Development of Polybenzimidazole-based, High-Temperature Membrane and Electrode Assemblies for Stationary and Automotive Applications (New FY 2004 Project)

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Objectives

- Select the appropriate polymer chemistry for polybenzimidazole (PBI) proton exchange membrane materials optimized to fuel cell requirements.
- Demonstrate the long-term performance of the PBI membrane, including mechanical, electrochemical, and operating properties, in cells and stacks.
- Provide a cost analysis of a low-cost membrane manufacturing process with projected costs consistent with meeting the specified high-volume targets.

Technical Barriers

This project addresses the following technical barriers from the Fuel Cells section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year R,D&D Plan:

Transportation Systems Barriers

- C. Thermal Management
- E. Durability
- F. Heat Utilization

Component Barriers

- P. Durability
- Q. Electrode Performance
- R. Thermal Management

Approach

The goal of this project is to optimize a high-temperature PBI membrane to meet the performance, durability, and cost targets required for stationary and automotive fuel cell applications. The ultimate result will be a low-cost PBI membrane material and a corresponding manufacturing process that will meet the DOE targets for a membrane that operates at greater than 120°C at pressures up to 3 atm with a projected design lifetime in excess of 40,000 hours. The corresponding membrane electrode assembly (MEA) cost targets are <$10/kW for 500,000 automotive fuel cell stacks per year and <$1,500/kW for 1,000 stationary fuel cell stacks per year. In this project, the Plug Power team will conduct extensive testing and verification of candidate PBI materials under automotive and stationary operating conditions, followed by selection of the best chemical composition and manufacturing process that will yield a highly reliable, low-cost membrane.

The proposed work covers a three-year period and is divided into three principal parallel and integrated technology focuses. The first focus addresses screening of candidate polymers and membrane fabrication processes. Film properties will be measured, and their relationship with polymer structure will be determined; the parameters that control film fabrication and manufacturing scale-up will be defined.

In the second focus, MEAs will be screened for numerous performance characteristics, followed by in-depth parametric studies for both short- and long-term applications. Scaled-up MEAs with active areas of at least 250 cm^2 will be assembled into and evaluated in short stacks.

The third focus is the development and demonstration of hardware optimized for PBI-based MEAs. Specifically, membrane/electrode interfaces, flow fields and acid management strategies will be investigated. Cathode performance improvements will be sought by optimizing standard electrode architectures and by investigating unique solutions such as nanotechnologies. The coupling of hardware and MEA performance will be a significant aspect of this work. A key deliverable will be a model to quantify the manufacturing cost of the selected PBI membrane.

The Plug Power team includes two university partners, Rensselaer Polytechnic Institute (RPI) in Troy, New York, and Albany NanoTech (ANT) at the State University of New York (SUNY) in Albany. The third partner is Celanese Ventures (GmbH), a polybenzimidazole (PBI) manufacturer.