QuasiDry

Quasi-anhydrous and dry membranes for next generation fuel cells (Contract number 256821)

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http://www.quasidry.eu/

Project Information

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Beneficiary name	Country	Partner type
Centre National de la Recherche Scientifique	France	Research
University of Lund	Sweden	Research
Max-Planck Institut für Polymerforschung	Germany	Research
Consiglio Nazionale delle Ricerche – Institute for Advanced Energy Technologies	Italy	Research
Johnson Matthey Fuel Cells Ltd	United Kingdom	Industry
Funktionelle Membranen und Anlagentechnologie GmbH	Germany	Industry
PRETEXO	France	SME

Start date: 1st December 2010	**Duration: 36 months**
Cost: €2.53 million	EC funding: €1.73 million
Collaborative Project	EC grant number: 256821

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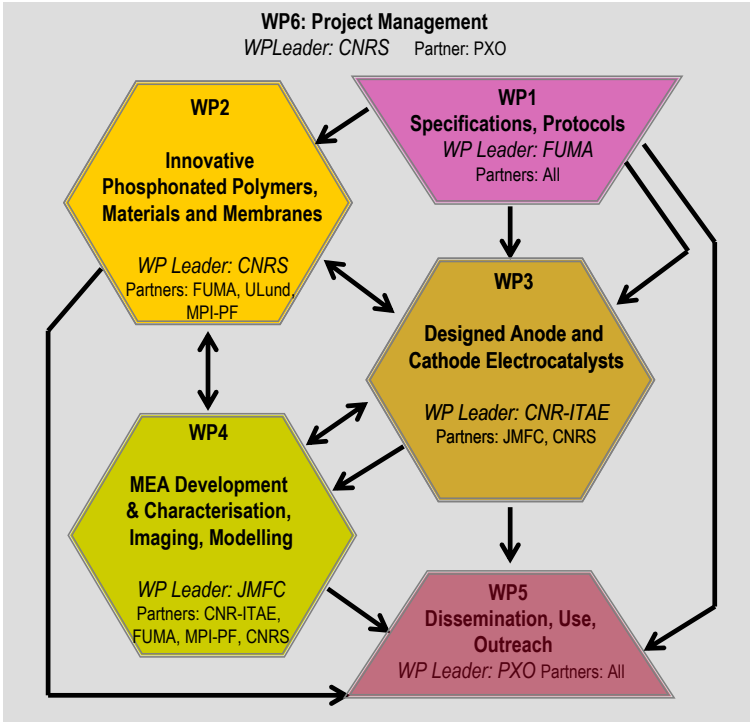
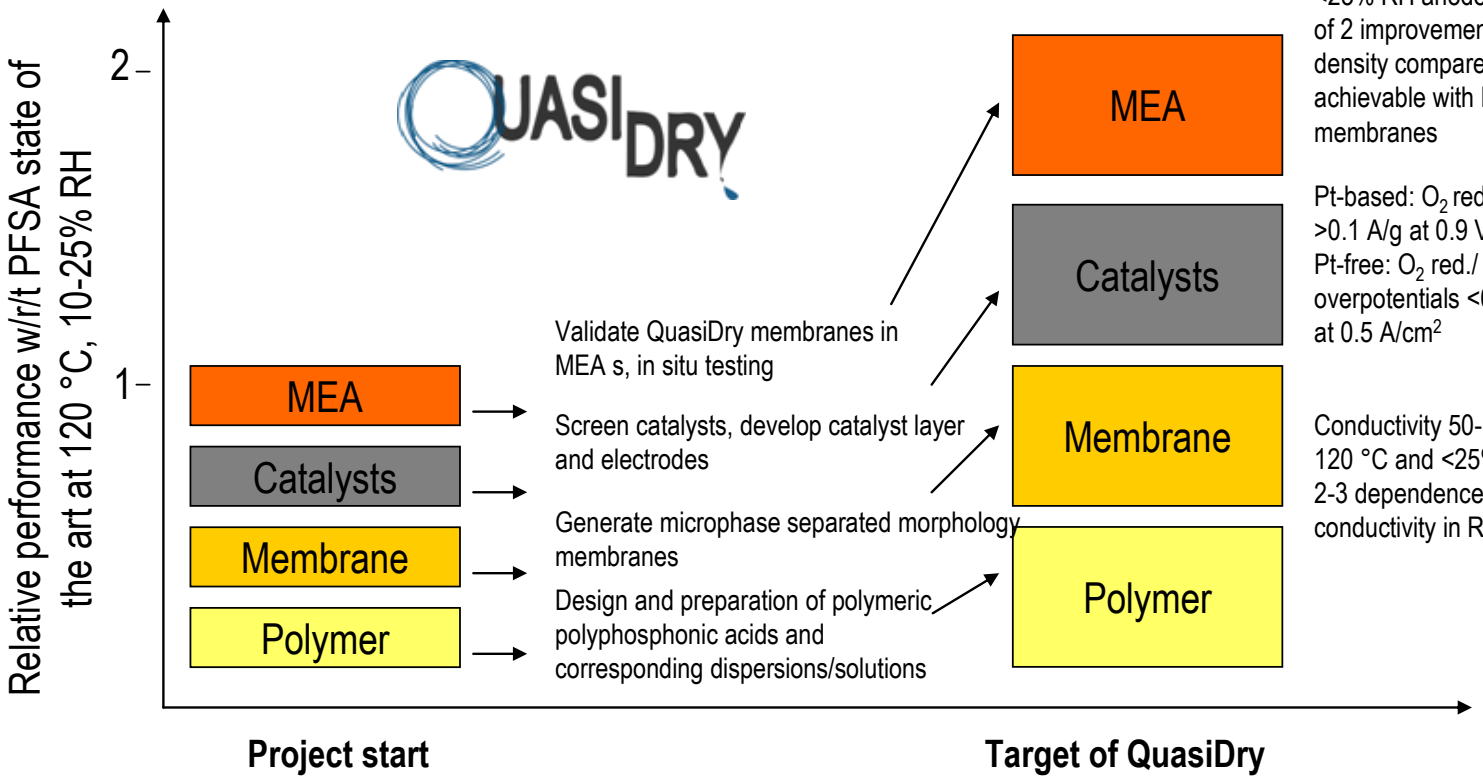


QuasiDry objective:

To develop the fuel cell electrolyte membranes of the next generation of fuel cells, showing increase of proton conductivity with temperature, including at low RH, and satisfying the long-term automotive targets.



Step-change in fuel cell performance at 120 °C and <25% RH anode/cathode: factor of 2 improvement in power density compared with what is achievable with PFSA membranes

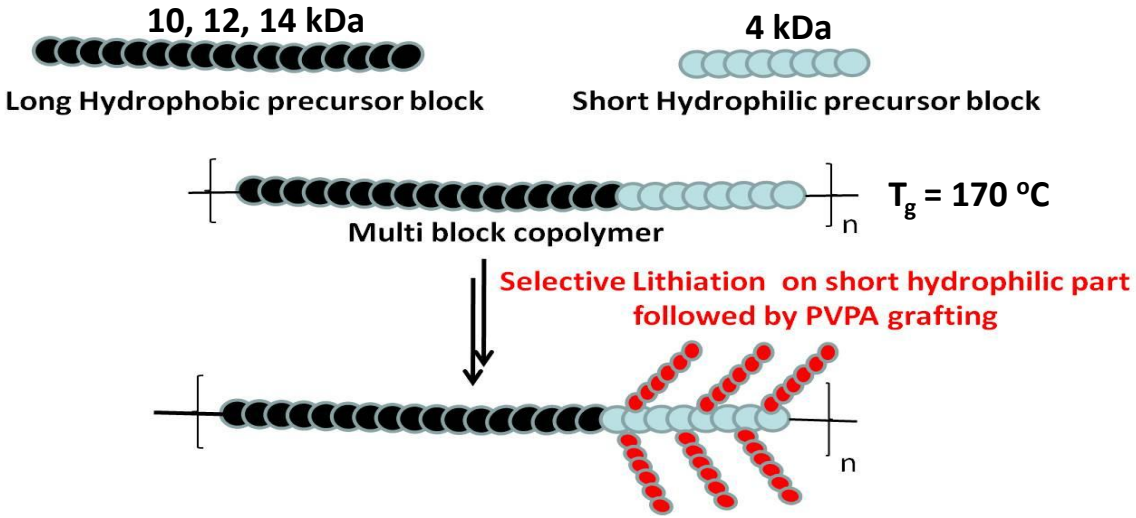
Pt-based: O_2 red. mass activity >0.1 A/g at 0.9 V RHE;
Pt-free: O_2 red./ H_2 oxidation overpotentials <0.4 V and <0.1 V at 0.5 A/cm^2

Conductivity 50-100 mS/cm at 120 °C and <25% RH and factor 2-3 dependence of HT conductivity in RH range 20-95%

WP2: Innovative phosphonated polymers, materials and membranes

WP2.1: ULund has prepared phosphonated copolymers that self-organise into phase separated and well-structured membranes for high conductivity and morphological control under hot and dry conditions

Synthetic strategy:



Main results so far:

- Five different multiblocks prepared with different molecular parameters
- Two different phosphonated graft copolymers prepared
- Good quality films of the grafted block copolymers obtained by solvent casting

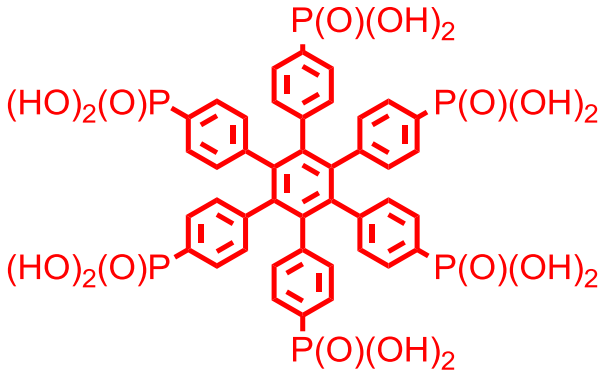
In progress:

- Measurements of conductivity vs. RH and T
- Microscopic nvestigatation of morphology

Technical Achievements and Progress

WP2: Innovative phosphonated polymers, materials and membranes

WP2.3: MPIP has prepared self-assembled crystalline highly phosphonated organics



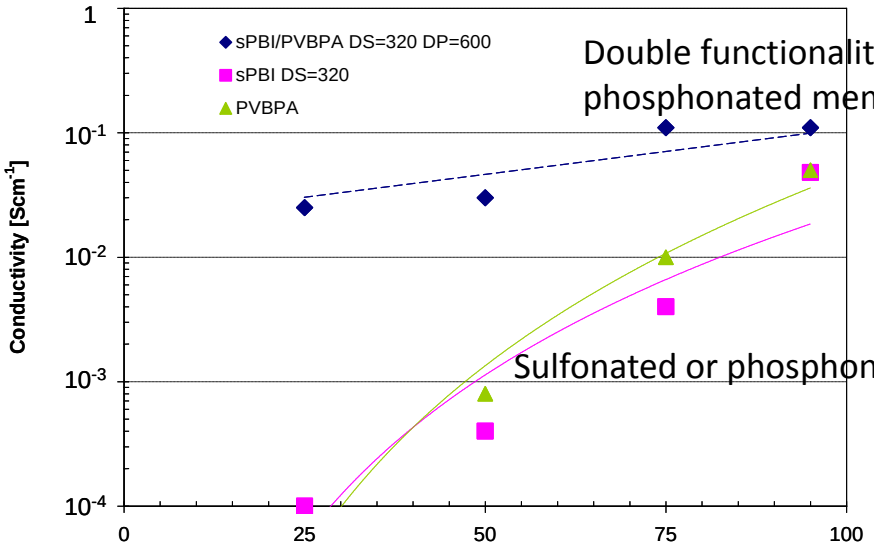
Main results so far:

- Supply of phosphonic acid functionalised organic crystals

In progress:

- Preparation of composite membranes with non-functionalised and sulfonated polymers

WP2.2 FuMA-Tech has provided novel PBI for functionalisation. CNRS has prepared interpenetrating network mixed functionality phosphonic sulfonic membranes and model polyphosphonic acid ionomer *dispersions* with particles of size 100 nm



Main results so far:

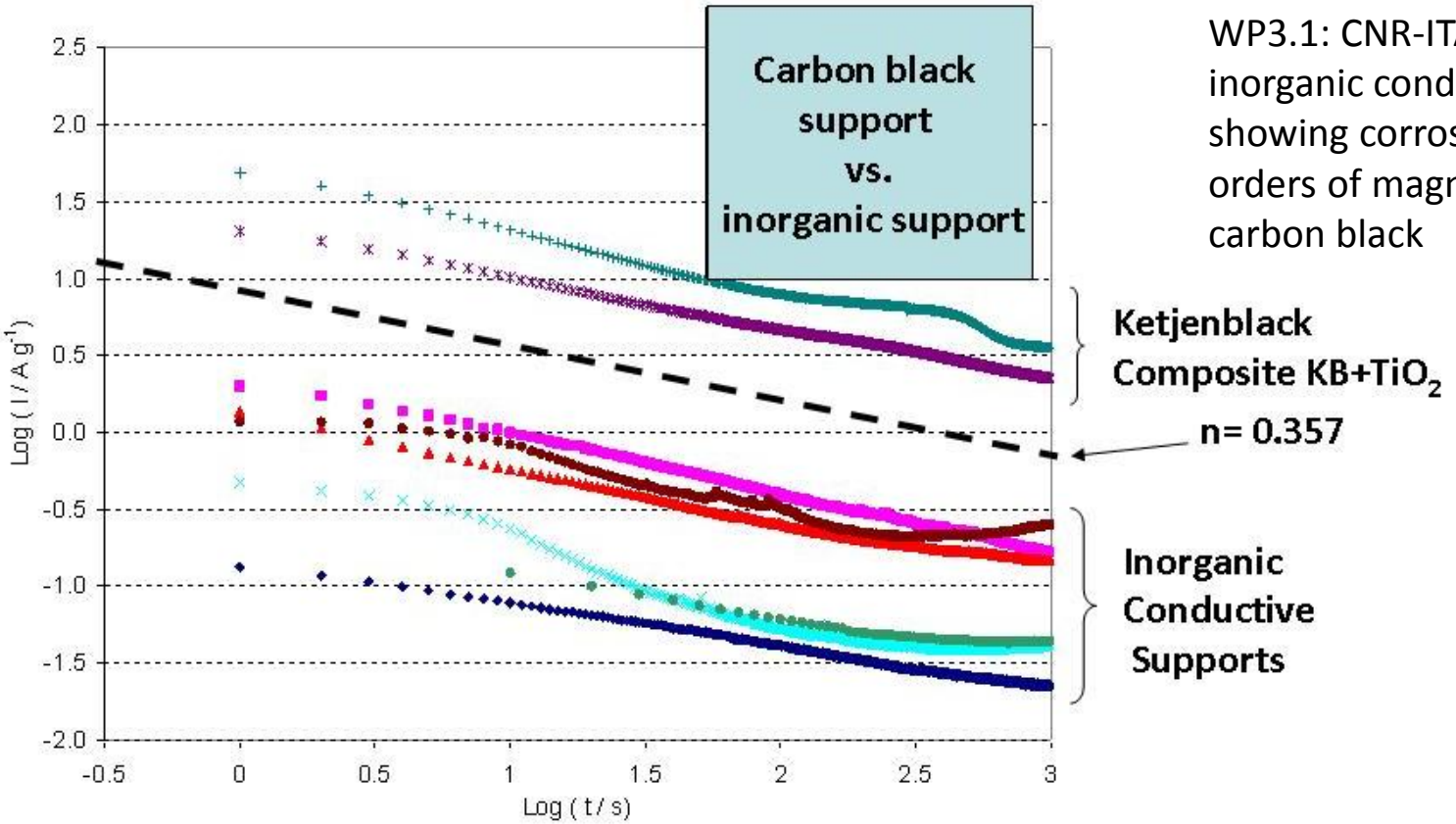
- Preparation of semi-IPN membranes containing double functionality showing high conductivity at 120 ° C and low RH

In progress:

- Improve control of sulfonic/phosphonic acid ratio

WP3: Designed anode and cathode electrocatalysts

Support corrosion and reaction order for corrosion at 1.4 V RHE

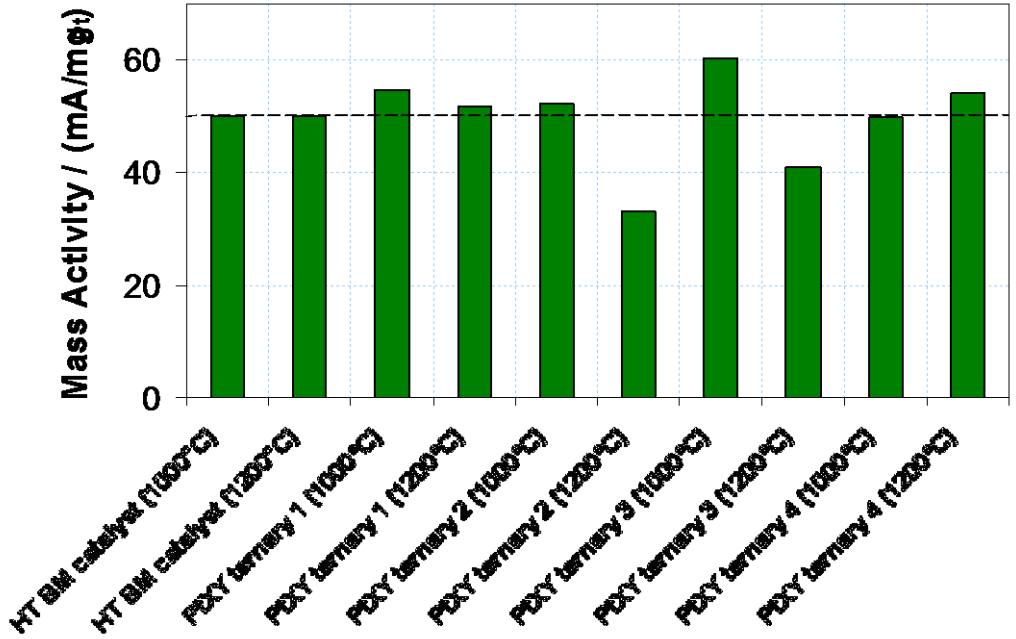


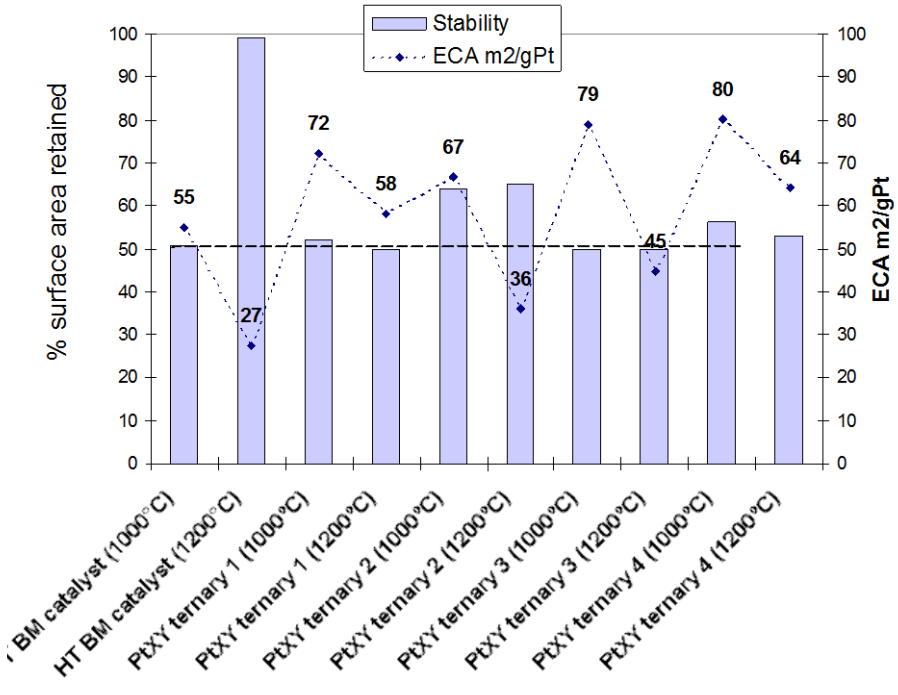
WP3.1: CNR-ITAE has prepared inorganic conductive supports showing corrosion currents 2-3 orders of magnitude lower than carbon black

Technical Achievements and Progress

WP3: Designed anode and cathode electrocatalysts

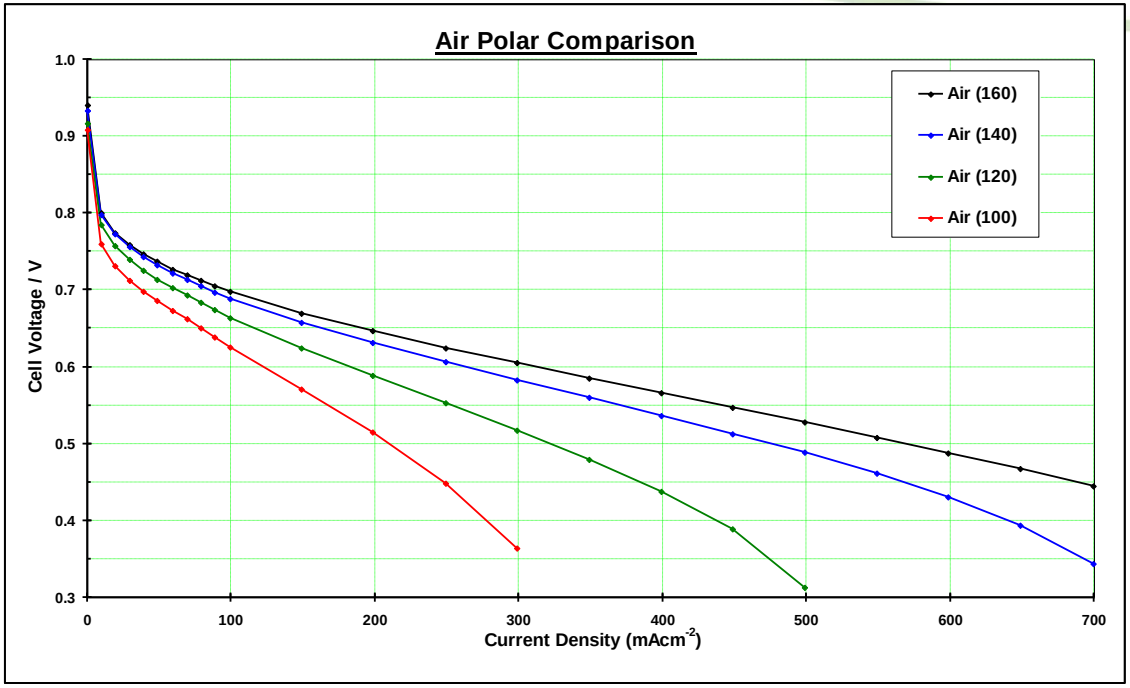
- In WP3.2, JMFC has prepared and investigated a range of novel PtXY ternaries
- Mass activity performance and stability investigated ex situ at HT using phosphate ion model electrolyte system
- Two ternary formulations down selected for cell testing
  - "Ternary 2" formulations show enhanced stability over baseline and matching activity
  - "Ternary 3" matches baseline stability with 20% activity improvement





WP4: MEA Development

- Baseline MEA testing



❖ Initial testing at JMFC of WP4 protocol to validate the use of Fumapem AM PBI provided by FuMA-Tech as baseline membrane

❖ Reference MEA from 160° C to 100° C

- Standard HiSpec 4000 anode
- HT benchmark cathode catalyst sintered at 1200° C
- Fumatech Fumapem AM PBI membrane

Alignment with MAIP

Part 2, Slide 1/4

QuasiDry is funded under the Future Emerging Technologies for Energy Applications call (FET) 2009:

The development of energy technologies is often impeded by bottlenecks which require the development and application of basic science and cross-cutting technologies … breakthroughs … from progress in basic materials science that underpins energy technologies due to the radical upgrade in the properties of the materials. … tangible objectives beyond 'Increased Understanding' and be ahead of conventional approaches, be highly novel, very ambitious, with an orientation towards long-term innovation … clearly defined scientific goal and/or proof of concept … lies well beyond what is considered state of the art at international level.

QuasiDry is fully relevant to the FCH-JU MAIP, AA Transportation and Refuelling

The main objective of this application area is the development and testing of competitive hydrogen-fuelled road vehicles …and the full range of supporting elements for market deployment and increased industrial capacity. RTD will mainly address specific issues related to PEMFC technology for transport applications. This will include *inter alia*: mechanically stable and long-life membranes allowing for system architectures simplification; electrochemically stable and low-cost catalysts for polymer Membrane and Electrode Assemblies (MEAs)… manufacturing and process development…

Alignment with AIP 2010

Part 2, Slide 2/4

QuasiDry is fully relevant to e.g. AIP2010 Section 1.2 Specific topic for the 2010 Call "SP1-JTI-FCH.2010.1.2: Next generation European MEAs for transportation"

- **The objective is to …increase the ability to operate above 100 ° C and low relative humidity, while maintaining high power density. Approaches can be based on improvement of existing materials, and/or by development of innovative concepts .... Development should be aimed at the particular set of properties required for transportation fuel cell application.**
- **New and alternative concepts for membranes, electrode structures and catalyst supports providing increased Pt activity and utilisation may be included.**
- **… development of novel catalyst structures, platinum thrifting approaches …**
- **MEA integration should be considered ….The compatibility of materials and their durability, especially for high temperature operation (120 ° C) …shall be verified by assembling high performance MEAs for benchmarking purposes.**
- **The project activities should include …Development of membrane materials and ionomer solution/dispersion having properties appropriate for transportation fuel cell application**
- **consortium … academia/research institutes, materials developers, SMEs, OEMs and application related end-users**
- **3 year, collaborative project**

Project Achievements vs. MAIP/AIP

Part 2, slide 3 of 4

Since 01/12/2010, QuasiDry has:

- with regard to the FET objective, QuasiDry has already demonstrated **progress in basic materials science to underpin energy technologies with radical upgrade in the properties of the materials. … for the tangible objectives of transportation (and stationary) fuel cell application**

- initiated **ahead-of-conventional-approach** RTD activities with **development of innovative concepts for membrane materials increasing the ability to operate above 100 ° C and low relative humidity, alternative concepts and architectures for catalyst supports, electrochemically stable and low-cost catalysts with novel catalyst structures, and assembled high temperature MEAs for benchmarking purposes** with industrial **manufacturing and process development…**

- achieved **M12** project milestone for **conductivity** of membrane materials under **target temperature and RH** (WP2) and **20% mass activity improvement** with novel catalyst formulations having baseline stability maintained (WP3)

- assembled a skilled **partnership of academics, researchers, materials developers, and an SME**

Gaps & Priorities in RTD&D in MAIP/AIP

Part 2, slide 4 of 4

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

- **Development of membrane and electrode materials, and MEAs, satisfying the required performance and durability targets under the future conditions of operation of an automotive power train is hugely challenging, and it requires sustained research effort for breakthrough materials approaches and innovative design and architectures. The association of research organisations with materials developers, manufacturers and OEMs is essential.**

Cross-cutting issues

Part 3, slide 1 of 1

QuasiDry addresses and contributes to:

- **Training/education** of 2 Ph.D. students, 4 post-doctoral researchers in polymer chemistry and materials sciences, materials processing, characterisation, testing and validation
- **Dissemination** of project results through conference presentations, publication in high impact international journals, and via project web site:
  - To date: 1 public deliverable (characterisation protocols) available through project web-site; 4 conference presentations; 2 publication in press, including a review article on novel architectures for electrochemical conversion and storage devices. A co-authored (CNRS-ULund-MPIP-FuMA-Tech) state of the report (review article) on "emerging approaches to high temperature/low RH membranes" is in preparation.
- **Public awareness** activities to increase public understanding of future fuel cell and hydrogen technologies (renewable energies exhibition Energaia 2010 and 2011)

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**

Project future perspectives

Part 4, slide 2 of 2

- **Present status is that the project is on track technically and is on schedule**
- **FuMA-Tech will seek to develop and scale-up novel polymer and membrane formulations**
- **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**