2006 DOE Hydrogen Program
Dimensionally Stable High Temperature Membranes

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This presentation does not contain any proprietary or confidential information

Project ID #
FCP 16

Overview

Timeline

- Begin 4/3/2006
- Review 4/2/2009
- <10% Complete

Budget

- Total project funding (to 2009)
  - $899K DOE Funding
  - $529K Recipient
  - 37% Cost Share
  - $150K 2006

Barriers addressed

A. Durability
B. Cost

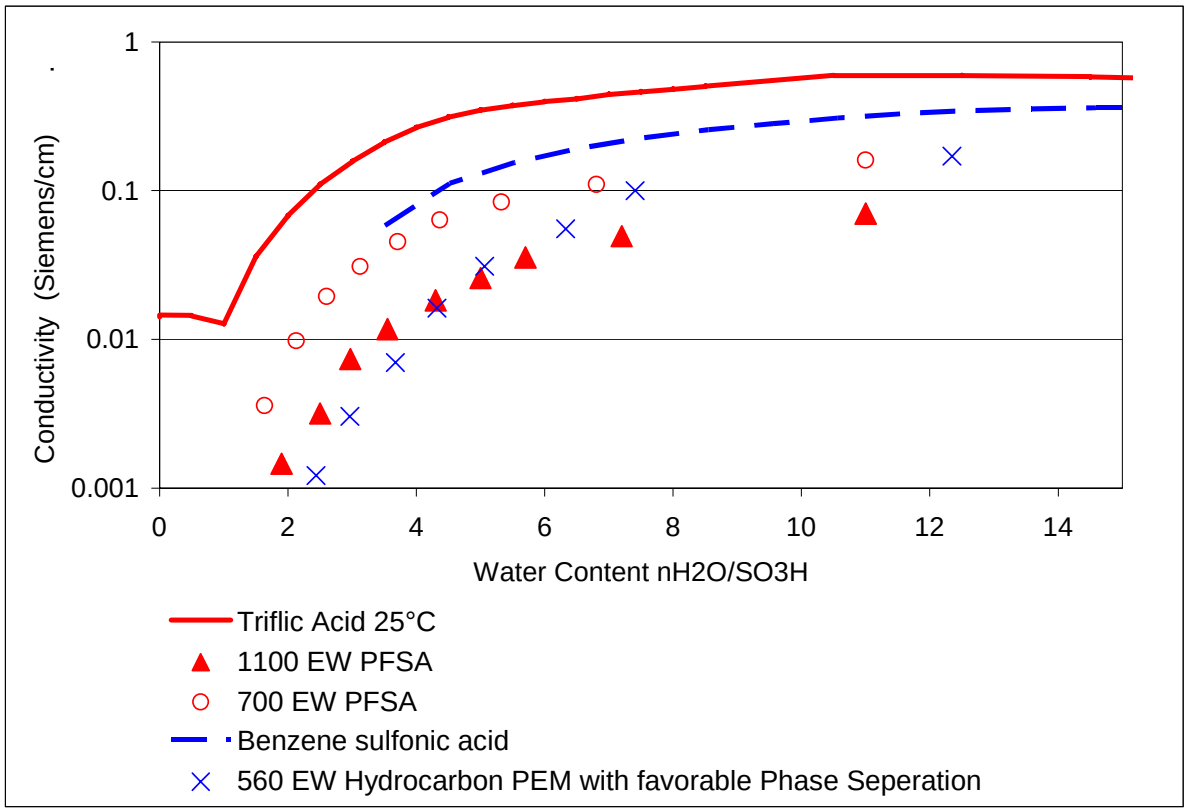
Technical Targets (DOE 2010 Targets)

- 0.10 S/cm at 1.5 kPa H_2O Air inlet
- <$40/$m^2$
- > 5000 h lifetime
- Stability in Condensing conditions

Partners

- General Motors

Background



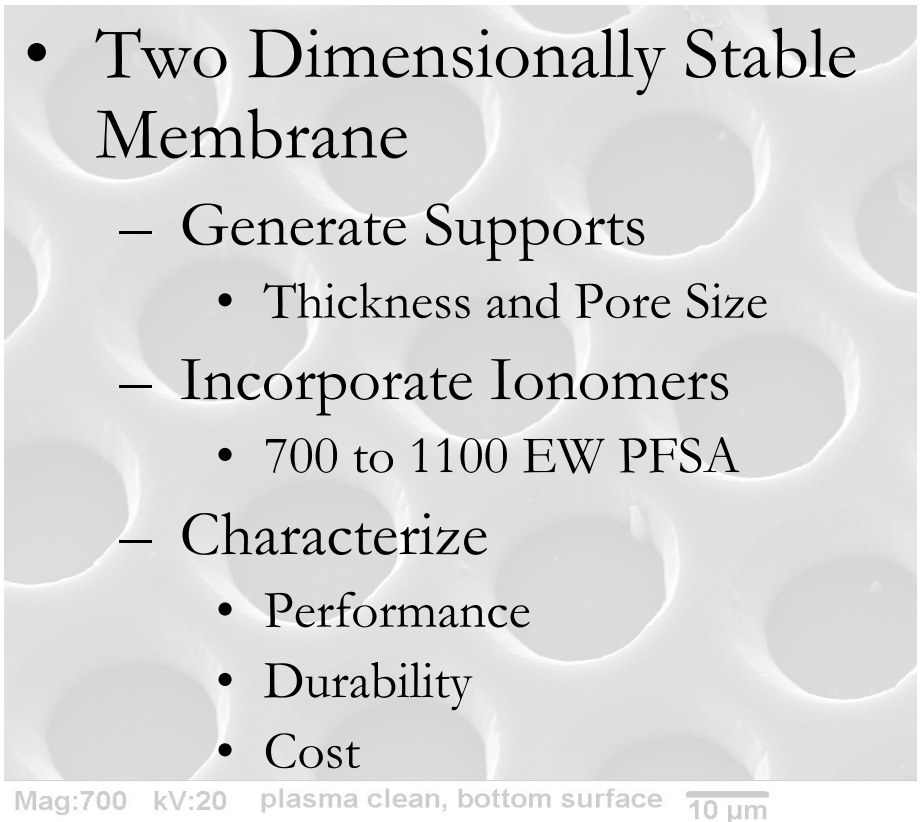
In characterizing hundreds of PFSA and hydrocarbon membranes we found:

1. all ionomers have the same nH_2O/SO_3H at a given RH (RH<70%).
2. PFSA's *always* have a higher conductivity at a given water content for similar EV (EW/density).
3. Promoting phase separation in HC membranes improves conductivity.
4. Difference in conductivity is almost identical to the difference in conductivity of small model acid compounds.

Even low EW PFSA's will have to be very thin to meet DOE targets for area resistivity.

Approach: Lower EW of perfluorosulfonic Acid ionomers to increase low RH conductivity and support the ionomer with two and three-dimensional non-ionic materials

- Two Dimensionally Stable Membrane
  - Generate Supports
    - Thickness and Pore Size
  - Incorporate Ionomers
    - 700 to 1100 EW PFSA
  - Characterize
    - Performance
    - Durability
    - Cost

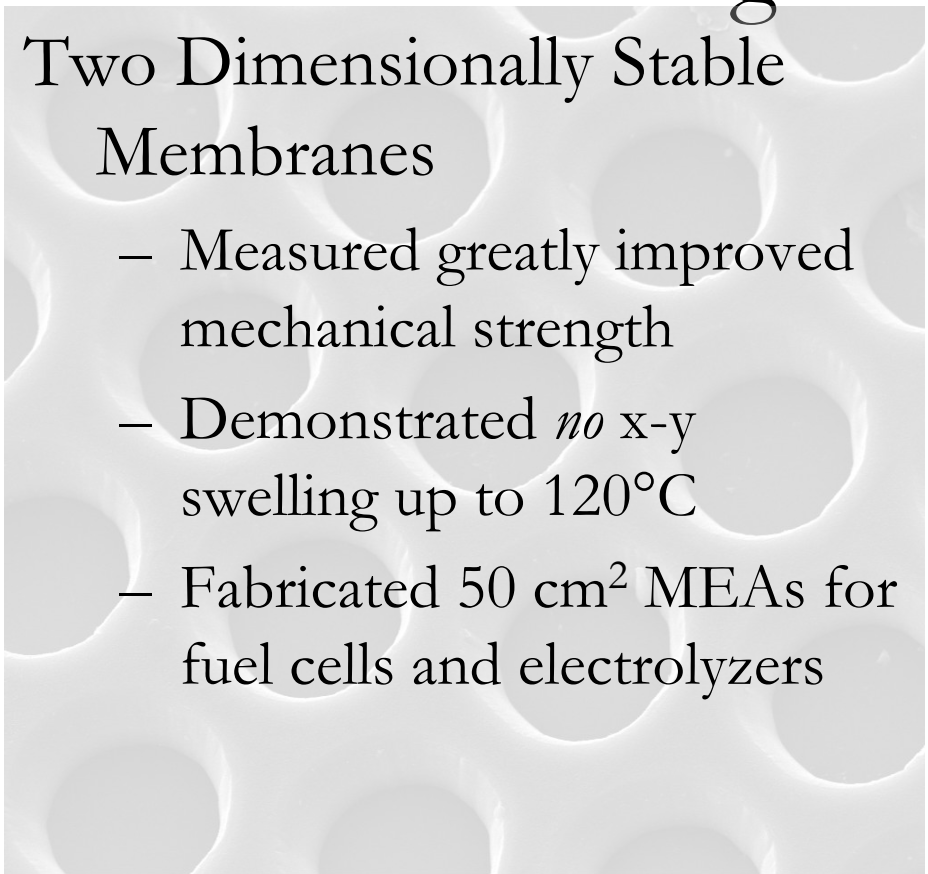


- Three Dimensionally Stable Membrane
  - Develop Bulk Polymerization Methods
  - Polymerize in Selected Supports
  - Characterize
    - Performance
    - Durability
    - Cost

Technical Accomplishments/ Progress/Results

Two Dimensionally Stable Membranes

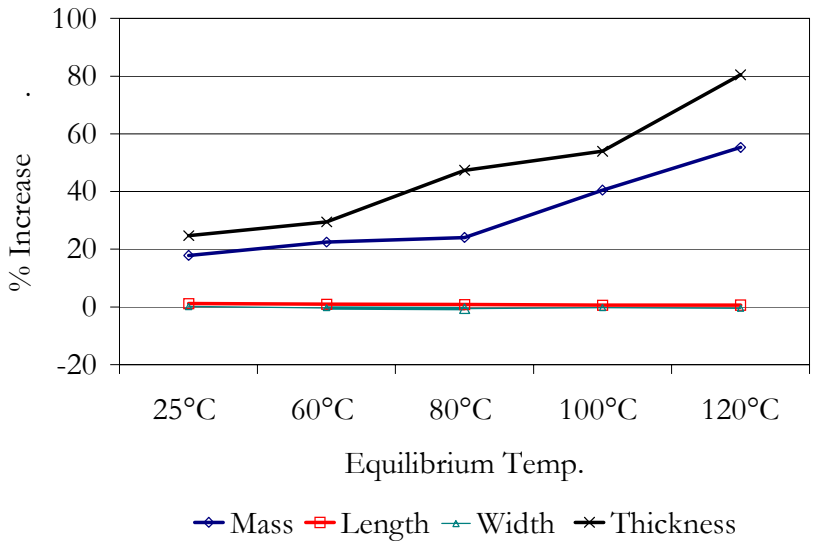
- Measured greatly improved mechanical strength
- Demonstrated *no* x-y swelling up to 120°C
- Fabricated 50 cm^2 MEAs for fuel cells and electrolyzers



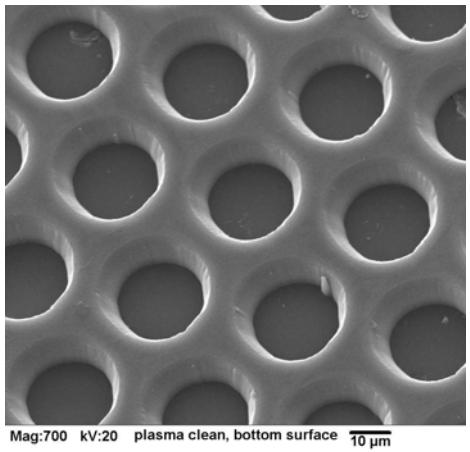
Three Dimensionally Stable Membranes

- Purified Ionomer
- Generated oligomers

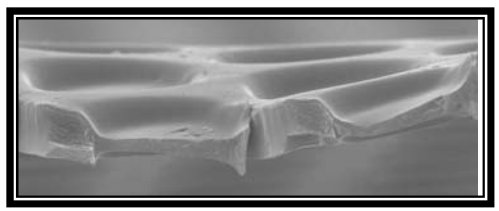
Accomplishments/Progress



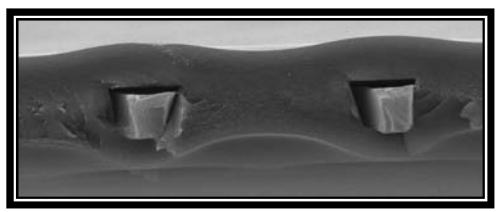
Dimensional and mass increase of composite membranes consisting of 1100 EW PFSA incorporated in 8- µm polyimide support seen in adjacent figure.



Porous Support
- •polyimide
- •8µ thick
- •50% open
- •20µ holes



Surface Tension leads to uniform filling of holes during casting



Addition of more ionomer leads to desired PEM thickness

Future Work

- 2006
  - Highlights will be to fabricate and characterize matrix of 2DSM
    - Pore size
    - EW
    - Thickness
  - Bulk Polymerization for 3DSM
- 2007
  - Demonstrate ability to make performance targets
- 2008
  - Demonstrate ability to make cost and durability targets