MembrAnEs for STationary application with RObust mechanical properties (MAESTRO)

Key Objectives of the project

MAESTRO aims to establish methods to increase the mechanical stability of state of the art low equivalent weight perfluorosulfonic acid membranes for stationary application of proton exchange membrane fuel cells (PEMFC) to increase their durability and cell lifetime. The concept will be validated by the integration of the robust, mechanically stabilised membranes into MEAs, which will be tested in realistic conditions, including stability under dynamic conditions, start/stop events and stand-by mode, in compliance with performance targets of the Multi-Annual Implementation Plan.

Challenges/issues addressed

An issue clearly highlighted in the Multi-Annual Implementation Plan in the stationary application area is the need to address lifetime requirements of 40,000 hours for cell and stack, and the call for improved materials leading to step change improvements over existing technology in terms of performance, endurance, robustness and cost. In general, failure mechanisms of PEMFC membranes are of two main types: chemical (e.g. from attack by peroxide radicals on susceptible polymer end groups), and mechanical, which originates from weak intermolecular interactions between polymer chains. While methods of chemically stabilising the polymer end groups have been developed, failure due to insufficient membrane mechanical properties limits cell and stack lifetime. The problem is exacerbated by the trend in use of membranes of thickness only 25-30 µm (compared with the use of membranes of ca. 175 µm some 10 years ago), and the desire to employ lower equivalent weight membranes that can enable higher temperature operation, but which are inherently mechanically weaker and negatively impact membrane strength.

Technical approach/objective

The MAESTRO project is developing solutions to the above bottlenecks through a range of approaches to improve the mechanical stability of state of the art perfluorosulfonic acid (PFSA) type PEM fuel cell membranes via improved polymer chemistries and manipulation of membrane architecture. The final project target for the membrane is to have increased the tensile strength (compared with the benchmark material at the project beginning) by 50%, with a milestone at the mid-term stage of improvement by 20-25%. In terms of the MEA integrating the mechanically stabilised membranes, the target is for 4000 hours of operation under conditions relevant to stationary application, with performance degradation less than 10% compared to beginning of life.

Key technical items delivered in year 1 of the project include: Protocols for characterisation of membranes and MEAs including accelerated stress testing and long-term operation; Elaboration of benchmark MEAs and their characterisation according to these protocols; Development of membranes having elastic modulus increased by 78% compared with that of the project benchmark, while retaining conductivity of ca. 0.01 S cm^{-1} at 25% relative humidity and 0.2 S cm^{-1} at 90% relative humidity; State of the art report on approaches to membrane mechanical stabilisation.

Expected socio and economic impact

The long lifetime resulting from excellent chemical stability and enhanced mechanical properties, associated with sufficiently high operation temperature will contribute to reliability and costs reduction of stationary power generation systems, and improve European competitiveness in this market area.

The availability of mechanically robust and performant membranes will also have positive impact on fuel cell application in other sectors such as, for example, transportation.

Information

Project reference: FCH JU 256647
Call for proposals: 2009
Application Area: Stationary
Project type: Research and Technological Development
Topic: SP1-JTI-FCH.2009.3.2: Materials development for cells, stacks and balance of plant
Contract type: Collaborative project
Start date: 01/01/2011 — **End date:** 31/12/2013
Duration: 36 months
Project total costs: € 2264765
Project funding: € 1040049

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Beneficiary name	Country
Centre National de la Recherche Scientifique (Montpellier)	France
Solvay-Solexis	Italy
Johnson-Matthey Fuel Cells	United Kingdom
Università di Perugia	Italy
Pretexo	France

Project website: http://www.maestro-fuelcells.eu