GAIA

next Generation AutomotIve
membrane electrode Assemblies

NEWSLETTER #3
OCTOBER 2021

GAIA reaches its Power Density Target

We reported in the last newsletter that GAIA had reached its mid-term (June 2020) power density target of 1.5 W/cm^2 at 0.6 V. Despite the challenging working conditions that we have all experienced since then, project innovations in catalysts, catalyst supports, ionomers, membranes, gas diffusion layers, catalyst layers and MEA design have led to an advanced MEA that **reaches Europe's 2024 power density target of 1.8 W/cm² at 0.6 V**. Notably, advancements on a single-component level were not sufficient to reach this very ambitious target, and significant coordinated progress and synchronised improvements were all essential.

GAIA intends to continue to advance in the remaining 9 months of the contract by now targeting 6,000 operation hours, including operation at 105 °C, of a 10-cell short-stack. A techno-economic evaluation will then assess how the GAIA MEA cost is positioned with respect to the very ambitious 6 €/kW MEA cost target.

In other developments, project partners have combined their efforts and advanced electrochemical, spectroscopic, surface science, and electron microscopic characterisation techniques to identify the weakest link in their most durable MEA construction to date. An update is given in this issue. Work specifically designed to increase the longevity of this component is progressing, and a set of materials with further design improvements for increased lifetime are earmarked for the next generation of GAIA MEA.

This issue of the newsletter also highlights some of the catalyst developments involving platinum alloy particles with tuned geometry and/or composition gradient as well as other novel catalysts with exceptionally high platinum loadings on carbon obtained using atomic layer deposition.

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
HIGHLIGHTS

WP4

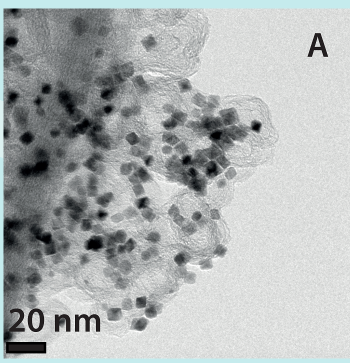
New Geometries and Topologies

The team at TU Berlin developed supported octahedra Pt ternary alloys such as PtNiRh/C (Figures A & B). Some of these were supported on N_2-plasma modified carbons developed by CNRS. These **catalysts gave very high kinetic activity for the oxygen reduction reaction** (ORR) in the rotating disc electrode (RDE).

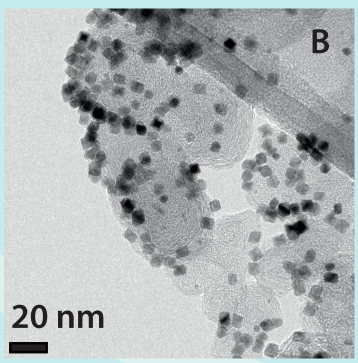
The group at CNRS developed supported Pt rare earth alloys, in which the Pt rare earth core is protected by an Pt rich overlayer, figure C .

The team at JMFC developed **alternative Pt deposition methods** with the use of Atomic Layer Deposition (ALD) to produce a 50% Pt/C catalyst powder, as shown in figure D.

Oh-PtNiRh/KB300



Oh-PtNiRh/N-KB300



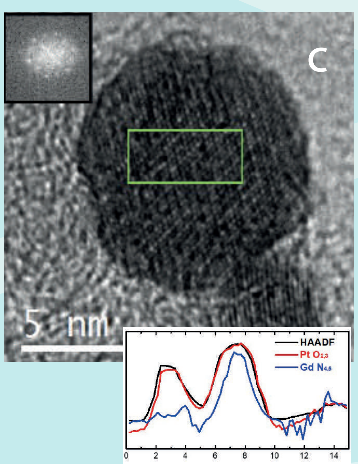
A: Oh-PtNiRh/KB300 from TUB

B: Oh-PtNiRh/N-KB300 from TUB

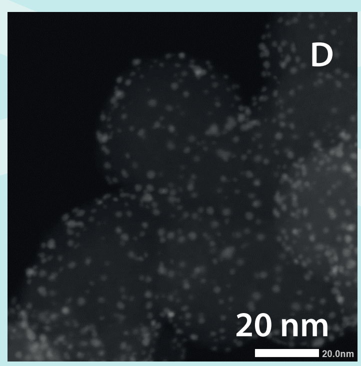
C: PtGd/KB300 from CNRS

D: 50%Pt(ALD)/C2 from JMFC

PtGd/KB300



ALD, 50% Pt/C2



Post-Test Analysis
Inputs for Improving MEA Durability

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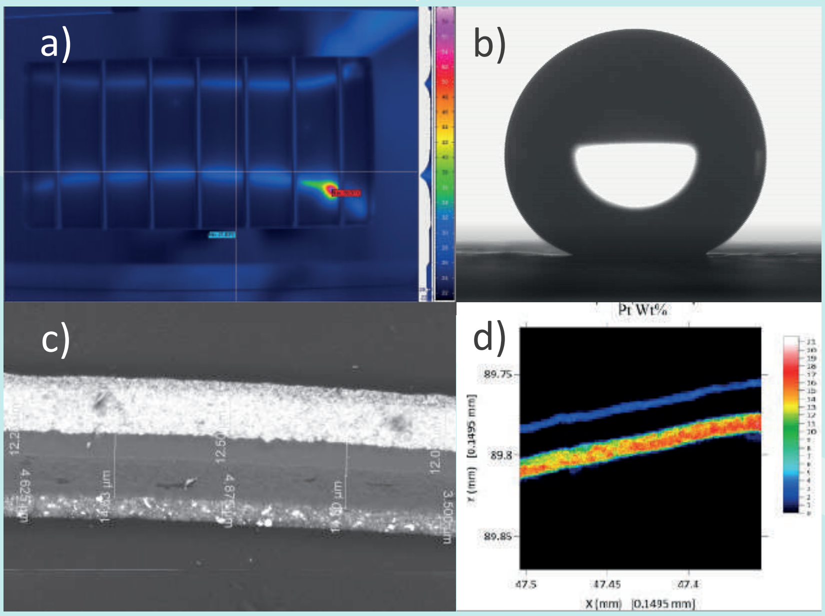
In addition to the power density target of 1.8 W/cm² @ 0.6 V reached by the GAIA Gen3 MEA, GAIA aims to demonstrate **MEA durability achieving ≤10% degradation after 6,000 hours operation**.

A stable MEA especially under high temperature operation (105 °C) is required to achieve the target. PBI-reinforced membrane and modifications in the catalyst layer introduced in GAIA Gen2 increased the MEA durability significantly. Even further improvement of MEA lifetime is targeted in GAIA.

By performing post-test analysis after the GAIA test protocol to the components of the Gen2 MEA, the weak components can be identified. IR Thermal Imaging provided information of the degraded location that needs to be investigated **(a)**.

Contact angle measurements show the hydrophobicity of GDLs before and after the GAIA test protocol **(b)**.

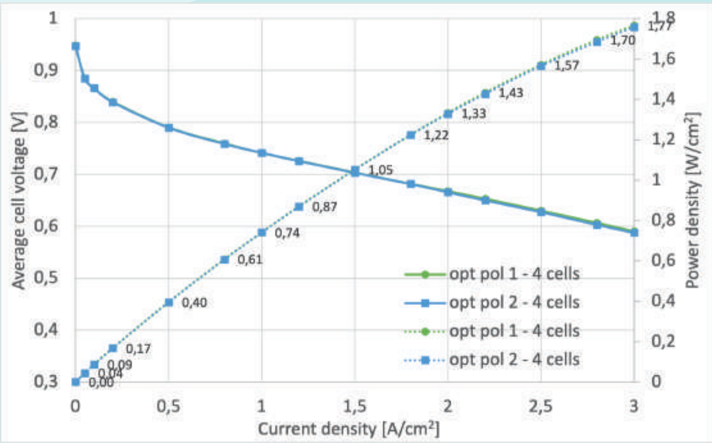


Cross-sectional SEM images of the CCM show the morphology and the thickness of the membrane and catalyst layer **(c)**.

Electron Probe Micro Analysis (EPMA) gives an indication of the changes in the catalyst layer, e.g. Pt dissolution **(d)**.

Information obtained from the post-test analysis will be used for improving components of the next generation GAIA Gen4 MEA to reach the durability target.

GAIA has delivered a fuel cell power density of 1.8 W/cm² @ 0.6 V This market-leading result marks a significant step forward for fuel cell technology.



The GAIA consortium has succeeded in reaching the 1.8 W/cm² @ 0.6 V power density target .

This leading accomplishment, which hits the FCH 2 JU Multi-Annual Work Plan target for light-duty vehicles for 2024, was achieved with high performance membrane electrode assemblies (MEAs) that integrate new materials and designs developed in the project in a full-size-cell (300 cm²) 4-cell stack, providing a Pt specific power density of 0.25 g Pt/kW.

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