Low-Cost Proton Conducting Membranes for PEM Fuel Cells

Project ID: FC151

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2016 DOE Annual Merit Review

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Overview

Timeline and Budget

SBIR Phase I Award, 2016

•Project Start Date: February 22, 2016
•Project End Date: November 21, 2016

Percent complete: On-going project, 30%

Total Project Budget: $150K

Barriers

Barriers addressed

- **A. Durability:** Membrane and MEA durability
- **B. Cost:** PEM that is much cheaper than Nafion membranes
- **C. Performance:** High MEA performance at low relative humidity and high temperature

Partners

- US DOE: Project Sponsor and Funding
- Los Alamos National Laboratory: Assist in Membrane and MEA characterization and evaluation through an Small Business Voucher award

Relevance

DOE Technical Targets: Fuel Cell Membranes for Transportation Applications

Characteristics	Units	2020 Target
Maximum operating temperature	^{o}C	120
Area specific proton resistance at:		
Maximum operating temperature and water partial pressures from 40 to 80 kPa	Ohm cm^2	≤ 0.02
80°C and water partial pressure from 25-45 kPa	Ohm cm^2	≤ 0.02
30°C and water partial pressure up to 4 kPa	Ohm cm^2	≤ 0.03
-20°C	Ohm cm^2	≤ 0.2
Maximum oxygen cross-over	mA/cm^2	2
Maximum hydrogen cross-over	mA/cm^2	2
Minimum electrical resistance	Ohm cm^2	1000
Cost	$\$/m^2$	≤ 20
Durability:		
Mechanical	Cycles with < 2 mA/cm^2 crossover	≥20,000
Chemical	Hours	>500

Objectives

The ultimate goal of this project is to develop a low-cost, high-performance proton conducting membrane for PEM fuel cells. The specific objectives of the Phase I effort are:

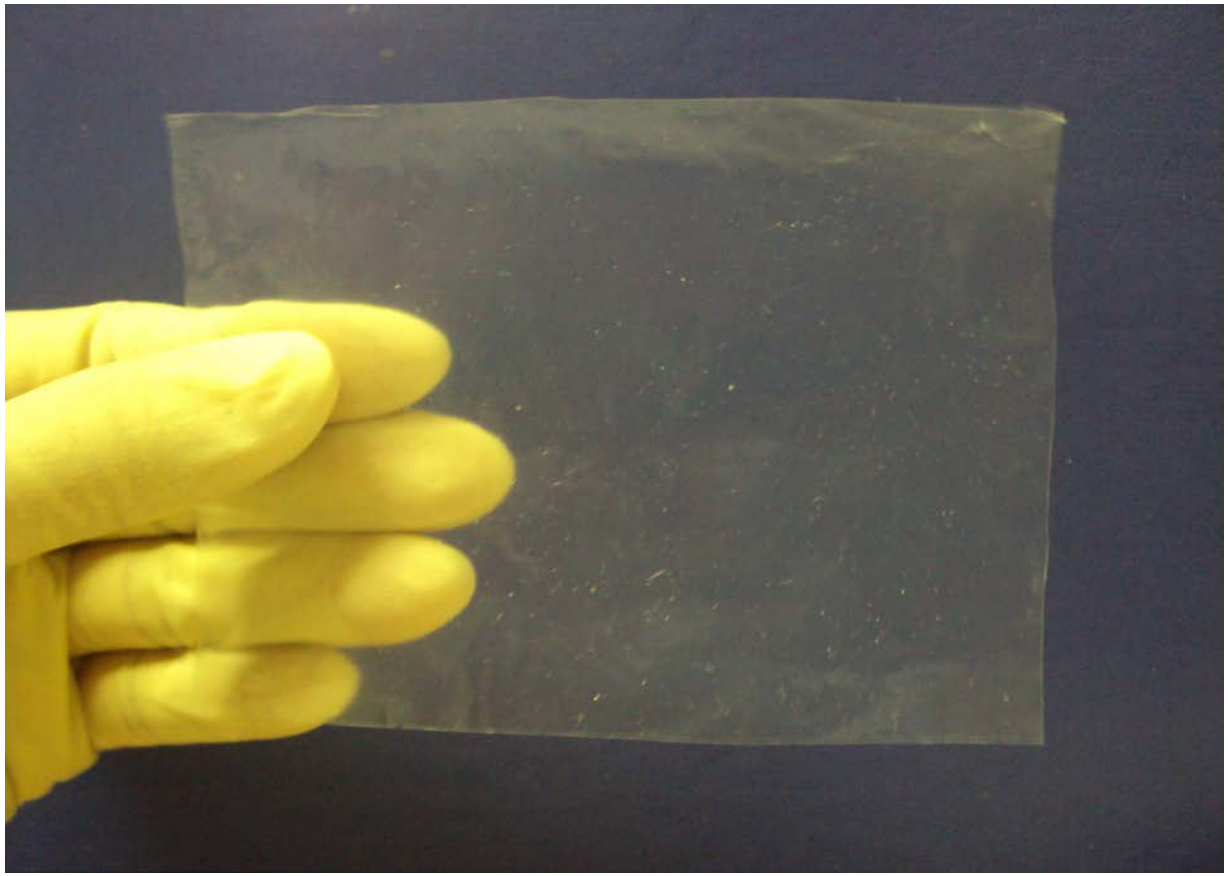
- To determine the best material system for the new PEM;
- To establish a suitable process for fabrication of the new PEM;
- To characterize the new PEM in terms of physical and chemical properties;
- To test the new PEM under fuel cell conditions;
- To evaluate economical significance of the new PEM.

Approach

Amsen Technologies LLC chooses to address the DOE call with a novel reinforced PEM approach based on new, non-PFSA proton conducting ionomers developed from our previous DOE SBIR projects. Along with this approach is the use of very cheap, ultra thin and highly porous microporous meshes as the support for the membrane.

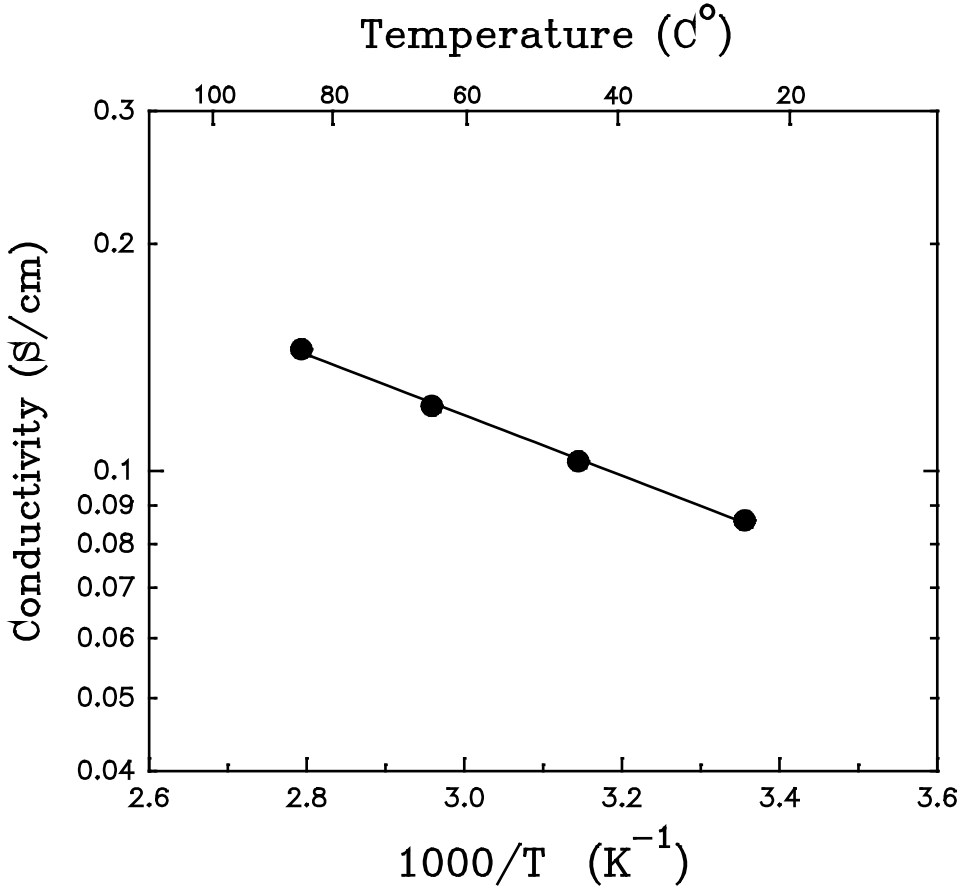
The prepared PEM membranes will be systematically characterized in terms of relevant physical and chemical properties to demonstrate feasibility of meeting the DOE targets.

Accomplishments



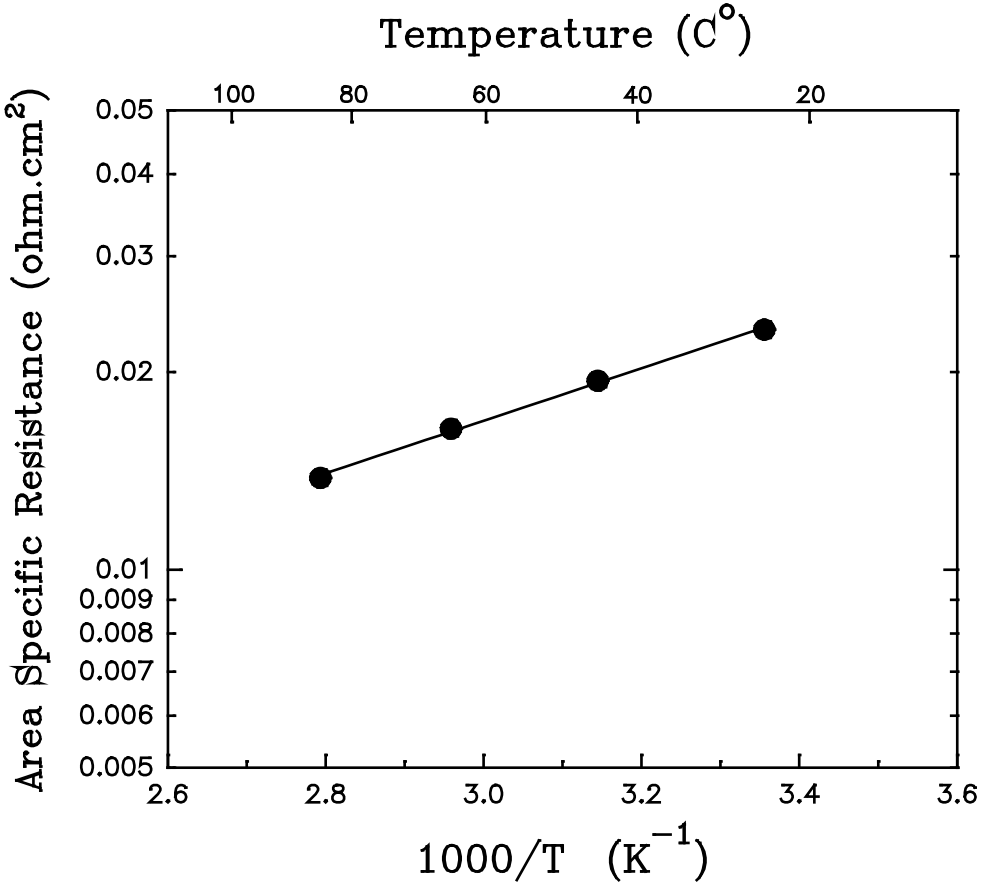
Sample new membrane prepared at Amsen

Accomplishments



Arrehenius plots of proton conductivity of the new membrane at 100% RH

Accomplishments



Arrehenius plots of area specific resistance of the new membrane at 100% RH

Collaboartion

Amsen and Los Alamos National Laboratory (LANL) have on-going collaborations through a DOE Small Business Voucher award in our efforts for the development of new ionomer membranes. At the end of Phase I, the new membrane samples will be tested and evaluated independently by LANL to verify our own testing results.

Future Work

Complete the Phase I work as planned, including:

- Determine the best material system for the new PEM;
- Establish a suitable process for fabrication of the new PEM;
- Characterize the new PEM in terms of structural and microstructural features;
- Characterize the new PEM in terms of physical and chemical properties including maximum operating temperature, proton conductivity and area specific proton resistance in a range of temperature and humidity conditions, oxygen crossover, hydrogen crossover, resistance to electronic conduction, and mechanical and chemical durabilities.
- Test the new PEM under fuel cell conditions.

Summary

- Objective: Develop a low-cost, high-performance proton conducting membrane for PEM fuel cells.
- Relevance: Low-cost and high performance PEM is the key component for fuel cells meeting the DOE targets.
- Approach: Non-PFSA proton conducting membrane reinforced by ultra thin and highly porous microporous support.
- Accomplishments: Preliminary membrane samples have been prepared and high proton conductivity has been measured.
- Future Work: Complete SBIR Phase I work as planned.