HIGHLANDER

HIGH PERFORMING ULTRA-DURABLE MEMBRANE ELECTRODE ASSEMBLIES FOR TRUCKSMARITIME SECTOR

Project ID	101101346
PRR 2024	Pillar 3 – H_2 end uses: transport
Call topic	HORIZON-JTI-CLEANH2-2022-03-02: Innovative and optimised MEA components towards next generation of improved PEMFC stacks for heavy duty vehicles
Project total costs	EUR 3 331 247.50
FCH JU max. contribution	EUR 3 331 247.50
Project start - end	1.1.2023–31.12.2025
Coordinator	Centre national de la recherche scientifique, France
Beneficiaries	Elmarco s.r.o., Forschungszentrum Jülich GmbH, Johnson Matthey Hydrogen Technologies Ltd, Johnson Matthey plc, Pretexo, Rhodia Laboratoire du Futur, Rhodia Operations, Robert Bosch GmbH, Solvay Specialty Polymers Italy SpA, Speciality Operations France, Technische Universität Berlin, Université de Montpellier

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 involve the design, fabrication and validation of the HDV MEAs at the cell and short-stack levels using accelerated stress test and load profile test protocols for heavy-duty vehicles. Material-screening efforts will be supported by the development and use of improved predictive degradation models bridging scales from the reaction site level to the cell level. Model parameterisation will be implemented using experimental characterisation data at the materials, component and cell levels. Highlander aims to bring about a significant reduction in stack cost and fuel consumption through improving catalyst-coated membrane performance and developing a new, lower-cost single-layer gas diffusion. It also aims to achieve the 1.2 W/cm² at 0.65 V performance target at 0.3 gPt/kW or less, meeting a lifetime target of 20 000 h. Sustainability considerations include benchmarking fluorine-free membranes for HDV MEA application and the reuse of platinum in the context of a circular economy.

PROGRESS AND MAIN ACHIEVEMENTS

- Implementation of liquid and gas phase characterisation tools online involving the electrochemical cycling of project catalysts to identify degradation products and determine correlations between them and electrochemical potential, and implementation of measurement methods for convective transport, electrical bulk conductivity and contact resistance of gas diffusion layers.
- Development of a series of novel ordered intermetallic catalysts on novel heteroatom-doped carbon and on reference carbon for the project that display a higher retained mass activity and electrochemical surface area than the reference catalyst for the project.
- Progress in the development of two series of novel sulfonated hydrocarbon ionomers for fluorine-free membranes and their benchmarking against perfluorosulfonic acid membranes.
- Advancement in the elaboration of low-cost gas diffusion layers with the development of a low-cost anode gas diffusion layer (GDL) giving identical performance to commercial GDLs.
- Formulation of a hierarchical degradation modelling framework and its implementation as a software code, available in the open access modelling platform (GitLab).

FUTURE STEPS AND PLANS

- Upscaling of selected catalysts for catalyst layer development and single-cell characterisation.
- Preparation of initial nanofibre-reinforced membrane and its delivery for catalyst coating and testing of initial 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?	SOA result achieved to date (by others)	Year for reported SOA result
SRIA (2021–2027) and AWP 2022	Durability of FC stack	hours	20	500 hours to end of test on single cell	⚙	30 000 (predicted based on 1 500 hours of actual load profile testing)	2023
	Power density	W/cm² at 0.65 V	1.2	N/A		1.2	2022
	PGM loading	g/kW	< 0.3	MEAs prepared with 0.42 mgPt/cm²		0.34	2023

Clean Hydrogen Partnership
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