that sustains clean energy. The Awards were presented at a ceremony at the Royal Museums of Fine Arts in Brussels on 20 November 2019, attended by about 300 industry, research and EU representatives.

"EU public support is speeding forward European hydrogen and fuel cells technology. All projects exchanged material and are using each other's outcomes (...) The stack will be competitive worldwide, strengthening European jobs and industry and increasing automotive performance". Deborah Jones, coordinator of GAIA, VOLUMETRIQ, and CRESCENDO projects and research director at the French National Scientific Research Council (CNRS).

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PROJECT PARTNERS

CNRS · Technische Universität Berlin · Johnson Matthey (Inspiring science, enhancing life) · FREUDENBERG (INNOVATING TOGETHER) · dyneon · TUM · elmarco · BMW Group · ZSW · PRETEXO

NEWSLETTER #1
FEBRUARY 2020

GAIA

next Generation AutomotIve membrane electrode Assemblies

Welcome to the first GAIA Newsletter!

As the end of the first year of the contract approaches, GAIA (next Generation AutomotIve membrane electrode Assemblies) can look back on some project highlights, as well as the great honour of being part of the project cluster recognised in the FCH JU Awards 2019 as "Best Success Story" (see page 4). GAIA has the very ambitious objectives of reaching 1.8 W/cm² power density at 0.6 V, including under high temperature conditions of operation at 105 °C. Despite the resounding successes of the recently completed projects VOLUMETRIQ and INSPIRE in reaching 1.5 W/cm² at 0.6 V at cell, short and full stack levels at 80 °C, this still represents a step-change in aspiration. Year 1 of GAIA has set the groundwork by selecting the hardware for use in the short stacks used to test and validate the GAIA membrane electrode assemblies (MEAs) as being that developed in INSPIRE. This hardware has already been produced and delivered at both full automotive size and 50 cm² screener cell sizes, and the results coming through as we go to press are showing very good agreement between full size and screener cells using project reference MEAs over the whole testing protocol. The first GAIA membrane is breaking new ground by showing exceptional durability in an experimental drive cycle test, while the box for the first project milestone has been ticked with the preparation of new alloy catalysts with electrochemical surface area and mass activity higher than those of the reference PtNi alloy catalyst. Test stand adaptations and deposition equipment upgrades over year 1 underpin future characterisation and production capabilities. All in all, GAIA has had a productive and exciting first year, and some of the project highlights are outlined on the following pages.

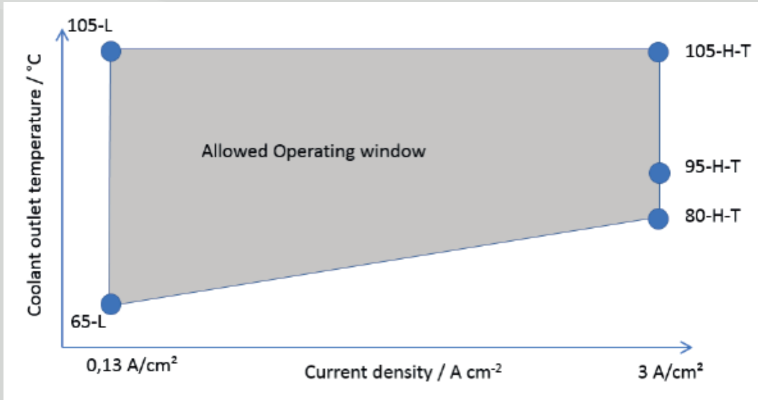
www.gaia-fuelcell.eu

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement N° 826097. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme, Hydrogen Europe and Hydrogen Europe Research.

GAIA
Some Highlights

WP2
Requirements, Test Methods and Operating Conditions, Benchmarking, Cost Assessment

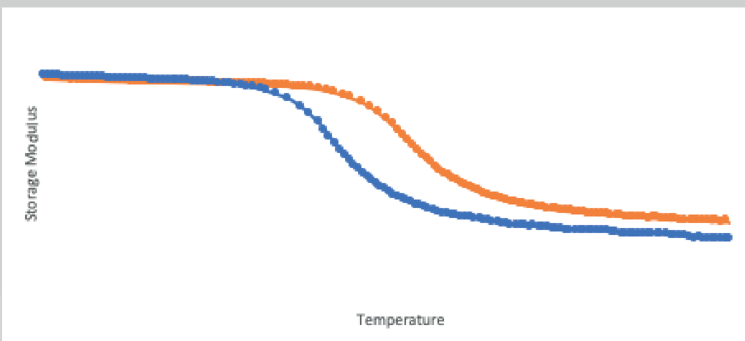
In WP2 a systems engineering approach was used to define the operating conditions and degradation tests for fuel cell systems for automotive applications. Based on this, the subcomponent properties have been defined that will be needed to meet the target stack and system performance. Subsequently, the test protocols were defined to serve as standard for testing among the partners and to allow comparison of component performance among different partners. This work package defined the automotive scale cell that serves as the basis for definition of the MEA geometrical requirements. Last, to address one of the most important requirements of the call, this work package will be responsible for calculating the cost of the final GAIA MEA in €/kW, using the MEA performance results at the reference current density, and costs information.



Desired allowed operating conditions for the GAIA automotive size short stack

WP3
Ionomer, Reinforcement and Membrane

One component of WP3 is the generation of ionomers that are being modified in order to deliver preferred properties in an automotive fuel cell. These ionomers will both be incorporated in the membrane material and be employed as as the proton conductive binder in the catalyst layers. There will be modifications in the chemistry of the ionomers in the attempt to reach the goals in this project. Furthermore, a broad range of equivalent weights of the ionomer, along with variations in the molecular weight of the polymer chains will be attempted. First results indicate that all of these variations are feasible, for example a change in the ionomer chemistry results in a shift of the glass transition temperature of the precursor material, as indicated in the Figure, which will affect the ionomer behaviour in the membrane and in the catalyst layers. In addition, a broad range of molecular weights could be obtained in the perfluorosulfonic acid polymer for the analysis of this property in the membrane electrode assembly.

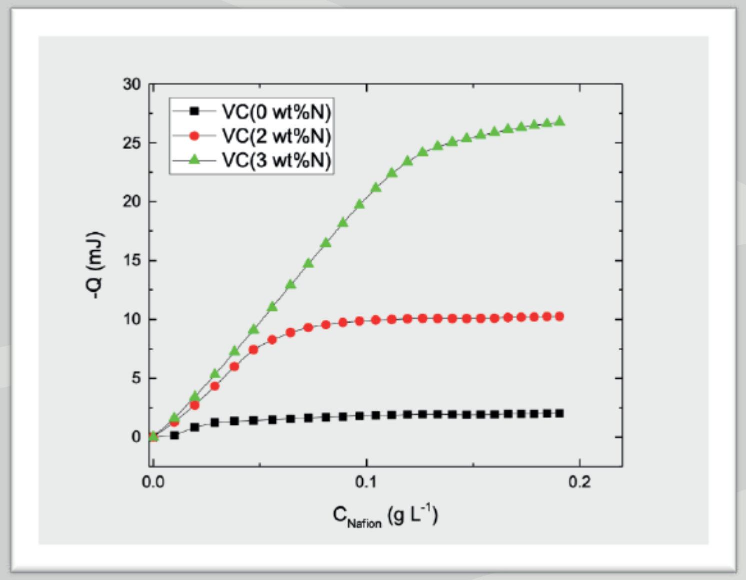


Tg of precursor materials (orange-800EW; blue-modified precursor)

WP4
Catalyst Support and Catalyst Design

In catalyst inks for PEM fuel cell applications, the interaction of the ionomer with the carbon support can influence many properties of the final catalyst layer, including ionic conductivity, water handling and mass transport. To improve our ability to measure and understand the way carbon supports and typical fuel cell ionomers interact, the partners have investigated a range of characterisation methods to assess their utility in describing and quantifying this interaction, with the aim of tuning the interaction to facilitate very high current density operation.

At CNRS, the technique of Isothermal Titration Calorimetry (ITC) was shown to be able to discriminate clearly between carbon samples with different degrees of surface modification by nitrogen; increasing the nitrogen content of the carbon surface increased the heat of adsorption of Nafion® on the modified carbon, indicative of a stronger interaction.



Cumulative heat release during titration of Nafion® with non-modified and nitrogen-doped carbon black suspended in water/1-propanol. Nitrogen content is expressed as wt%N in brackets.

At JMFC, changes in the zeta potential for a range of dispersions gave clear evidence of how the solvent type and concentration govern the charge interactions between the ionomer and carbon support. It was clear that in aqueous dispersions of Nafion®, the strength of the ionomer interaction with different carbons could be quantified.

A method to determine ionomer adsorption isotherms by means of quantifying the amount of residual non-adsorbed ionomer in a catalyst coating ink by means of ^{19}F NMR is being developed at TUM. While the limit of quantification afforded by ^{19}F NMR was shown to be sufficient, the detailed experimental procedure to obtain adsorption isotherms still has to be optimised and representative data will have to be validated by an independent analytical method.