MAESTRO

MembrAnEs for STationary application with RObust mechanical properties (Contract number 256647)

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http://www.maestro-fuelcells.eu

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Project Information

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

Project Coordinator

Application Area 3

SP1-JTI-FCH.2009.3.2:

Materials development for cells, stacks and balance of plant

Start date: 1st January 2011	Duration: 36 months
Cost: €2.2 million	FCH-JU funding: €1.04 million
Contract type: Collaborative Project	FCH-JU grant number: 256647

http://www.maestro-fuelcells.eu

MAESTRO objective:

Improve the mechanical properties of low equivalent weight state of the art perfluorosulfonic acid (PFSA) membranes

Final FC Operation Target

4000 h under operation conditions relevant for stationary operation

Milestones

MS1 Coordinated approach to membrane and MEA characterisation

MS2 Phase 1 down-selection of promising mechanically stabilised membranes for MEA fabrication

MS3 Selection of membrane for MEA fabrication for 4000 h test

MS4 MEA technology for 4000 h test

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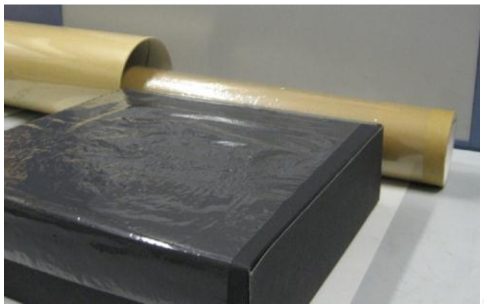
Project Structure

Part 3, Slide 3 of 7

CNRS
PXO
WP0 Project management



UPER
SLX
CNRS
WP2 membrane mechanical stabilisation

SLX
JMFC

WP3 MEA fabrication

CNRS
JMFC
SLX
UPER
WP1 Specifications, protocols and testing

PXO
CNRS
UPER
JMFC
SLX
WP4 Dissemination, outreach, exploitation

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Technical Achievements and Progress

Delivered items

WP0: Project internal shared work space	✓	M2
WP1: Characterisation protocols for membrane and MEA including accelerated stress testing to screen for mechanically stable membranes.	✓	M6
WP2: State of the art report on approaches to membrane mechanical stabilisation developed internationally	✓	M9
WP4: Project web site	✓	M3

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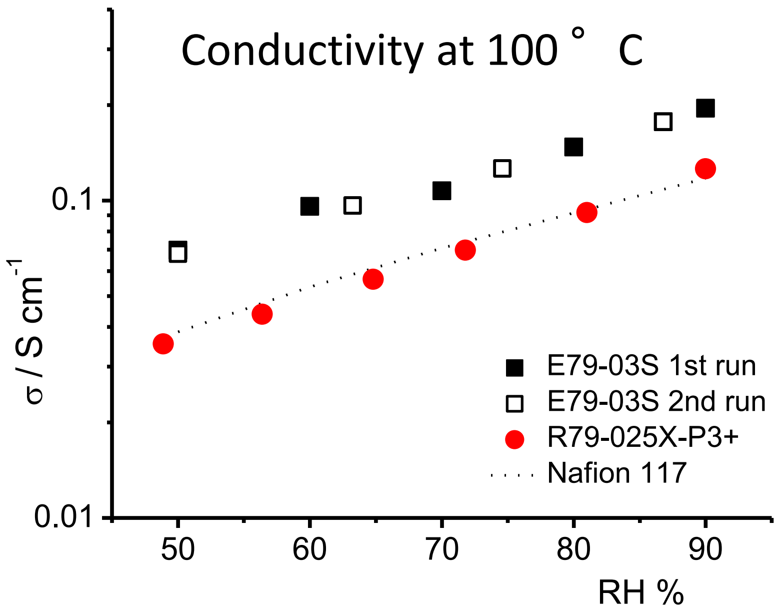
WP1: Specifications, protocols, testing

Task 1.1 Definition of operating conditions and protocols

Task 1.2 Membrane and MEA benchmarking

Membrane benchmark: Aquivion E79-03S (EW 790, 30 µm, chemically stabilised), and reinforced R79-025X-P3+ - conductivity, water uptake, tensile measurements performed

MEA benchmark: fabricated by JMFC using Aquivion E79-03S



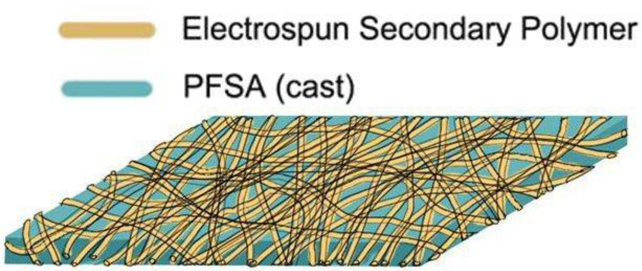
sample	T(° C), RH (%)	lambda	Elastic modulus (MPa)	σ in-plane (S cm^{-1})
E79-03S	20, 53	4.1	149	-
	80, 70	7.2	37.4	0.089
R79-02SX-P3+	20, 53	3.9	149	-
	80, 70	7.2	44.1	0.059

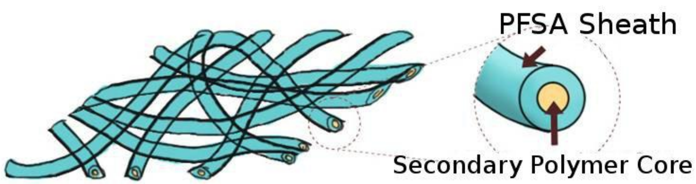
Technical Achievements and Progress

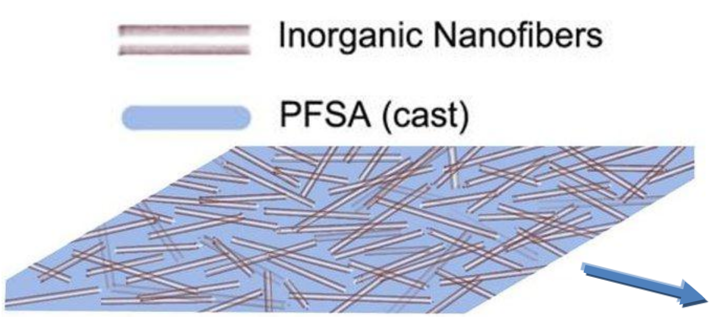
WP2: Mechanical stabilisation of PFSA Membranes

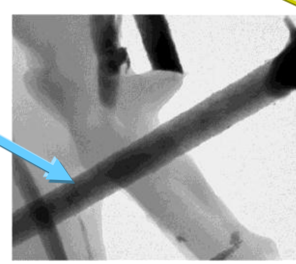
WP 2.4 electrospinning membrane processing

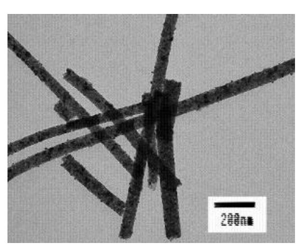
Sample	Dimensional Swelling (%)	Water Uptake (%)
Composite	73	105
Cast EW 700	120	141

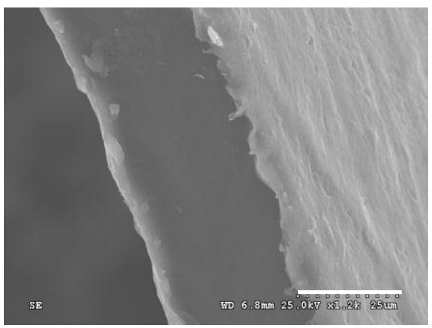


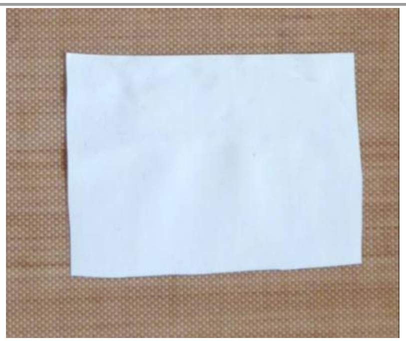


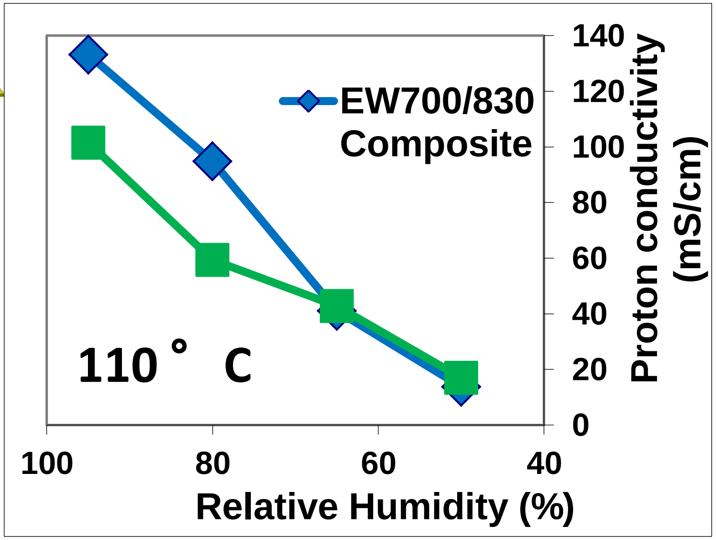












WP2: Mechanical stabilisation of PFSA Membranes

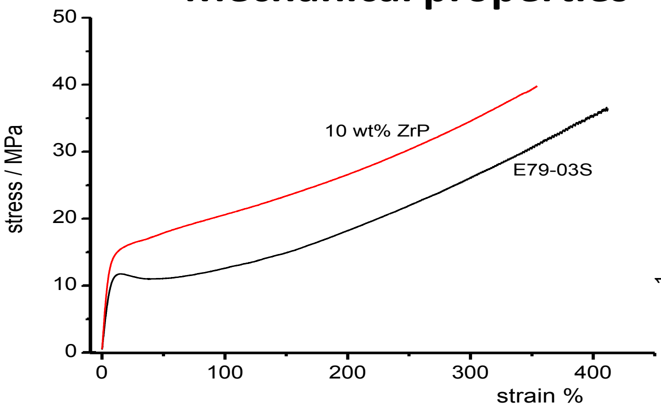
WP 2.5 Ionic cross-linking

Optimise composition (polymer/inorganic components) for best compromise between high conductivity and improved mechanical properties and durability

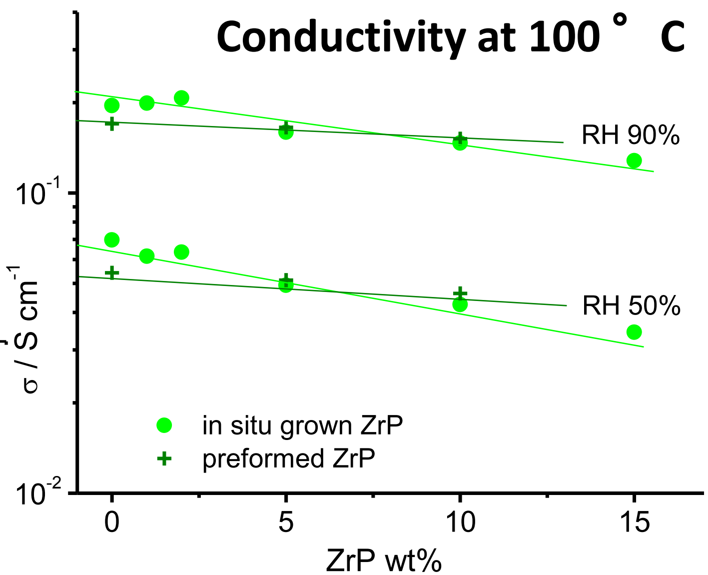
WP 2.2 Ultra-high molecular weight PFSA

Branched PFSA through novel copolymerisation leads to ultra-high molecular weight SSC PFSA with very low melt flow index and preparation of first membranes by dispersion casting

Mechanical properties



Increase of tensile modulus by 48% for only 5 wt% ZrP



Membrane of branched chain SSC PFSA

Alignment with MAIP

Part 2, Slide 1/4

MAIP Section 3.4.3 Stationary Power Generation & Combined Heat & Power:

*The overall objective of AA-Stationary i*s to **improve the technology for fuel cell stack** and balance of plant components to the level required by the **stationary power generation and CHP markets** by **bridging the gap between laboratory prototypes and pre-commercial systems.**

… RTD proposed will be **highly application orientated**…

…to achieve the **principal technical and economic specifications** necessary for **stationary fuel cell systems** to compete with existing and future energy conversion technologies.

… to deliver **new or improved materials at a component … level.** RTD directed towards **developing components** … as well as **novel architectures** for cells…leading to **step change improvements** over existing technology in terms of **performance, endurance, robustness, durability and cost**…. **degradation and lifetime fundamentals related to materials** and typical **operation environments**…

… **substantial effort** is needed to address **lifetime requirements of 40,000 hours for cell** and stack, as well as **competitive costs**

… **test campaigns for product validation** under real market conditions.

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Alignment with AIP 2009

Part 2, Slide 2/4

AIP09 Section 3.2 Specific topic for the 2009 Call for Proposals
"SP1-JTI-FCH.2009.3.2: Materials development for cells, stacks and balance of plant"

Projects are expected to cover:

❖ Development and design of materials to improve performance of both cells and stack and BoP components. Mechanical, thermal and electro-chemical stability should be considered and lifetime and degradation issues relevant to production cost for single cells and stacks ✓ MAESTRO

❖ Investigation of failure mechanisms… robust low resistance membranes in PEMFCs… ✓ MAESTRO

❖ New and improved material production techniques to reduce cost, emissions and improve yields, quality and performance in industry relevant cells… ✓ MAESTRO

❖ The consortium should include academia, research institutes, material producers and cell/stack manufacturers: ✓ MAESTRO - 1 RO (CNRS), 1 Univ. (UPER), industrial materials producers (SLX, JMFC) and cell/stack assemblers/testers (JMFC)

❖ 3 year, collaborative project

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Project Achievements vs. MAIP/AIP

Part 2, slide 3 of 4

MAESTRO commenced 01/01/2011.

To date it has:

- assembled a compact, focussed and skilled **partnership of academics, researchers, materials developer and cell manufacturers**
- developed **test and characterisation protocols** to **validate products** of the RTD work including **accelerated stress testing** and **long-term validation** in conditions **relevant to stationary and CHP application** and **addressing the lifetime** requirement
- initiated RTD activities leading to **new and improved PEMFC cell components** (membrane) having **novel architecture** at the nano- or micro-scale
- initiated all planned research and innovation activities in WP2 incorporating **new production techniques** and leading to **robust PEM fuel cell membranes** with **step-change improvement** (currently +48% improvement in tensile strength) in **mechanical properties** (directly impacting **endurance and extending lifetime**), while minimally impacting electrical resistance (high conductivity) and maintaining performance
- guaranteed **cost competitiveness** of RTD approaches through close collaboration between research and industrial partners, and **bridging the gap** between **laboratory prototype samples** and **transfer to industrial** laboratories for **commercialisation**

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Priorities and topics possibly under/over-estimated in the AIPs in terms of technical challenge

- **initial benchmark MEA testing re-affirms the need for the project and show a stiff technical challenge ahead to significantly enhance the mechanical robustness of low EW PFSA**
- **mechanical characterisation at controlled temperature/RH more time-consuming than estimated**

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MAESTRO addresses and contributes to:

- **Training/education** of 1 Ph.D. student, 2 post-doctoral researchers in materials science, processing of ionomers, characterisation of polymer and inorganic electrolytes
- **Dissemination** of project results through conference presentations, publication in high impact international journals, via project web site
  - To date: ECS Fall meeting 2011 (oral presentation), Publishable state of the art report on routes to mechanical stabilisation of PFSA membranes (draft form available)
- **Public awareness** activities are planned, especially with schools, aimed at increasing public understanding of the implications of peaked oil reserves and the need for alternative energy sources, the role to be played by use of hydrogen as a fuel, and by fuel cells for residential and other small stationary applications.

Technology transfer/cooperations

Part 4, slide 1 of 2

Links, collaborations, interactions and interfaces

- **Link to previous work on testing protocols performed within framework of Autobrane**
- **Interfaces with other projects, institutes, and other cooperations are expected to be built up as the project progresses**

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Project future perspectives

Part 4, slide 2 of 2

- Present status is that the project is on track technically and is on schedule
- SLX will seek to implement the membrane mechanical stabilisation routes developed in the project into their product offerings
- JMFC will seek to evaluate promising MEAs comprising the new project membranes for application with leading fuel cell system developers worldwide
- Contributions to the future development FCH JU Programme are probable
- Increased cooperation at International, EU, Member States or Regional levels will be pursued

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