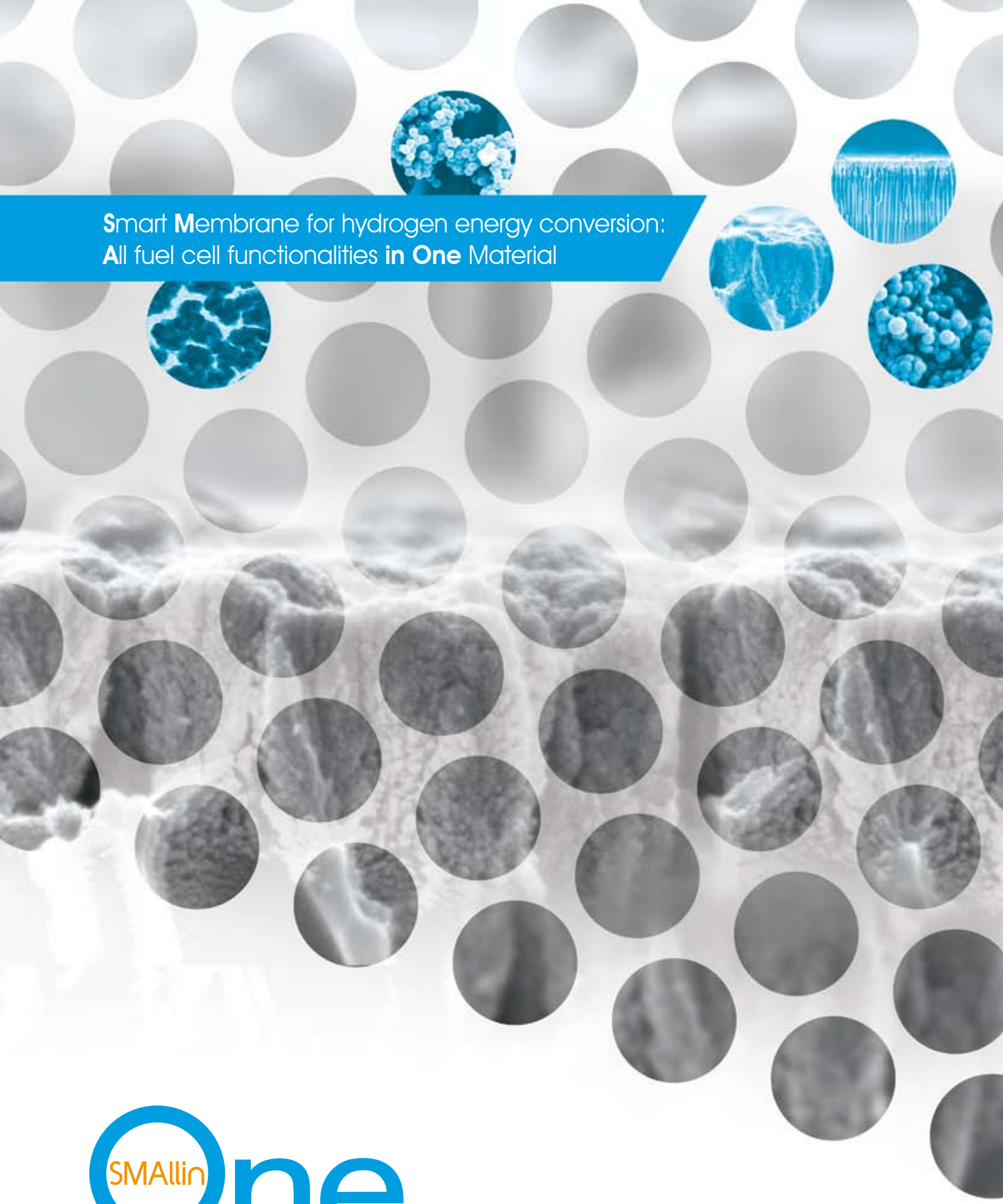


Smart **M**embrane for hydrogen energy conversion:
All fuel cell functionalities **in One** Material

SMAllin One

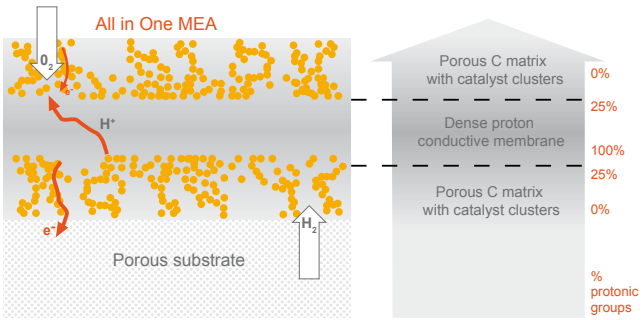
A European Small-Scale Project supported through the Seventh Framework Programme
for Research and Technological Development.

Context

Previous work made in the field of membrane electrode assembly for fuel cells is based on the optimization of both stand alone materials: the catalytic electrode and the membrane. The assembly of these "separately optimized" materials into a Membrane Electrode Assembly (MEA) is usually done by a hot press procedure. The MEA performances, therefore, are usually not limited only by materials properties but also by the interface effect between the catalytic layers and the membrane.

All in one innovative concept

The SMAllinOne project introduces a **"Smart All in One" fuel cell** corresponding to a **thin film protonic conductive membrane with two catalytically functionalized sides**. The AllinOne membrane is a novel composite material adapted for fuel cell technologies as there is no boundary between the membrane and the electrodes. The innovative idea is to keep a same proton conductive backbone for each layer, and to functionalize it with embedded conductive catalyst particles for the electrodes.



The strategy is articulated around four main phases:

1- The basic materials for the membrane and the catalytic electrode will be developed separately using vacuum based nanomaterial science technologies.

2- The selected components will be merged to generate a first composite material without interfaces: AllinOne membrane.

3- Enhancement of the materials capabilities will be done through nano-particulates addition to produce a second generation of smart multi-functionalized membrane: SMAllinOne.

4- This second generation will be optimized and tested for further industrial implementation.

Scientific and technological objectives

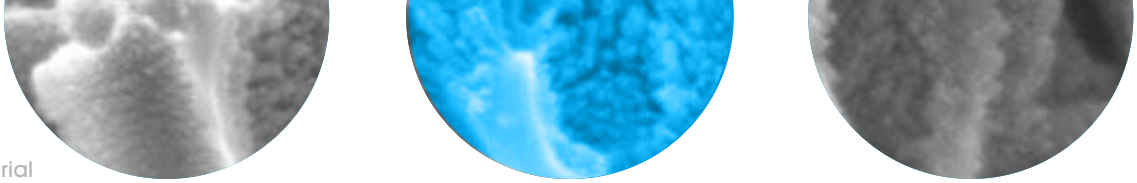
The SMAllinOne project aims to build a smart functionalized protonic membrane without interfaces, keeping in mind future large scale initiatives.

Synthesis of a proton conductive membrane via vacuum techniques:

For the vacuum growth of this advanced proton conductive membrane, new volatile chemical precursors will be synthesized, with protected acidic functions. The challenge is thus to prevent the decomposition of the functional groups during the thin film membrane deposition. Various vacuum techniques will be investigated.

Structuring of a platinum catalytic network inside the membrane:

The potential of several vacuum methods (sputtering, co-deposition, atomized spray plasma deposition…) will be evaluated. Then the catalytic network will be integrated in the proton conductive membrane.



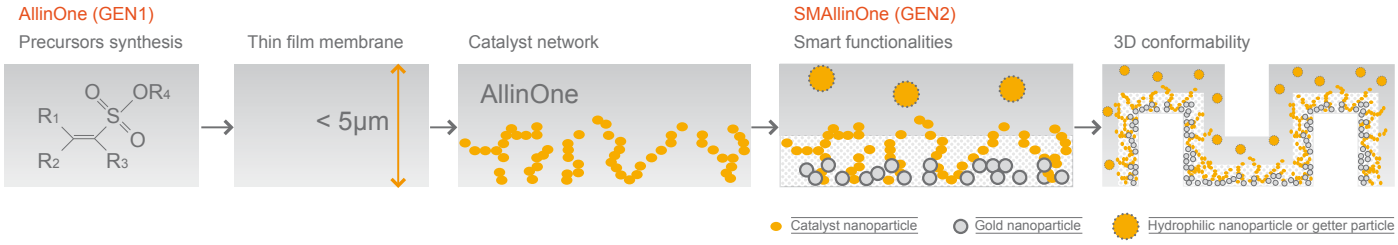
Smart Membrane for hydrogen energy conversion: All fuel cell functionalities in One Material

Adding smart functionalities:

The smart functionalities target the enhancement of the electrical conductivity, the water management, the membrane permeability and the porosity of the catalytic networks. To add such functionalities, low cost nano-particles will be introduced near the Pt nano-particles, hydrophilic domains and hydrogen getter will be added to the membrane and the porosity of the catalytic sides will be adjusted for efficient fuel supply.

3D conformability:

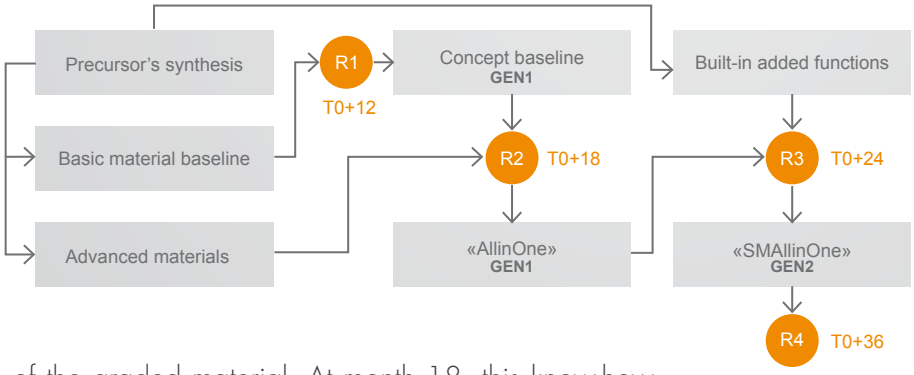
3D conformability of the material will be studied for an increased apparent active surface.



SMAllinOne solution pathway and Workpackages

In the 1st phase, basic catalytic and membrane materials will be separately set up to be used as preliminary building blocs.

→1st main review point, (R1) at Month 12: Basic material synthesis.



In the 2nd phase, these preliminary building blocs will be merged together to set up the concept baseline of the graded material. At month 18, this know-how will be applied to optimized materials to produce a first generation of composite membrane material: the AllinOne concept.

→2nd main review point, (R2) at Month 18: Proof of AllinOne concept GEN1.

In the 3rd phase, advanced functionalities such as electrical conductivity, tailored porosity, water retention and 3D conformability will be developed on a single material. In parallel, the AllinOne concept will be optimized.

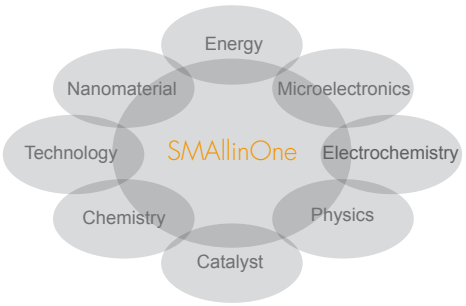
→3rd main review point, (R3) at Month 24: Optimized AllinOne concept.

In the 4th phase, advanced functionalities will be embedded in the AllinOne concept to produce a smart composite membrane: SMAllinOne with enhanced electrochemical performances.

→4th main review point, (R4) at Month 36: Proof of SMAllinOne concept GEN2.

Consortium

The SMAllinOne consortium consists of 7 partners in 5 countries.
The project brings together a wide scope of scientific and industrial partners - each player with its genuine knowledge - to form a multidisciplinary consortium:



- **Commissariat à l'Energie Atomique (France):** Project coordination; development, characterization and integration of catalytic and membrane processes and materials
- **Universita degli Studi di Bari (Italy) :** New volatile acidic chemical precursor synthesis; plasma and vacuum deposition processes
- **Surface Innovations Ltd (UK):** Creation of proton conducting membranes and catalysts by Atomised Spray Plasma Deposition technique
- **Bar-Ilan University (Israel):** Multi-step organic / organo-metallic precursor synthesis; nanofabrication of hybrid systems
- **IRD Fuel Cells A/S (Denmark):** Characterization, testing and benchmarking in fuel cell domain
- **Federal Mogul Systems Protection (France):** Orientation the membrane synthesis process for future up-scaling
- **ALMA Consulting Group SAS (France):** Project management and communication

Acknowledgement

The SMAllinOne project (Energy.2008.10.1.2/NMP-2008-2.6-1) addresses the joint call thematic "Novel materials for energy applications". It has been running since 1st of April 2009 and will last 36 months. The research led in this project has received funding from the European Union Seventh Framework Programme (FP7/2007 – 2013) under grant agreement n° NMP3-SL-2009-227177.

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SMAllinOne management is operated with Myndsphere Internet Platform: www.myndsphere.com.

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