
V.B.13 Lead Research and Development Activity for DOE's High Temperature, Low Relative Humidity Membrane Program

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Contract Number: DE-FC36-06GO16028

Subcontractors:

BekkTech LLC, Loveland, CO
Scribner Associates, Inc., Southern Pines, NC

Start Date: April 1, 2006

Projected End Date: March 31, 2009

Program Multi-Year Research, Development and Demonstration Plan:

- (A) Durability
- (C) Electrode Performance
- (D) Thermal, Air and Water Management

Technical Targets

Florida Solar Energy Center (FSEC) will develop and evaluate new polymeric electrolyte phosphotungstic acid composite membranes to increase conductivity. FSEC will also develop standardized experimental methodologies to 1) measure conductivity (in-plane and through-plane); 2) characterize mechanical, mass transport, and surface properties of the membranes; and 3) predict durability of the membranes and their membrane electrode assemblies.

The membranes will meet the following DOE targets:

- A non-Nafion[®] membrane with a demonstrated conductivity of 0.07 S/cm at 80% relative humidity at room temperature by the third quarter of year two.
- A membrane with a demonstrated conductivity of >0.1 S/cm at 120°C and 1.5 kPa water vapor partial pressure (50% relative humidity measured at room temperature). This is a go/no go decision point for the third quarter of year three.

Objectives

- Demonstrate conductivity of 0.07 S/cm at 80% relative humidity (RH), 25°C using new polymeric electrolyte phosphotungstic acid (PTA) membranes.
- Demonstrate conductivity of >0.1 S/cm at 120°C and 1.5 kPa inlet water vapor partial pressure to the fuel cell stack.
- Standardize methodologies for in-plane and through-plane conductivity measurements.
- Provide High Temperature Membrane Working Group (HTMWG) members with standardized tests and methodologies.
- Organize HTMWG bi-annual meetings.

Technical Barriers

This project addresses the following technical barriers from the Fuel Cells section (3.4.4.2) of the Hydrogen, Fuel Cells and Infrastructure Technologies

Approach

Non-Nafion[®] based poly[perfluorosulfonic acids] (PFSA) of equivalent weight lower than 1100; sulfonated poly(ether ether ketone)s (SPEEKs) with various sulfonation degrees; and sulfonated poly(ether ketone ketone) (SPEKK) as the proton-conducting component in a blend with either poly(ether sulfone) (PES) or SPEKK with different sulfonation levels will be fabricated into new composite membranes containing small particle-stabilized phosphotungstic acid. The FSEC team along with subcontractors, Bekktech and Scribner Associates, working with the fuel cell community, will develop standardized experimental methodologies to 1) measure conductivity as a function of relative humidity and mechanical properties of membranes; 2) characterize mechanical, mass transport, and surface properties of the membranes; and 3) predict durability of the membranes and

their membrane electrode assemblies, which will be fabricated by the FSEC team for both the in-house research project and for membranes provided by the High Temperature, Low Relative Humidity Membrane Research Program members. FSEC will develop and provide the DOE's High Temperature Membrane Working Group (HTMWG), <http://www1.eere.energy.gov/hydrogenandfuelcells/htmwg.html>, with standardized tests and methodologies along with short course education offerings on these tests. An easily-implemented protocol and rapid test apparatus for evaluating the through-thickness conductivity (or resistance) of membranes over a broad range of conditions will be developed. FSEC will use its in-house experience in developing accredited standardized test methods for the solar thermal, photovoltaic and building energy efficiency industries to support this activity.

FY 2006 Publications/Presentations

1. Fenton, James M., "Lead Research and Development Activity for High Temperature, Low Relative Humidity Membrane Program" presented at the High Temperature, Low Relative Humidity Membrane Working Group Meeting. Washington, D.C., May 19, 2006.
2. Fenton, James M., "Lead Research and Development Activity for High Temperature, Low Relative Humidity Membrane Program" Poster presentation at the 2006 DOE Hydrogen Program Annual Merit Review, Washington, D.C., May 16, 2006.
3. Linkous, Clovis A., "New Solid Polymer Electrolytes Based on Phosphotungstic Acid" presented at the High Temperature, Low Relative Humidity Membrane Working Group Meeting. Washington, D.C., May 19, 2006.