V.B.17 High Temperature Membrane With Humidification-Independent Cluster Structure

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Objectives

- Develop humidity-independent, thermally stable, low equivalent weight 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 durability and reduce gas cross-over
- Expand the operating range to sub-freezing temperatures

Technical Barriers

This project addresses the following technical barriers, as identified in the Fuel Cells section (3.4.4.2) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

(A) Durability

(B) Cost

(D) Thermal, Air and Water Management

Technical Targets

This project is developing a composite membrane to meet the following DOE 2010 technical targets for membranes:

- Membrane Conductivity: at 120°C: 0.1 S/cm; at room temperature: 0.07 S/cm; at –20°C: 0.01 S/cm
- Cell Area Specific Resistance: 0.02 Ωcm^2

Approach

The approach used to conduct the research is described in Table 1.

TABLE 1. Approach for the Composite Membrane

Target Parameter	DOE Target (2010)	Approach
Conductivity at: • 120°C • Room temp. • -20°C	 0.1 S/cm 0.07 S/cm 0.01 S/cm	 Lower equivalent weight Higher number of functional groups 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	 >2,000 hours >5,000 hours	Thermo-mechanically compliant bonds, higher glass transition temperature
Survivability	-40°C	Stabilized cluster structure design

FY 2006 Publications/Presentations

1. L. Lipp, P. Patel, R. Kopp, "High Temperature Membrane With Humidification-Independent Cluster Structure", 2006 DOE Hydrogen Program Merit Review and Peer Evaluation Meeting, Washington D.C., May 16-19, 2006.

2. L. Lipp, P. Patel, R. Kopp, "High Temperature Membrane With Humidification-Independent Cluster Structure", High Temperature Membrane Working Group Meeting, Arlington, VA, May 19, 2006.