CARISMA
A Networking Project for High Temperature PEMFC MEA Activities in Europe

(Coordination Action for Research on Intermediate and high temperature Specialized Membrane electrode Assemblies)

High Temperature Membrane Working Group Meeting
May 14, 2007
Arlington, Virginia

CARISMA – HTMWG Meeting

- **The objective of this presentation is to introduce members of the HTMWG to a new EU Coordination Activity - CARISMA**
  - What is a coordinated action
  - Objectives of CARISMA
  - Project organisation
  - Work package breakdown and key deliverables
  - CARISMA and International Cooperation
  - Initiate development of ideas to foster international cooperation

CARISMA – An EU Coordination Action Project

- **EU Coordination Action Projects seek to coordinate research activities in Europe - on focussed technical topics - in order to:**
  - Promote discussion and review
  - Formalise a “network” of related EU and national funded programmes
  - Promote networking activities and information dissemination
  - Agree technical goals and priority actions
  - Inform and interact with the EU Hydrogen and Fuel Cells Platform to refine the Strategic Research Agenda
  - Ensure Europe is playing a key role on the world stage
  - Facilitate interactions with similar networks/working groups in other continents/IPHE countries.

Rationale – Why CARISMA?

- Around 20 years of European Commission funding of research projects on PEMFC but more interaction among research groups needed

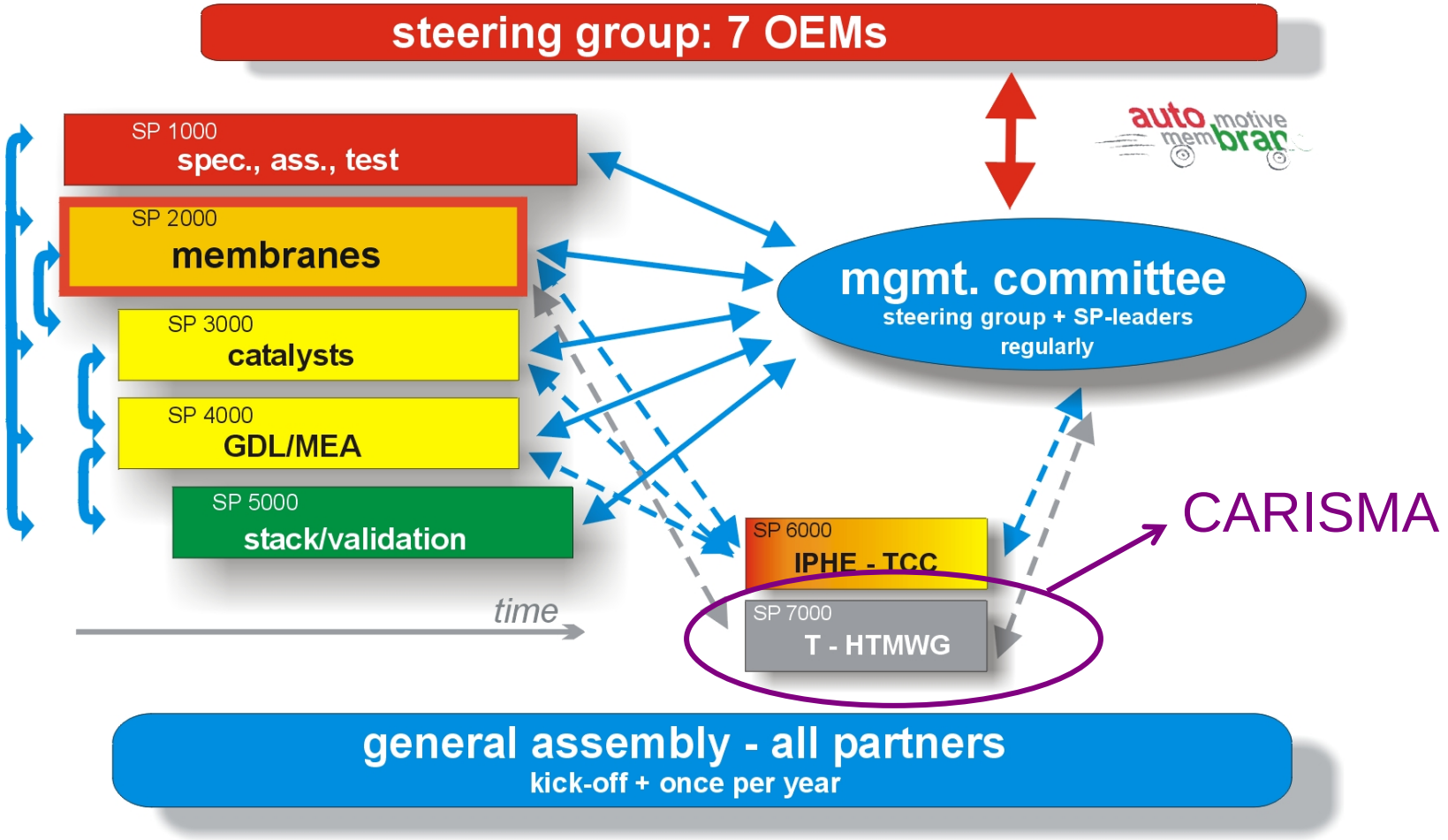
- Create mechanism in Europe for clustering a critical mass – research on high T membranes and MEAs
  - International conference / series held in Europe
  - Create opportunities for discussions of roadblocks and possible solutions
  - Avoid fragmented research efforts, duplicates or separate initiatives

- Create a Euro version of the HTMWG and link with US DoE HTMWG
  - Initial Plan: to initiate and implement a network of groups developing HT membranes in Europe
  - the next step was from High Temperature Membranes Working Group to "Coordination Action on high temperature MEAs"; added value for Europe/ status reports; primary purpose is to link the projects together / Commission

Goals/ Aims and Ambitions of CARISMA

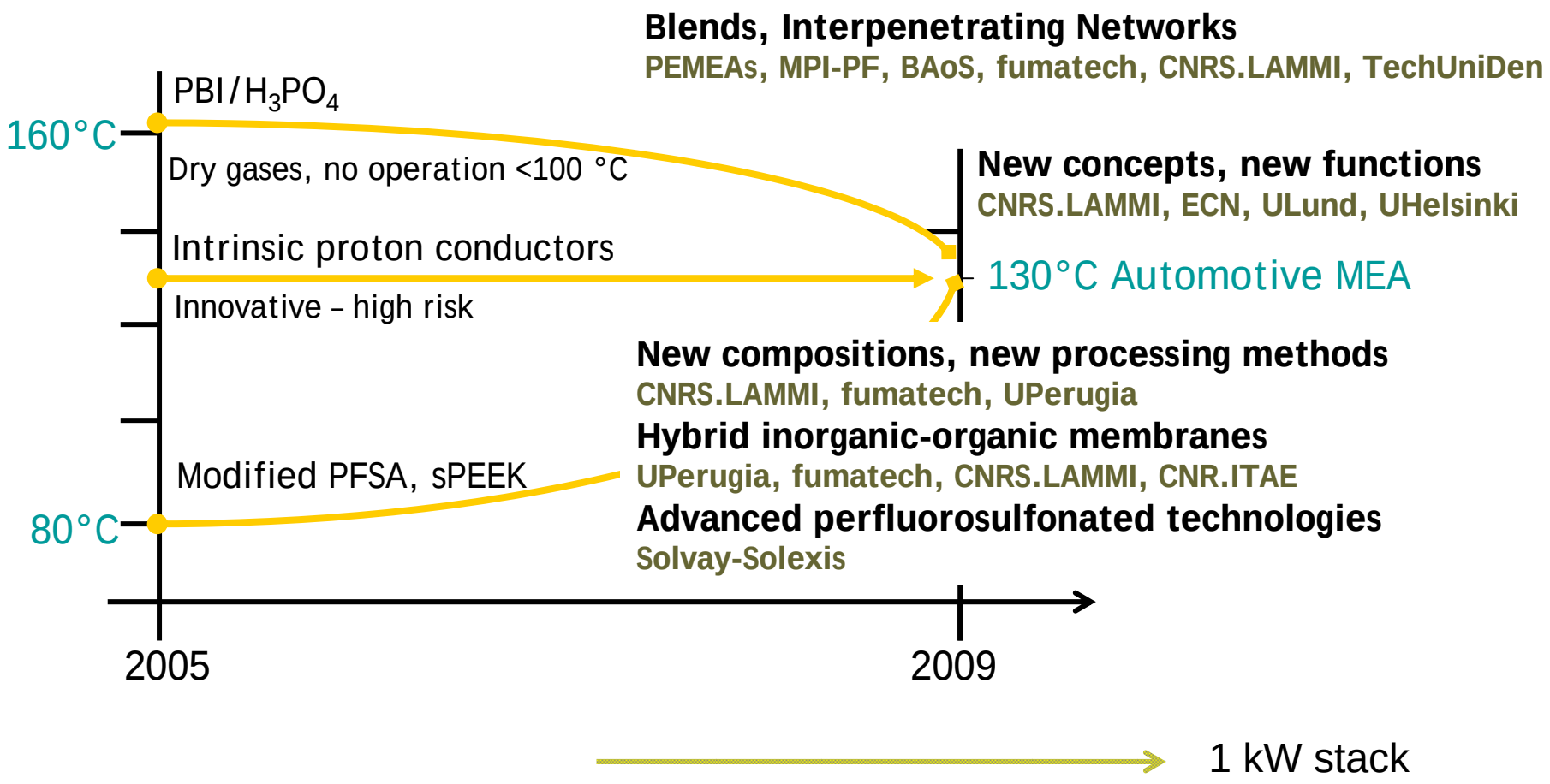
- Network (funded) research activities in Europe on HT MEA and their components. Coordination activities are centered around:
  - membranes, catalysts and high temperature MEAs, with
  - cross-cutting activities on HT durability/ degradation of MEA components, identification of H+ transfer mechanisms in low RH/ H2O-free conditions, and tech spec for high temperature PEMFC applications.
- Assemble the expertise in HT PEMFC in European research institutes and universities and include committed stakeholders from SMEs, industrial developers of HT MEAs, membranes, catalysts, gas diffusion layers, carbon supports, as well as end users of HT MEAs/ stacks.
- Interact with the Hydrogen and Fuel cells Platform to refine the Strategic Research Agenda (SRA) and facilitate interaction with equiv groups in other continents; interaction with equivalent groups in other continents.
- Considers establishing a sustainable mechanism for continuing the networking / coordination action after the project is complete.

Autobrane Project Structure

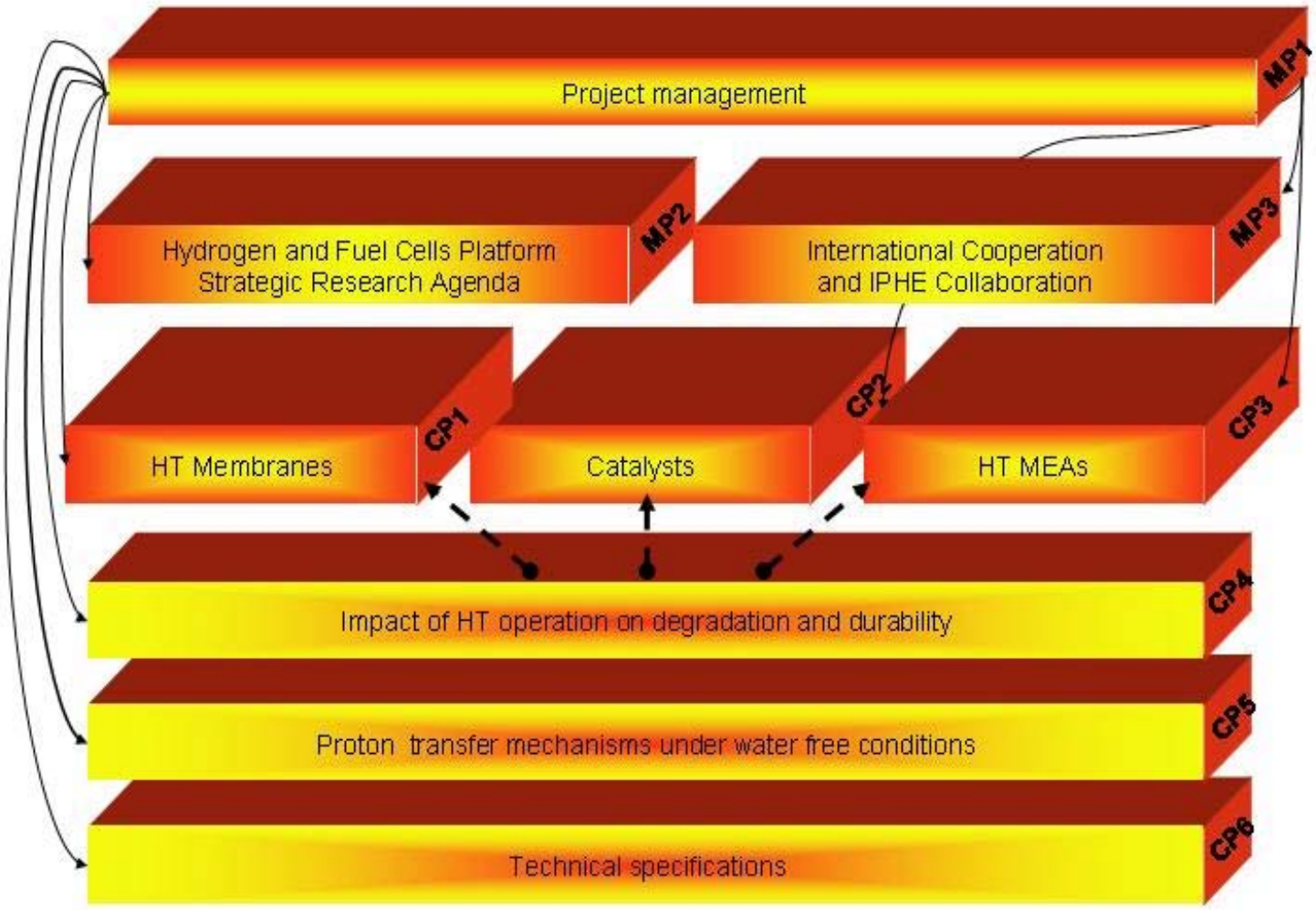


30 Contractors: 17 industrial partners, 6 universities, 7 research institutes

Autobrane – towards membranes for automotive applications



CARISMA Workpackage Structure



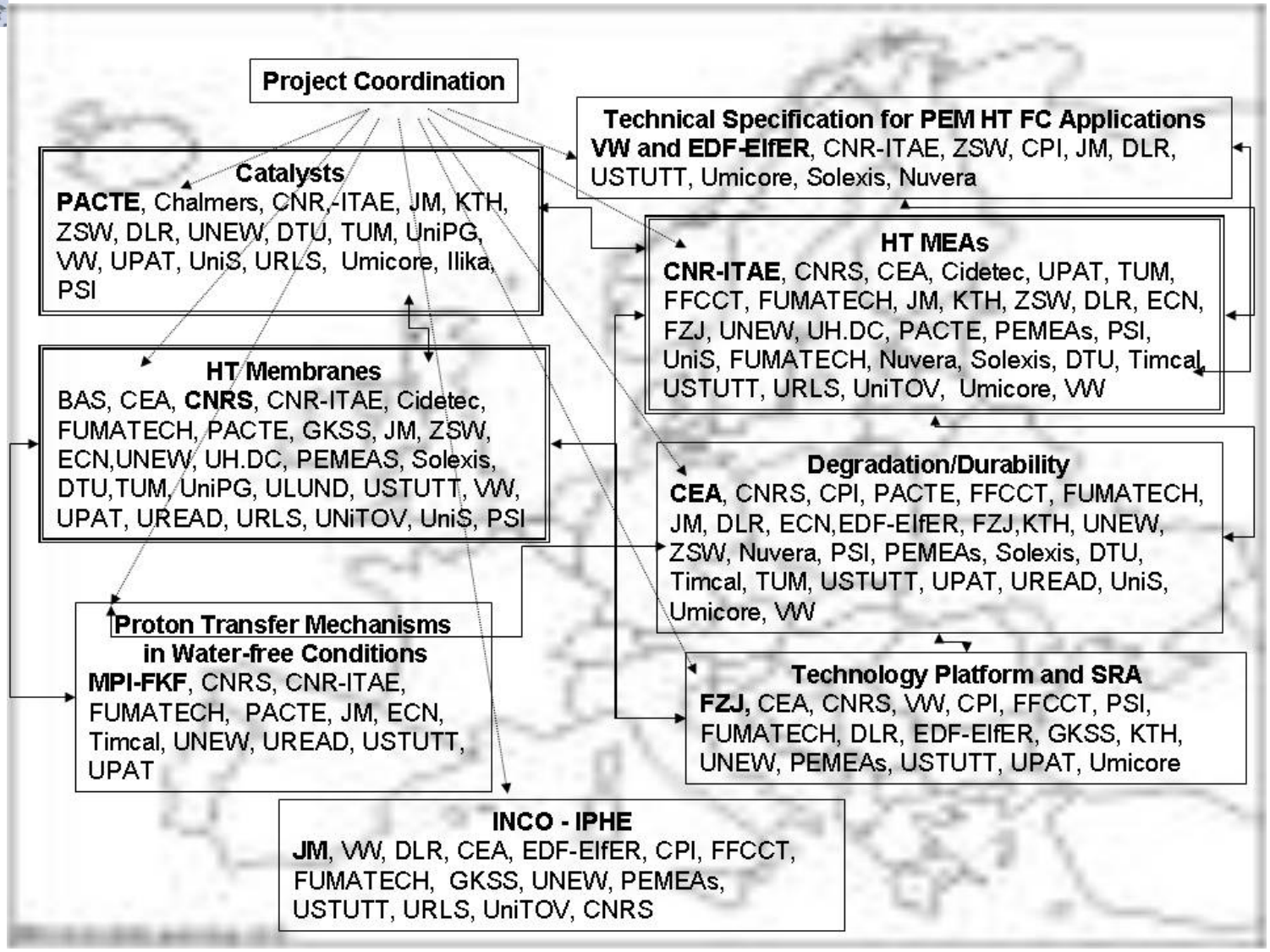
CARISMA Partnership(1)

Partic. Role	Partic. No.	Participant name	Country
CO	**1**	Centre National de la Recherche Scientifique	France
	1b	Groupement de Recherche Piles à Combustible Tout Electrolyte	France
CR	**2**	Bulgarian Academy of Sciences, Sophia	Bulgaria
CR	**3**	Commissariat à l'Energie Atomique	France
CR	**4**	Centre for Process Innovation Limited Ltd	United Kingdom
CR	**5**	Chalmers University of Technology	Sweden
CR	**6**	Cidetec	Spain
CR	**7**	Consiglio Nazionale delle Ricerche	Italy
CR	**8**	Volkswagen AG	Germany
CR	**9**	Deutsches Zentrum für Luft- und Raumfahrt eV	Germany
CR	**10**	Energy research Centre of the Netherlands	Netherlands
CR	**11**	European Institute for Energy Research	Germany
CR	**12**	Freudenberg FCCT KG	Germany
CR	**13**	Forschungszentrum Juelich	Germany
CR	**14**	Forschungszentrum Geesthacht GKSS GmbH	Germany
CR	**15**	FUMA-TECH GmbH	Germany
	16	now 1b	
CR	**17**	Ilika Ltd	United Kingdom
CR	**18**	Johnson Matthey Fuel Cells Ltd	United Kingdom
CR	**19**	Kungliga Tekniska Hogskolan	Sweden

CARISMA Partnership(2)

CR	**20**	Max Planck Gesellschaft	Germany
CR	**21**	Nuvera Fuel Cells Inc.	Italy
CR	**22**	PEMEAs GmbH	Germany
CR	**23**	Solvay Solexis SpA	Italy
CR	**24**	Technical University of Denmark	Denmark
CR	**25**	Timcal SA	Switzerland
CR	**26**	Umicore AG	Germany
CR	**27**	University of Perugia	Italy
CR	**28**	University of Helsinki	Finland
CR	**29**	University of Lund	Sweden
CR	**30**	University of Stuttgart	Germany
CR	**31**	Paul Scherrer Institut	Switzerland
CR	**32**	University of Newcastle upon Tyne	United Kingdom
CR	**33**	University of Patras	Greece
CR	**34**	University of Rome La Sapienza	Italy
CR	**35**	University of Surrey	United Kingdom
CR	**36**	Technical University of Munich	Germany
CR	**37**	University of Rome Tor Vergata	Italy
CR	**38**	University of Reading	UK
CR	**39**	Zentrum für Sonnenenergie- und Wasserstoff-Forschung	Germany

Partnership throughout the WPs



Workpackage Leaders

Work-package No	Workpackage title	WPL
Management Package No	**Management activities**	
MP1	Project management	CNRS Montpellier
MP2	FP7 Technology Platform and SRA	Detlef Stolten, Bernd Emonts, FZ Juelich
MP3	International Cooperation Activities (via IPHE etc)	Graham Hards, Anca Faur Ghenciu, Johnson Matthey Fuel Cells
Coordination Package no	**Coordination activities**	
CP1	Ionomer, membranes Current approaches, new strategies and breakthrough approaches	Deborah Jones, Jacques Rozière CNRS - University of Montpellier
CP2	Catalysts: noble and non-noble metal	Jean-Michel Léger CNRS - University of Poitiers
CP3	HT MEAs	Vincenzo Antonucci CNR-ITAE, Messina
CP4	Impact of HT operation on degradation and durability (components and MEAs)	Sylvie Escribano, Arnaud Morin, CEA Grenoble
CP5	Experimental and modelling approaches to proton conduction mechanisms under water free conditions	Klaus-Dieter Kreuer, MPI-Solid State Research, Stuttgart
CP6	Technical specifications for stationary, and transport applications	Gerold Hübner, Volkswagen, Ludmila Gautier, Mathieu Marrony, EDF-ElfER, Karlsruhe

Centre National de la Recherche Scientifique

Johnson Matthey Fuel Cells

Consiglio Nazionale delle Ricerche - Italy

Commissariat à l'Energie Atomique, CEA-LITEN, France

Max Planck Gesellschaft / Institute, Germany

European Institute for Energy Research (ElfER)

Deliverables

Deliverable	Deliverable title	Delivery date/ Month	Nature [1]	Dissem. level [2]
DM1	Activity and management reports, financial statements etc, year 1	12	R	CO
DM2	Activity and management reports, financial statements etc, year 2	24	R	CO
DM3	Project presentation material	6	O	PU
DM4	Report on raising public participation and awareness (obligatory deliverable)	24	R	RE
DM5	Input to and refinement of SRA	18	R	RE
DM6	Final plan for using and disseminating knowledge (obligatory deliverable)	24	R	RE
DM7	Links established with HT membrane/MEA working group in the US and other third countries	From month 4	O	RE
DC1	Kick-off workshop on high temperature membranes	3	O	CO
DC2	Summary report on enhancing stability of Pt catalysts at high temperature and opportunities for stabilisation of non-noble catalysts	18	R	CO
DC3	International conference on high temperature MEAs	12	O	RE
DC4	Summary report on impact of high temperature operation on MEA component degradation	24	R	CO
DC5	Communication to MEA conference on proton conduction mechanisms in low RH environment	12	O	RE
DC6	Sets of materials properties specifications for transport and stationary applications	12	R	RE

R = Report
P = Prototype
D = Demonstrator
O = Other

Dissemination level codes:

PU = Public
PP = Restricted to other programme participants (including the Commission Services).
RE = Restricted to a group specified by the consortium (including the Commission Services).
CO = Confidential, only for members of the consortium (including the Commission Services).

Proposed Project Activities

- *Workshop on* **Catalysts** for high temperature PEMFC (Spring 2007): "**Key issues to improve activity and durability of catalysts for PEM fuel cells**", 15th & 16th May 2007, Espace Hamelin, Paris.
- *Workshop on* High temperature **MEAs, tools** and methodologies for ageing and **degradation** studies: 5th & 6th July 2007, Grenoble.
- *School and Workshop on* **fundamental** and **applied aspects of PEM FC Membranes** (material prep and char) with emphasis on intermediate and high temperature operation: development, bottlenecks, proton transfer **mechanisms** 8th-9th November 2007 followed by the Workshop 12th-14th Nov 2007, Stuttgart.
- **International Conference** on Materials for High Temperature Membrane Electrode Assemblies (September 2008)
- **International Collaboration** symposia
- Special **journal editions** resulting from Workshops and International Conference
- Suggest CARISMA Hospitality suites at US Conferences/ Seminars (FC Seminar Oct 2007 San Antonio, TX)

Workshop objectives: presentation of tools and methodologies, comparison of results, identification of problems in each WP area, formation of working groups, identification of areas for networking activities, implementation of networking activities.

School objective: training element; includes people in the area, not necessarily internationally

Work Packages

- MP1 - Project coordination
- MP2 - FP7 Technology Platform and SRA
- MP3 - International Cooperation Activities (via IPHE, etc)
- CP1 - Ionomers, membranes: current approaches, new strategies, breakthrough approaches
- CP2 - Catalysts, noble and non-noble metals
- CP3 - High Temperature MEAs
- CP4 - Impact of high temperature operation on degradation and durability (MEA and components)
- CP5: Proton conduction mechanisms under low RH/ water free condition; experimental and modeling approaches
- CP6: Technical specifications for PEM HT FC stationary and transport applications

MP2: H2-FC Technology Platform and Strategic Research Agenda

- ***Objectives:***
  - link with with the HFP technology platform in the Hydrogen and Fuel Cells area
  - inform the CARISMA consortium of technology platform activities and initiatives and identify opportunities for participation of CARISMA in these actions
  - provide input to and refinement of the strategic research agenda with regard to high temperature membrane-electrode assemblies, and membranes and catalysts for high temperature PEM
- ***Deliverable:*** Input to and refinement of SRA; final plan for using and disseminating knowledge
- ***Milestones and expected results:*** partnership informed on the various initiatives of the HFP to enhance partners involvements, and that CARISMA will contribute to the platforms in its areas of competence.

MP3 – International Cooperation

- Key Objective: Establish interactions/ formal links with other networks
  - Identify and Interact with initiatives on high temperature MEAs / components at International level, particularly in IPHE partner countries (http://www.iphe.net/).
  - Through MP3, CARISMA will aim to represent a pan-Community-funded grouping to facilitate interaction and links with other working groups or networks on HT MEAs / components.
- Seek to obtain IPHE label for CARISMA
- Propose forums (sustainable) to promote international cooperation:
  - Seminars/workshops
  - International conferences
  - Specialist technical publications
- ….and facilitate organisation of agreed cooperation activities.

CP1: Ionomers and Membranes

- ***Objective:*** network the activities on ionomer preparation and high temperature membranes and characterization in funded Community and national initiatives
- ***Work:***
  - Evaluation of current and breakthrough approaches, and novel strategies via annual workshops
  - Identification of available tools and test-beds for polymer/membrane characterization with a view to developing a robust set of characterization approaches
  - Materials exchanges
  - Joint research activities:
    - Conductivity measurement, round-robin action
    - Mechanical properties –relevant values ?
    - Identification of tools and test-beds
- ***Deliverable:*** kick-off workshop on high temperature membranes: where we are and where we want to be for HT PEM applications (month 3)
- ***Milestones and expected results:*** increased pan-European cooperation across Community funded projects and integrating national activities on high temperature membranes

Looking back
- from acid doping to immobilized solvent

- 1994 – first reports on phosphoric acid "doping" of polybenzimidazole, concept leads ultimately to PEMEAs Celtec-P
- 1995 – first report on replacing water as proton carrier in sulfonated polymers
- From end-1990s – immobilization of alternative proton carriers on oligomers in model systems (imidazole, benzimidazole, phosphonic acid etc.) …towards "immobilized solvents" in a fully polymeric system
- From mid-1990s – first development of methods to prepare inorganic particles and proton conductors in situ in a polyelectrolyte membrane or polymer solution
- Use of macroscopic reinforcements – Gore membranes, fibrillar reinforcements etc.
- Acid-base blend membranes

The challenge of high temperature membranes

- Both automotive and stationary applications require membranes able to operate at high temperature
  - Heat rejection – automotive radiator dimension
  - Higher quality heat for cogeneration
  - Increased CO tolerance of catalyst allows use of reformate gas
- Both automotive and stationary applications require membranes with high proton conduction properties at low relative humidity
  - No/low hydration of feed gases, non-pressurized system
- Both automotive and stationary applications require membranes that are chemically, mechanically and dimensionally stable between fully humidified and dry states
  - Temperature and load cycling generate locally high/low relative humidity

Key Membrane Properties

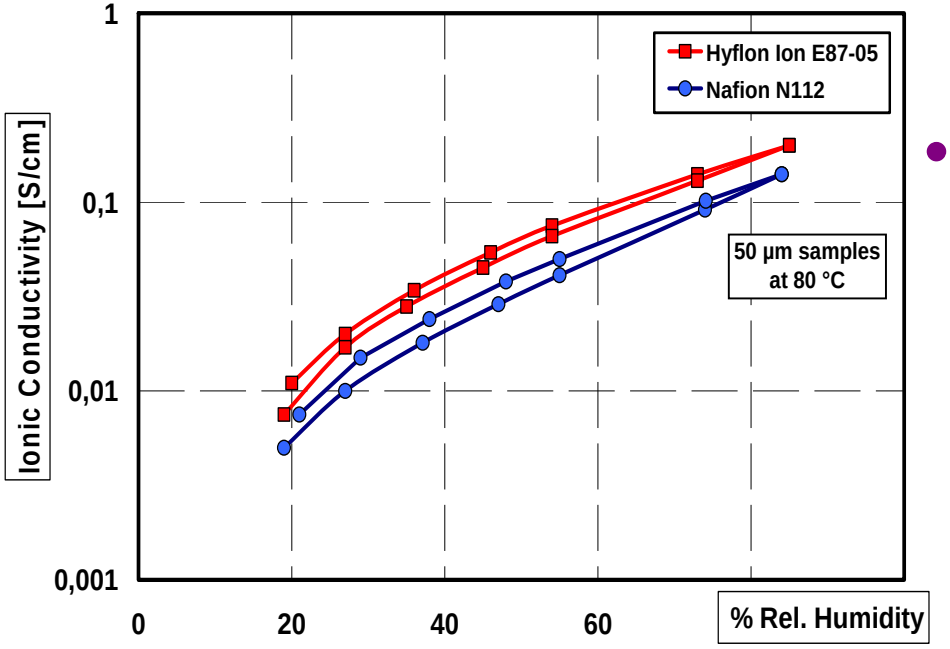
- Water uptake: from liquid water, at various temperatures

- Conductivity and realtions with water uptake:
  - reported data are often incomplete
  - Differences between measurements made in-plane and through-plane
  - **Range of conductivity** values in the literature for Nafion (=reference material). Under nominally identical conditions of T and RH, a **distribution** of conductivity values over an **order of magnitude**

- Mechanical properties:
  - What mechanical properties are driven by the processing and what are application-driven; what are target requirements for HT applications ?

CP1: How can Nafion be improved ? (1) New PFSA-type structures

- Conductivity of Nafion depends strongly on the degree of hydration
- High hydration: excessive plastification, dimensional change, swelling; high temperature, low RH: brittleness, lower conductivity
- Thermal and swelling cycling contribute to mechanical fatigue … failure
- Hyflon® Ion exhibits increased conductivity compared with N112
- BASELINE Material, EW 850 g/mol, 50 µm



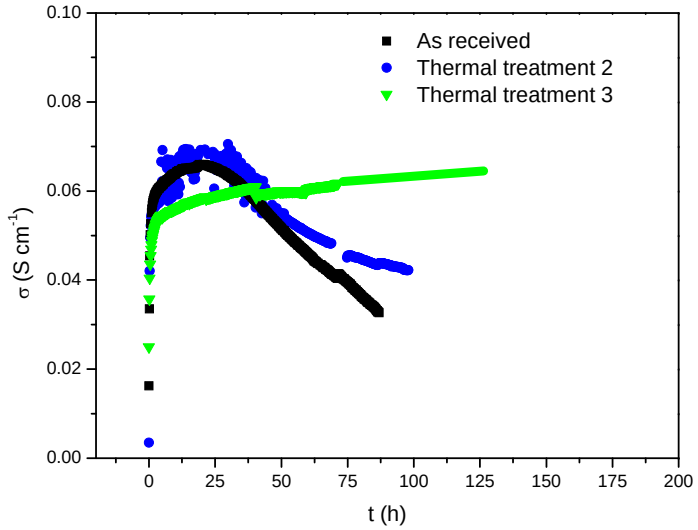
- Short side chain type PFSA

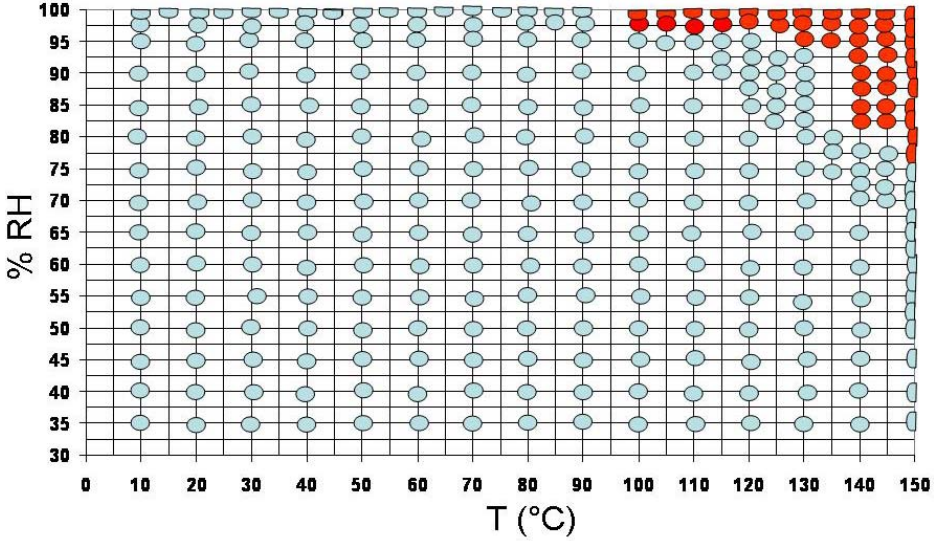
SOLVAY SOLEXIS

automotive membrane

How can Nafion be improved ? (2) New processing methods

- Through-plane conductivity of Nafion-117, 100 °C, 98 % RH; temporal stabilization by membrane thermal pre-treatment





- Mapping stability of conductivity with time at various temperatures and relative humidity

CEMIN (Excellence Center for nano-structured materials)
Università di Perugia

New polymers, new functions, blends and interpenetrating networks(2)

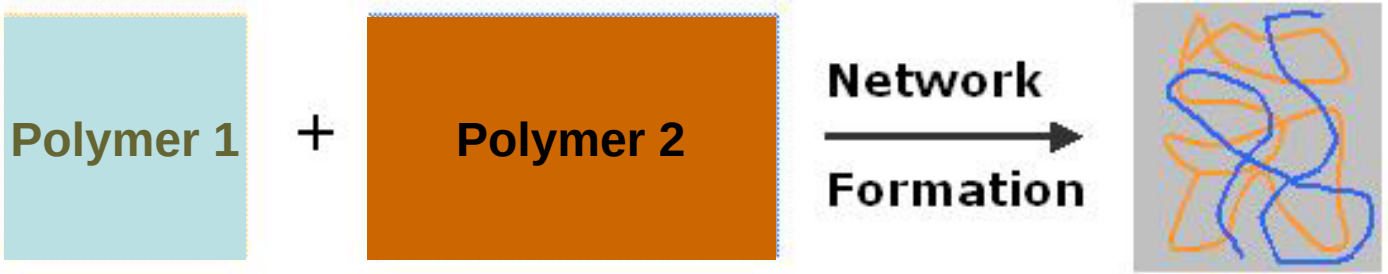
- Combine polymer types to draw best advantage from each
  - Blends and interpenetrating networks

Basic
- Imidazole
- polybenzimidazole

Acid
- sulfonic, phosphonic acid functionalised

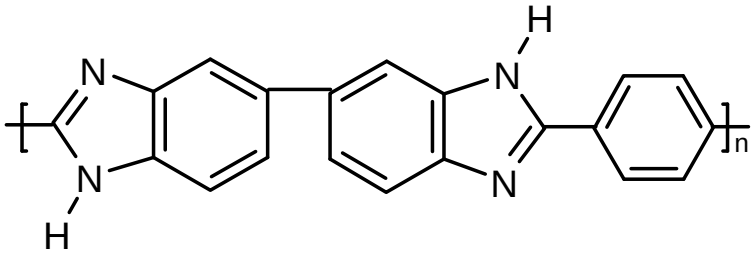
Weak acid
- phosphonic

Acid
- sulfonic



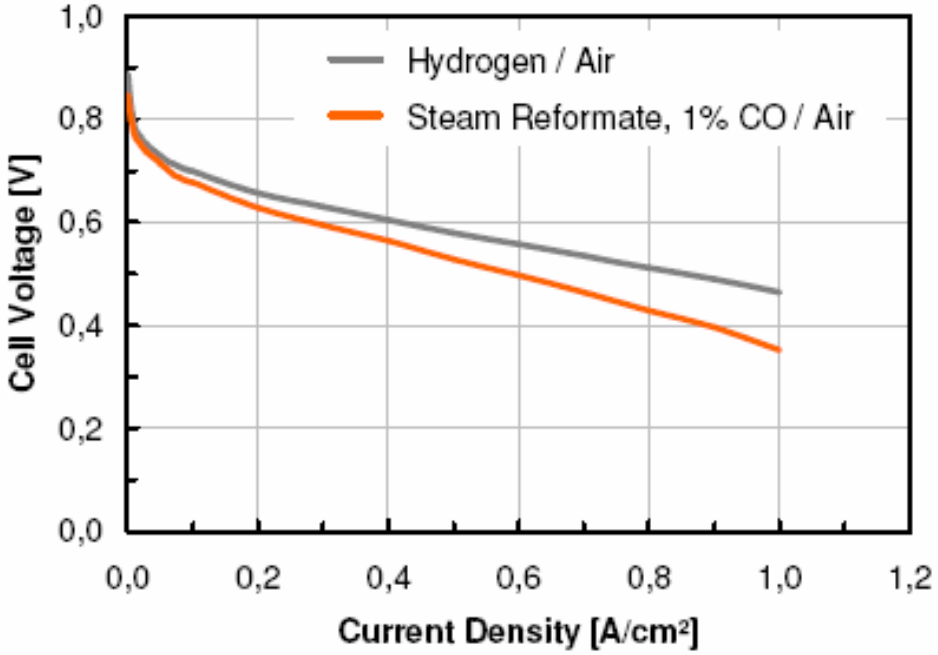
Current high temperature membranes, the need for immobilized solvent systems

complexation of polybenzimidazole by H_3PO_4



- Doping of PBI films by phosphoric or sulfuric acid leads to a homogenous polymer electrolyte system

- ….inspired the **"immobilised solvent"** concept



Celtec®-P1000 MEA
Temperature: 160°C
Ambient pressure
Cathode: λ = 2.0
Anode: λ = 1.2
Active area: 45 cm²
Humidification: none

PEMEAS
Fuel Cell Technologies

http://www.pemeas.com/documents/

Towards immobilized solvent systems

- Tethering **oligomeric imidazole** species on to a polybenzimidazole backbone, giving **membranes "swollen"** by **immobilised imidazole**

Properties:

- 70 wt% graft component
- **Thermal stability**, air: > **400 °C**
- **Conductivity** (membranes, through plane and 4-point measurements) measured under a range of temperature/RH conditions: **Promising** proton **conductivity** under **low RH conditions**

$2*10^{-2}$ S/cm, 60 °C, 30% RH, through-plane

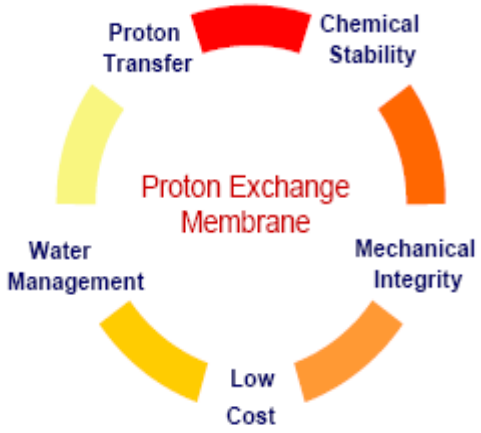
New membrane and MEA development in FP6 projects

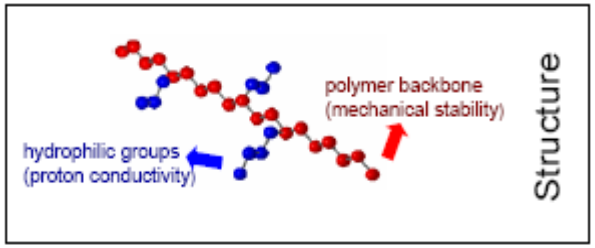
- IP: Autobrane - Automotive High Temperature Fuel Cell Membranes
- IP: FURIM – Further Improvement and System Integration of High Temperature Polymer Electrolyte Membrane Fuel Cells
- STREP: Apollon-II
- STREP: MorePower
- STREP: IPHE-GENIE –International Partnership for a Hydrogen Economy for the GENeration of new Ionomer mEmbranes

CP1: Other Approaches

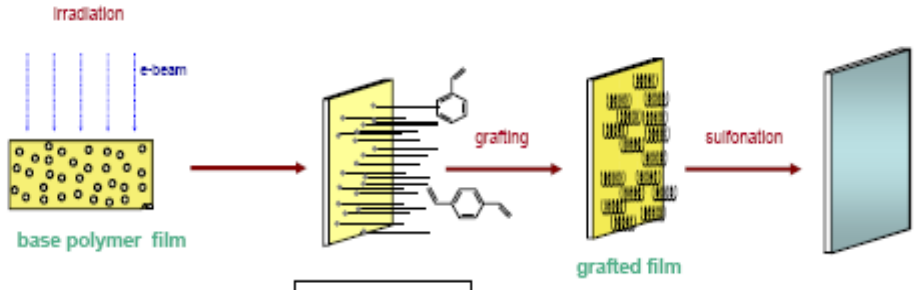
PAUL SCHERRER INSTITUT PSI

Radiation Grafted Fuel Cell Membranes





Membrane preparation



Base Polymers

FEP
$[CF_2\text{-}CF_2]_n\text{-}[CF_2\text{-}CF(CF_3)]_m$

ETFE
$[(CH_2\text{-}CH_2)\text{-}(CF_2\text{-}CF_2)]_n$

Monomers

styrene, divinylbenzene (crosslinker), α-methyl-styrene, methacrylo-nitrile (co-monomer)

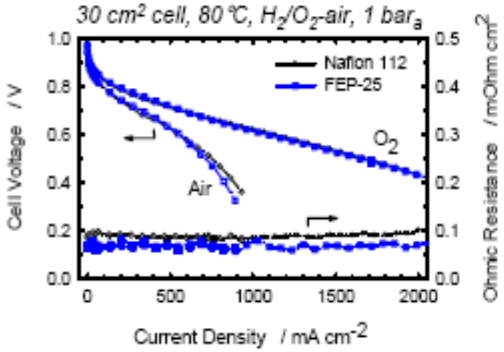
CP1: Other Approaches

PAUL SCHERRER INSTITUT

PSI

Fuel cell testing

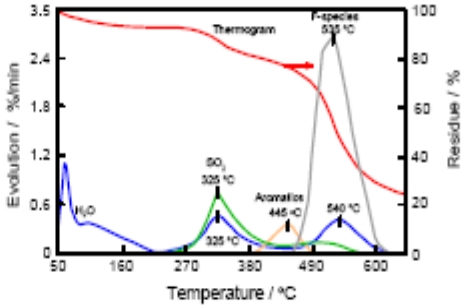
Performance

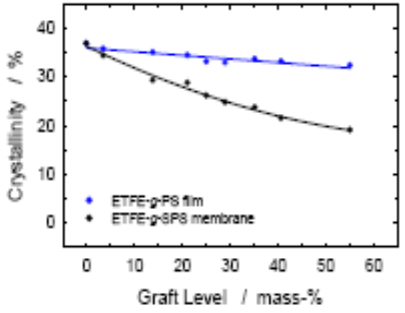


- Identical performance compared to Nafion®
- ohmic resistance = membrane resistance: slightly lower than Nafion®

Membrane characterization

Thermal analysis





- Thermal decomposition suggests 2-phase structure
- Slight decrease in crystallinity after grafting
- Significant decrease in crystallinity after sulfonation

CP1: Ionomers and Membranes

- ECN – membrane development – hc based
- U Lund: new functional polymer electrolytes for energy-related technologies, including fuel cells, batteries and electrochromic windows.
    - Polysulfones with sulfonated and phosphonated side chains prepared by chemical grafting (modification)
    - Sulfonated copolymers prepared by direct copolymerization using pre-sulfonated monomers
    - Polymers and oligomers carrying side chains functionalized with various heterocycles for dry proton conductors
- Perugia University: Composite proton conducting membranes with enhanced dimensional stability at high T

Outline of CP1

- Evaluation of current approaches to FC membrane development via annual workshops, with outside invitation to key international speakers (1 – 3 outside speakers)
- First workshop will be jointly held with CP5 – proton transfer mechanisms, in November 2007
- Workshop format: themed sessions, with adequate time for open discussion.
- Publication of proceedings: either
  - a summary paper prepared as a review article or
  - Build on success of *Fuel Cells* "Topical Issues on PEMFC membranes" (Spring/Summer 2005) with a Snapshot 2007 Topical Issue on Progress in High Temperature Membrane Research

Outline of CP1

- Before the first workshop: Assess tools and methods available within CARISMA laboratories with a view to collaboration through access to infrastructure and facilities, and exchange of researchers

- Conductivity – the key parameter. Develop a means of standardizing conductivity values obtained in CARISMA partners laboratories [integration with HTMWG – link]

- Round-robin type activity in Spring-Summer 2007 to determine conductivity – of a standard CARISMA industrial partner supplied membrane (single batch, common pre-treatment) - under defined temperature and relative humidity (3 sets of conditions). Co-authored publication of results

- Conference reports

CP1 partners

Hybrid inorganic-organic membranes

CEA
CNR-ITAE
CNRS
UniPerugia
TUniMunich
FuMA-Tech
UniRom2

New proton Conducting polymers

ULund
UReading
FuMA-Tech
CNRS
GdR-PACTE
UPatras
PSI

Immobilised solvent type systems

ECN
CNRS
MPI-Solid State
UniHelsinki

Blends and IPNs

PEMEAs
UStuttgart
CNRS
Bulgarian Acad.Sci.
MPI Polymerforsch
TechUniDenmark
Volkswagen
Cidetec
UPatras

Anion exchange membranes

UNEW
GdR-PACTE
USurrey

Advanced PFSA technologies

Solvay-Solexis
FuMA-Tech

CP2: Catalysts

- ***Objective:*** network the activities on noble and non-noble catalysts for high temperature MEAs and characteriz. in funded Community and natl. initiatives
- ***Work:***
  - State of the art of approaches developed in funded national and Community programs: reduction in Pt loading, increasing tolerance to contaminants, optimization of dispersion etc., identification of complementary approaches
    - Understanding of the controlling mechanisms at low catalyst loading
    - Identification of catalysts and electrode structures for higher power
    - Stability of the catalyst under relevant operation conditions (Pt sintering or dissol. at high T)
    - Interaction and influence of novel electrolyte materials on the extent of decay in order to assess their impact and limit the effect
    - Chemical stability of non-precious metal catalytic sites in PEMFC
  - Non-noble metal catalysts, stabilization in PEMFC environments
  - Identification of available tools and test-beds for catalyst characterization with a view to developing a robust set of characterization approaches
  - Materials exchanges
  - Exchanges of researchers
- ***Deliverable:*** summary report on enhancement of stability of non-noble metal catalysts in PEMFC and stabilization of Pt catalysts at high T(month 18)
- ***Milestones and expected results:*** increased information flow to allow early assessment of novel approaches including characterization.

CP3: High Temperature MEAs

- ***Objective:*** network the activities on preparation and characterisation of high temperature membrane electrode assemblies in funded Community and national initiatives
- ***Work:***
  - Hands-on training in preparation of MEAs by a program of visiting researchers among the partnership to share best practice in this area
  - Materials exchanges
  - Exchanges of researchers
  - Exchanges of information with running projects on standardisation of test procedures to ensure that best practice is followed
  - International conference on high temperature MEAs with invitations to key international speakers (a) to exchange information (b) to give increased visibility of Community funded research in the high temperature MEA field and (c) to benchmark international most recent results
- ***Deliverable:*** international conference on high temperature MEAs at the Coordination Action (mid- / end-term stage).
- ***Milestones and expected results:*** accelerate progress in the high temperature MEA field

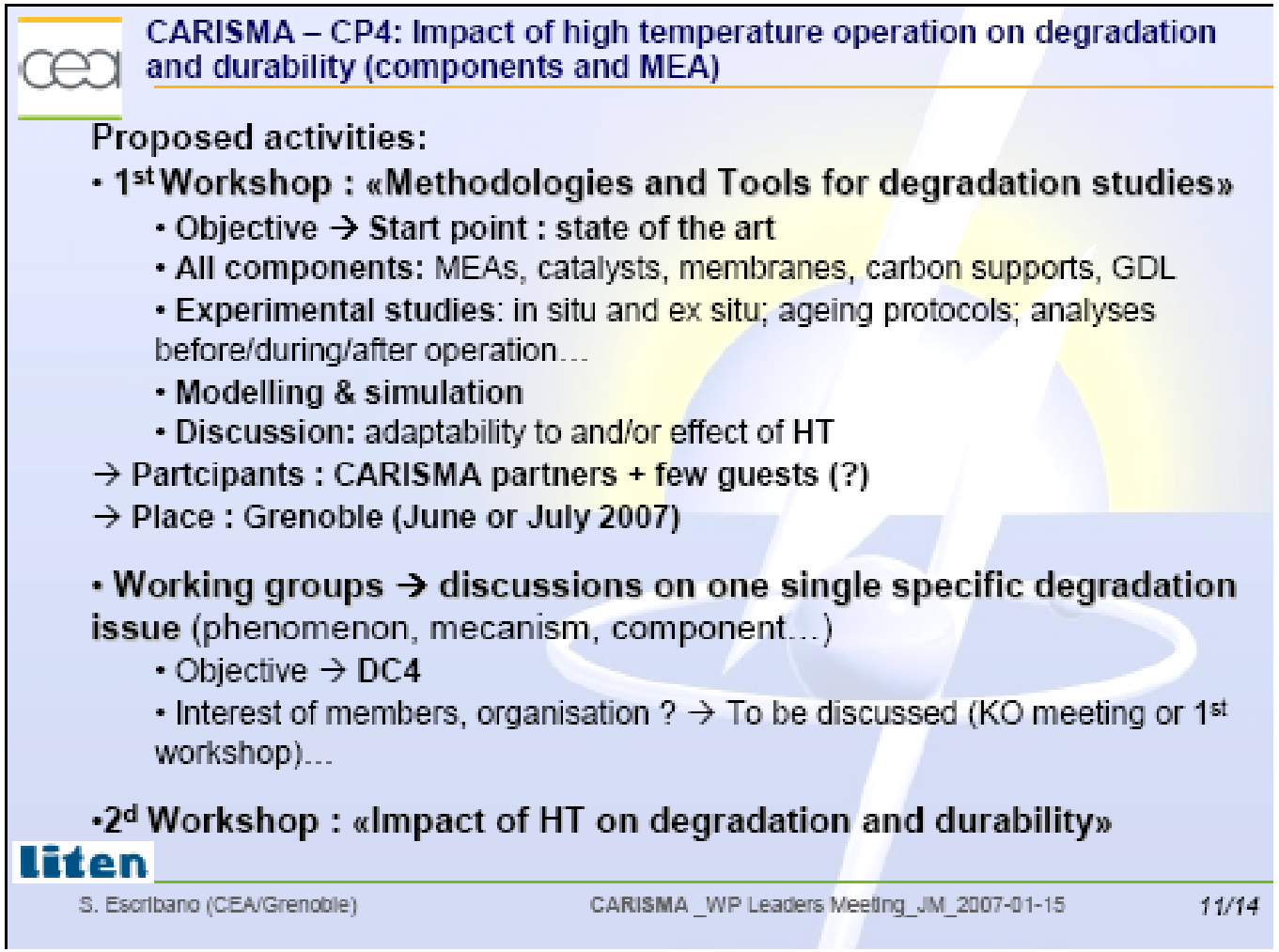
CP4: Impact of high temperature operation on degradation and durability

- ***Objective:*** network the efforts in Community- and nationally funded projects on determining the causes of MEA and component degradation; prioritize to enable cost reduction and improve durability
- ***Work:***
  - Joint studies on aging and degradation mechanisms of MEAs, catalysts, membranes, carbon supports, GDL, both in situ and ex situ
  - Survey of the international state of the art on understanding of degradation mechanisms of MEAs and their components, in particular at high temperature
  - Sharing of aging protocols
  - Exchange of information and results, for example via the CARISMA website and at the conference to be organized in the framework of CP3

- ***Deliverable:*** Summary report on international state of the art and results of joint studies (month 24)

- ***Milestones and expected results:*** increased understanding of the causes of and remedies to MEA component ageing and MEA failure under high temperature and application relevant operation conditions

CP4: Impact of high temperature operation on degradation and durability



CP5: Proton conduction mechanisms under low RH/ water free condition

- ***Objective:*** assemble and network critical mass in for greater understanding of proton transfer and conduction mechanisms in water-free and low relative humidity environments
- ***Work:***
  - Current state of the art in Europe on experimental and modelling studies of proton transport/ transfer in low RH/water-free environments will be established
  - International expertise will also be assessed and links made (e.g. via MP3) if judged useful
  - Organisation of a discussion day on proton transfer mechanisms
  - Networking, exchange of methodologies

- ***Deliverable:*** communication to MEA conference on proton conduction mechanisms in low RH environment

- ***Milestones and expected results:*** improved understanding of H2 dissociation and H^+ conduction in low RH environments

CP6: Technical specifications for PEM HT FC stationary and transport applications

- ***Objective:*** define automotive and stationary requirements and specifications for different future transport and distributed generation applications
- ***Work:***
  - Specification of materials properties and requirements with a focus on membrane, ionomer, catalyst and MEA properties
  - Definition of fuel cell operation boundary conditions in transport and stationary applications, including operating temperature, pressure, relative humidity
  - Supply of testing protocols for ageing/degradation studies under stationary/automotive relevant load profiles and operating conditions

- ***Deliverable:*** sets of materials properties specifications for transport and stationary applications

- ***Milestones and expected results:*** the outcome will enable mapping of current materials and MEA properties and performance against industry technical requirements

CP6: Technical Specifications

Technical specifications for PEM HT FC stationary and transport applications

- Materials Specification:
  - Data collection regarding specifications for automobile application
  - Simulation of certain reference cases, e.g. heating of stack at different environmental conditions/power demands
  - Environmental impacts of the materials used
  - Component recycling
  - Long term market prognosis
- Material Assessment:
  - Definition of ‘ideal’ operation conditions, cost targets, market introduction scenario
  - Contribution to accelerated aging protocols of MEAs and components
  - Assessment of data

Current Networking Activities

- *Website* https://carisma-network.eu/pages/index.html http://autobrane.org/pages/index.php and http://ec.europa.eu/research/fp6
- ***Applications submitted for*** IPHE Collaborative Project endorsement: March 2007
- *Workshop on* **Catalysts** for high temperature PEMFC (Spring 2007): "**Key issues to improve activity and durability of catalysts for PEM fuel cells**", 15th & 16th May 2007, Espace Hamelin, Paris.
- *Workshop on* High temperature **MEAs, tools** and methodologies for ageing and **degradation** studies: 5th & 6th July 2007, Grenoble.
- *School and Workshop on* **fundamental** and **applied aspects of PEM FC Membranes** (material prep and char) with emphasis on intermediate and high temperature operation: development, bottlenecks, proton transfer **mechanisms** 8th-9th November 2007 followed by the Workshop 12th-14th Nov 2007, Stuttgart.
- **International Conference** on Materials for High Temperature Membrane Electrode Assemblies (September 2008)

Future / Suggested Coordination Action Activities

- **CARISMA: Special journal edition resulting from Workshops and International Conference / Fuel Cell**

- **Suggested CARISMA Hospitality Suite at USA Conferences/ Seminars**:
  - FC Seminar Oct 2007 San Antonio, TX
  - ACS/ AIChE
- **Further on, suggested – possible – joint activities:**
  - **Link HTMWG in Europe with US DoE HTMWG: Use HTMWGs and other meetings (Gordon Conference on Fuel Cells) as opportunities to promote further interactions Europe/ USA / IPHE in the field of HT PEM FC/ MEA and components**
  - **Based on the similarity of the structures of the two working groups, some of the activities of the groups could be joined, at decided times/ periodicity, for example:**
    - **Joint sessions in special editions of fuel cells journals (in Europe and USA) – 2008**
    - **Joint hospitality suites (DoE HTMWG/ CARISMA) – example: FC Seminar San Antonio (Oct 15-19, 2007)**
    - **Dedicated CARISMA event to further promote Intl Coordin Action**

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Project Participants

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