Lead Research and Development Activity for High Temperature, Low Relative Humidity Membrane Program

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Florida Solar Energy Center

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FCP 5

Overview

Timeline

- Start Date: April 1, 2006
- End Date: March 31, 2011

Budget

- Total project funding
  - DOE - $2,500K
  - Contractor - $625K
- Funding for FY06 $250K

Barriers

- Barriers addressed (From Program Plan)
  - Thermal management
  - Electrode performance
  - Membrane and MEA Durability
- Targets
  - Conductivity = 0.07 S/cm at 80% relative humidity (RH) at room temp using alternate material – 3Q Yr 2 milestone
  - Conductivity >0.1 S/cm at 50% RH at 120 ^{o}C – 3Q Yr 3 Go/No Go

Partners

- BekkTech LLC – In–plane conductivity protocols
- Scribner Associates – Through-plane conductivity protocols

Objectives

- New polymeric electrolyte PTA membranes
- Standardized Characterization Methodologies
  - Conductivity f(RH, T, Phys. Props.) {Through & In Plane; As MEA}
  - Characterize mechanical, mass transport and surface properties of membranes
  - Predict durability of membranes and MEAs fabricated from other eleven HT Low RH Membrane Programs
- Provide HTMWG members with standardized tests and methodologies (Short Courses)
- Organize HTMWG bi-annual meetings

Approach

Task 1. Non-Nafion® based Poly[perfluorosulfonic acid] - phosphotungstic acid composite membrane and membrane electrode assembly, MEA, fabrication

Task 2. Sulfonated poly(ether ketone ketone) or sulfonated poly(ether ether ketone) - Phosphotungstic Acid Composite Membrane and MEA, Fabrication

Task 3. In-Plane Conductivity Measurement

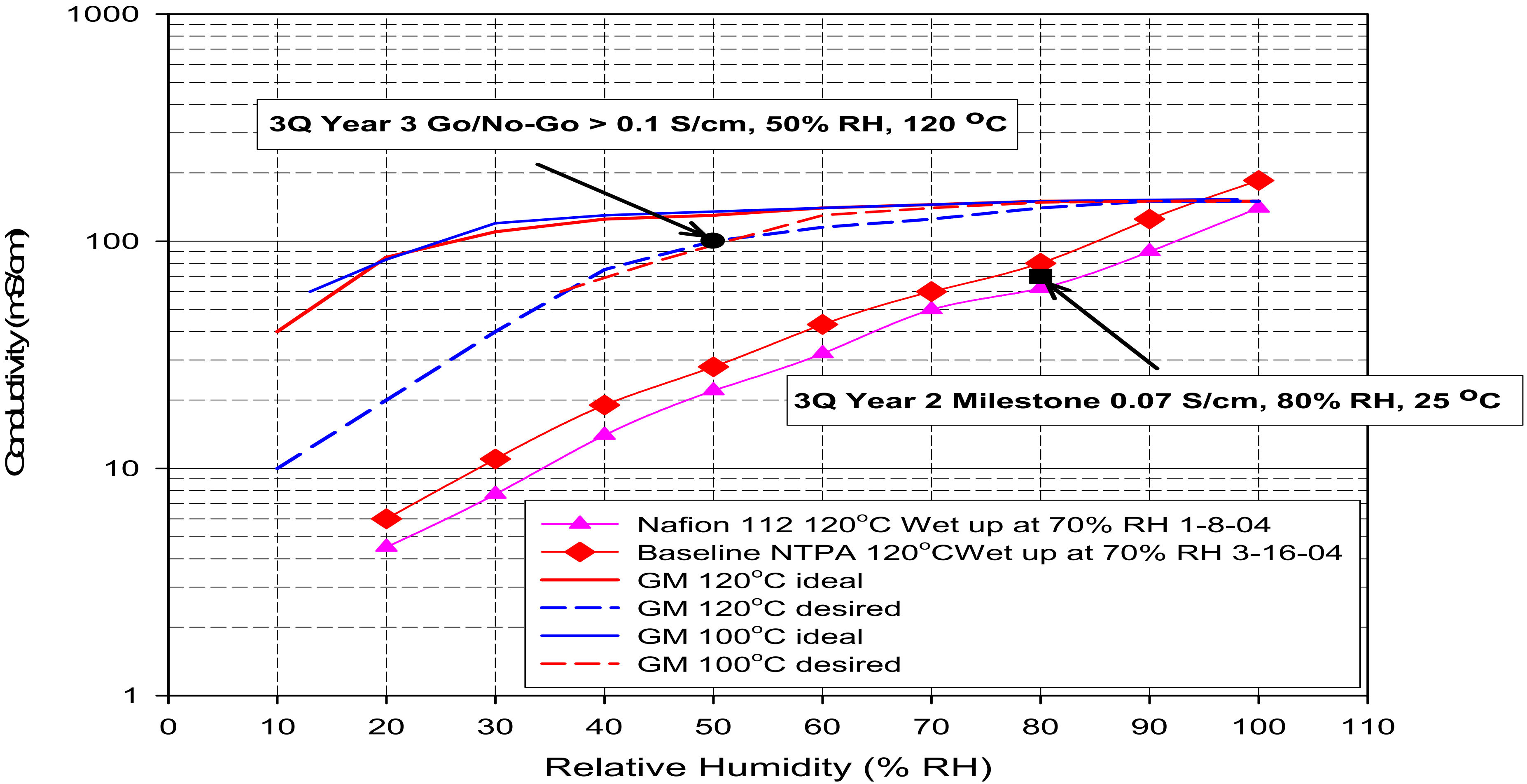
Task 4. Through-Plane Conductivity Measurements

Task 5. Characterize Performance of MEAs

Task 6. Membrane and MEA Durability

Task 7. Meetings and Activities of HTMWG

Technical Accomplishments



Mathias, M. F., and Gasteiger, H. A., In *Proceedings of the Proton Conducting Membrane Fuel Cells III Symposium*; The Electrochemical Society: 2002.


Compact Fuel Cell Test System
850C


Nahid Mohajeri
Darlene Slattery
Clovis Linkous
Ruichun Jiang

FSEC's First Fuel Cell Course a Big Success!

It was standing-room only during the laboratory sessions at "The 2006 Short Course in Fuel Cell Technology," held at FSEC February 5 – 8. Three days of presentations and hands-on lab sessions were led by FSEC director Jim Fenton, Kevin Cooper of Scribner Associates, Russ Kunz of the University of Connecticut and Vijay Ramani of the Illinois Institute of Technology.

Fuel cell course participants received hands-on instruction in FSEC's lab.

(Photo: Nick Waters)

The course was presented by FSEC and co-sponsored by Scribner Associates and the Electrochemical Society. Attendees included industry members, scientists, engineers, students and others from around the country interested in this new short course on basic and applied aspects of fuel cell technology, with an emphasis on polymer electrolyte and direct methanol fuel cells. The course is planned to be held again later this year at the center.

If you're interested in getting more information on this program, contact JoAnn Stirling at 321-638-1014 or joann@fsec.ucf.edu

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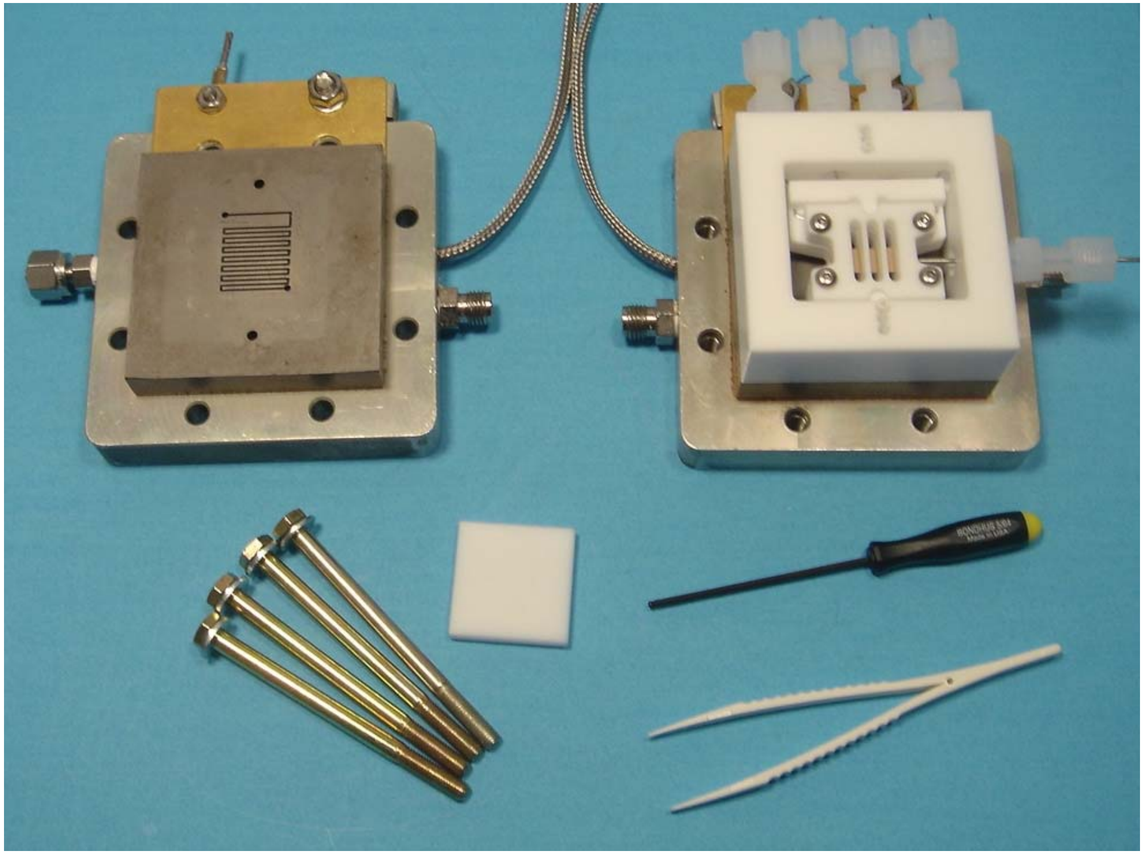
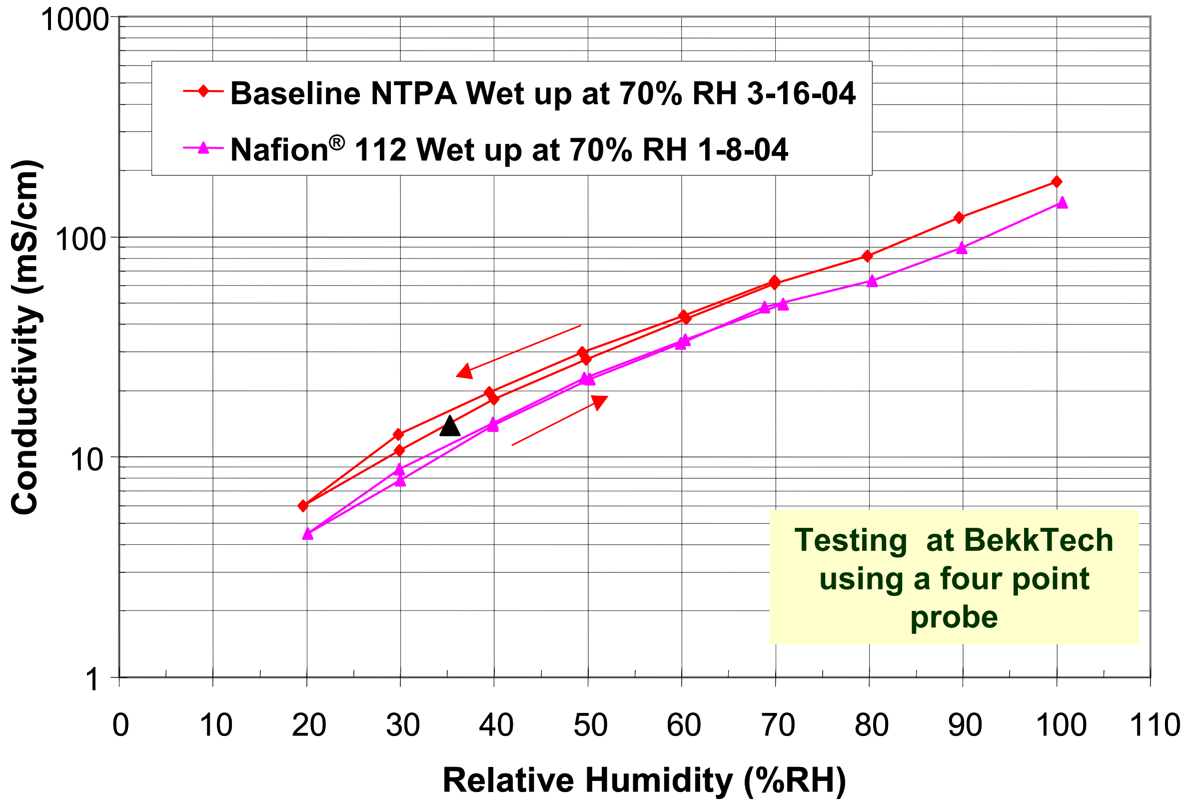


BT-112 BekkTech Conductivity Cell Assembled with the Fuel Cell Technologies Fuel Cell Hardware

Comparing Four Electrode Conductivity of NTPA to Nafion®
120 °C, 500 sccm H_2, 230 kPa



Nafion®-Teflon®-Phosphotungstic acid (NTPA) Membrane (25 µm) Resistance & Crossover

T, °C	R H, %	R, Ω-cm²	H_2 Crossover, mA/cm²
25	100	~	1.0
80	75	0.05	1.0~2.0
120	35	0.20	<5.0

Future Work

- FY 06
  - Poly[perfluorosulfonic acid] - Teflon® -phosphotungstic acid membrane fabrication
    - Low eq. wt. PFSA
    - Smaller particle phosphotungstic acid
    - Increase stabilization of membrane
  - Sulfonated poly(ether ketone ketone), SPEKK, or sulfonated poly(ether ether ketone), SPEEK, membranes
    - Smaller particle phosphotungstic acid added
  - In-plane conductivity measurements
    - Apparatus and protocols defined and verified
    - Commercially available membrane samples and baseline NTPA tested

Future Work

- FY 07
  - Apparatus for testing membranes will be built and verified
  - Test protocols will be conducted
  - Results from in-plane conductivity measurements on commercial samples will be submitted
  - Test apparatus and protocols for through-plane conductivity measurements will be developed and verified (milestone)
  - Comparison of in-plane to through-plane conductivity will be completed (milestone)

Summary

- Relevance: Optimize fuel cell thermal and water management and increase membrane durability
- Approach: Develop new polymeric electrolyte composite membranes with a conductivity of 0.1 S/cm at 50% relative humidity and 120 ^{o}C
- Technology Transfer/Collaborations: Membranes from other working group members will be tested using standardized protocols. Training in test methodologies will be provided

Critical Assumptions and Issues

- Minimize particle size of Phosphotungstic Acid (PTA) to enhance membrane conductivity and stability
  - Solvent selection
  - Ionic form of ionomers and PTA, thermal processing conditions
  - Membrane formation process optimization

- Use of low equivalent weight Poly[perfluorosulfonic acid] (PFSA)
  - Enhance membrane conductivity by combining low EW PFSA and small particle phosphotungstic acid
  - Improve the cathode oxygen reduction reaction, ORR, kinetics by applying low EW PFSA ionomer with PTA inside of cathode catalyst layer

- Enhance the conductivity, performance and durability of hydrocarbon based membranes and MEAs
  - Optimize hydrocarbon membrane tradeoffs between ion exchange capacity (IEC) and durability
  - Enhance proton conductivity by applying small particle phosphotungstic acid
  - Improve the MEA cathode ORR kinetics and the electrode/membrane interface using the same ionomer as used in bulk membrane