

HIGHLANDER

HIGH PERFORMING ULTRA-DURABLE MEMBRANE ELECTRODE ASSEMBLIES FOR TRUCKS

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Project ID	101101346
PRR 2025	Pillar 3 - H ₂ End Uses - Transport
Call Topic	HORIZON-JTI-CLEANH ₂ -2022-03-02
Project Total Costs	3 331 247.50
Clean H ₂ JU Max. Contribution	3 331 247.50
Project Period	01-01-2023 - 31-12-2025
Coordinator Beneficiary	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS, FR
Beneficiaries	RHODIA OPERATIONS, SPECIALTY OPERATIONS FRANCE, UNIVERSITE DE MONTPELLIER, JOHNSON MATTHEY HYDROGEN TECHNOLOGIES LIMITED, PRETEXO, ELMARCO SRO, Rhodia Laboratoire du Futur, ROBERT BOSCH GMBH, SOLVAY SPECIALTY POLYMERS ITALY SPA, JOHNSON MATTHEY PLC, FORSCHUNGSZENTRUM JULICH GMBH, TECHNISCHE UNIVERSITAT BERLIN

<https://highlander-fuelcell.eu/>

PROJECT AND GENERAL OBJECTIVES

The objective of HIGHLANDER is to develop membrane electrode assemblies (MEAs) for heavy-duty vehicles (HDVs) with disruptive, novel components, targeting stack cost and size, durability, and fuel efficiency. The project will design, fabricate, and validate the HDV MEAs at cell and short stack level against heavy-duty relevant accelerated stress test and load profile test protocols. Materials-screening efforts will be supported by the development and use of improved predictive degradation models bridging scales from reaction sites to cell level. Model parameterisation is implemented using experimental characterisation data at materials, component, and cell level. HIGHLANDER aims to bring about a significant reduction in stack cost and fuel consumption through improving catalyst-coated membrane performance and the development of a new, lower cost single-layer gas diffusion layer. It also aims to achieve the 1.2 W/cm² at 0.65 V performance target at 0.3 g Pt/kW or less, meeting a lifetime target of 20 000h. Sustainability considerations include benchmarking fluorine-free membranes for HDV MEA application and reuse of platinum in the context of a circular economy.

NON-QUANTITATIVE RESULTS

HIGHLANDER launched a project website, published two annual newsletters, disseminated project results through ten presentations at conferences and has published five journal publications to date. A project workshop will be conducted in year 3.

PROGRESS, MAIN ACHIEVEMENTS AND RESULTS

- Development of novel intermetallic electrocatalysts for the oxygen reduction reaction at the fuel cell cathode. Selected catalysts display

better retention of electrochemical surface area and equivalent or higher mass activity in rotating disc electrode conditions than the project reference catalyst.

- Progress in the development of two series of novel sulfonated hydrocarbon ionomers for fluorine-free membranes and their benchmarking against perfluorosulfonic acid (PFSA) membranes.
- Formulation of a hierarchical degradation modelling framework and its implementation as a software code, available in the open access modelling platform (GitLab), accessible at <https://go.fzj.de/jumper>.
- Progress in the elaboration of low-cost gas diffusion layers (GDLs). The developed anode gas diffusion layer provides the same in situ performance as commercial GDLs, at a lower cost.
- Progress in the development of catalyst coated membranes. Baseline catalyst coated membranes have been submitted to load profile testing over 500 hours, demonstrating that the degradation rate of a membrane electrode assembly with a novel catalyst and the Syensqo PFSA ionomer was reduced to 50 µV/h. The final performance and platinum group metal loading targets of the project were achieved.

FUTURE STEPS AND PLANS

- Upscale of selected catalysts for catalyst layer development and single-cell characterisation.
- Preparation of nanofiber-reinforced membranes and their delivery for catalyst coating and testing of project MEAs against project performance and durability targets.
- Pursuit of development of a novel low-cost cathode GDL, catalyst and ionomer, along with support materials and other membrane components.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?
Project's own objectives	Power density @ 0.65 V	W/cm ²	1.2	1.2	✓
	PGM loading	g Pt/kW	< 0.3	0.292	
	Durability	hours	20 000	Durability testing to take place in the project's last 6 months.	⚙️