High Temperature Membrane With Humidification-Independent Cluster Structure

For
DOE HTMWG Meeting

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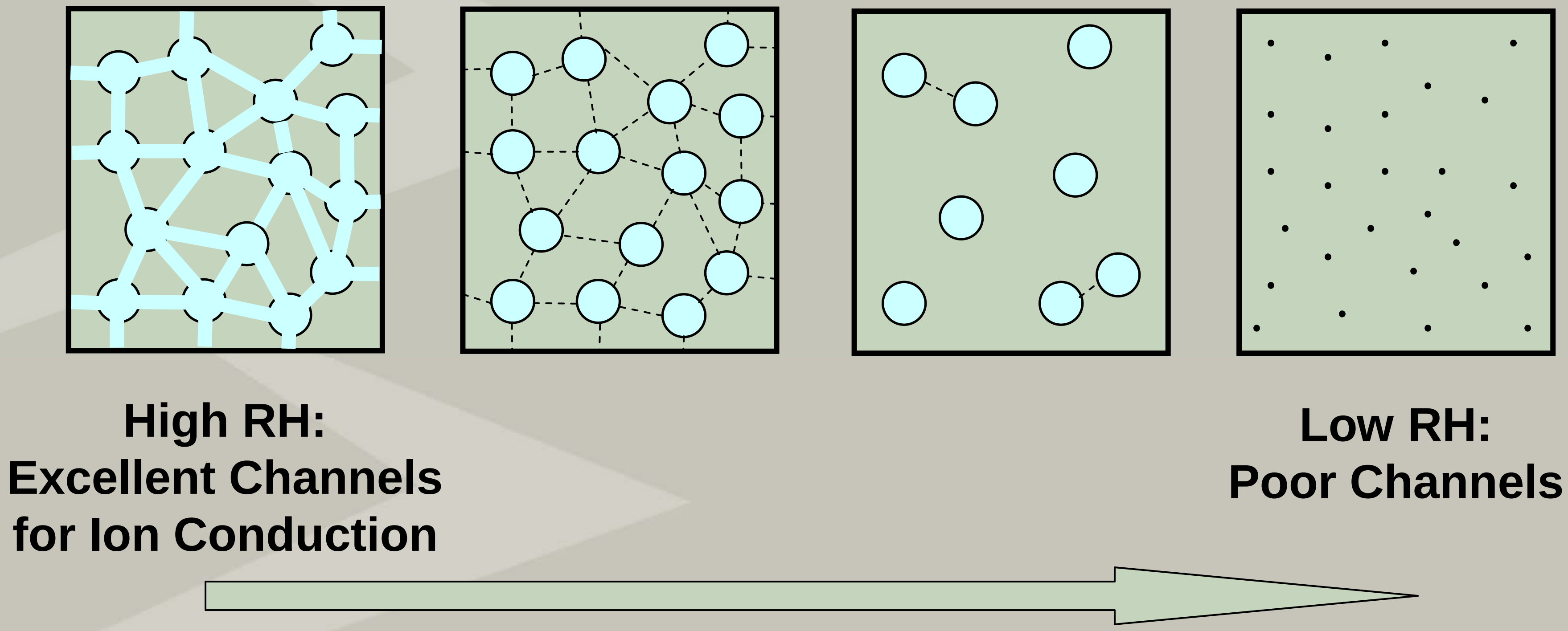
Objectives

- Develop humidity-independent, thermally stable, low-EW composite membranes with controlled ion-cluster morphology, to provide **high proton-conductivity** at 120°C (Overall Goal: Meet DOE 2010 targets)
- Improve mechanical properties to significantly increase the **durability** and reduce the gas cross-over
- Expand the operating range to **sub-freezing** temperatures

Challenge: Low RH Operation



Ion conducting path through the membrane is interrupted at low Relative Humidity (RH) conditions

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Approach for the Composite Membrane

Target Parameter	DOE Target (2010)	Approach
Conductivity at : 120°C	0.1 S/cm	Lower EW
: Room temp.	0.07 S/cm	Higher number of functional groups
: -20°C	0.01 S/cm	Stabilized nano-additives
Inlet water vapor partial pressure	1.5 kPa	Immobilized cluster structure
Hydrogen and oxygen cross-over at 1 atm	2 mA/cm^2	Stronger membrane structure; functionalized additives
Area specific resistance	0.02 Ωcm^2	Improve bonding capability for MEA
Cost	<40 $\$/m^2$	Simplify polymer processing
Durability: - with cycling at >80°C - with cycling at ≤80°C	 >2000 hours >5000 hours	Thermo-mechanically compliant bonds, higher glass transition temperature
Survivability	-40°C	Stabilized cluster structure design

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Planned Work

- Develop Baseline and Advanced polymer systems
  - Polymer composition
  - Polymer processing options
- Develop proton-conducting additives
  - Catalog promising additives and their properties
  - Evaluate concentration ratios
  - Evaluate compatibility with ionomer and solvents used for membrane preparation
  - Collect experimental data to develop computer model for conductivity estimates in a composite structure
- Characterize membrane samples
  - Measure EW, swelling and water uptake
  - Evaluate membrane mechanical properties
  - Perform membrane stability tests

Key Milestones for 2006-2007

- Select Baseline membrane material and processing technique (6 months)
- Update list of promising additives for high temperature and low relative humidity (HT-LRH) membrane (12 months)
- Complete characterization of promising membrane options (18 months)

Summary

- A composite membrane incorporating proton conducting additives in an advanced co-polymer system has a potential to meet the DOE requirements

- Candidate materials and processing options for high mechanical strength, durability and low cost have been identified for initial evaluation

- Synergistic exploitation of FCE's experience in PAFC, MCFC and SOFC is planned