PROJECT SUMMARY

Improved Ionomers and Membranes for Fuel Cells
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Problem Addressed: Proton exchange membrane fuel cells are one of the most promising energy conversion technologies for renewable clean energy applications. However, the current leading commercial perfluorosulfonic acid based materials are relatively expensive and have physical and chemical properties which limit fuel cell performance and durability, particularly under desirable high temperature operating conditions.

Approach to Solving Problem: This work is focused on the development and production of improved, non-perfluorosulfonic acid conductive polymers and composite membranes that have the potential of operating at a higher temperature than the current perfluorosulfonic acid ionomers. Importantly, the structure of these materials allows for custom tailoring of physical and chemical properties key to effective performance under the harsher operating conditions required for next generation fuel cell applications. Building on our Phase I accomplishments, down-selected ionomers will be systematically customized to meet the requirements of current and future commercial fuel cell units.

Phase I Accomplishments: During Phase I we successfully demonstrated the synthesis of a series of novel ionomers. Based on these materials, effective proton exchange membranes were produced with simultaneously higher conductivity and lower hydrogen crossover than the commercial perfluorosulfonic acid baseline. A number of approaches were successfully demonstrated to allow tailoring and control of water uptake, ion exchange capacity and conductivity. The most promising ionomers and techniques were down-selected for further development during Phase II.

Plans for Phase II: During Phase II, we plan to further optimize and develop our Phase I down-selected materials. Our primary focus will be to increase the efficiency by optimizing proton conductivity and further reducing the hydrogen permeability for each down-selected structure. Durability enhancing techniques will be applied to the most promising membranes in order to address specific demands of high temperature and low humidity operation, while maintaining excellent performance. Our collaborators for specialty in situ fuel cell testing include a National Laboratory and a leading fuel cell device manufacturer. Device relevant single cell fuel cell tests will be carried out by our commercial partner throughout Phase II, leading to laboratory stack tests and field tests for down-selected Phase II membranes along with a detailed production cost analysis.

Commercial Applications and Other Benefits: Success of this work would be a significant step toward clean energy production in two of the largest energy markets, transportation and stationary power. The development of more efficient fuel cells would result in a reduced dependence on fossil fuels and the associated economic, political and environmental issues related to their extraction, refinement, supply and final use.

Member of Congress Summary: Hydrogen fuel cells are one of the most promising technologies for renewable clean energy production, however current membrane components fall short of critical cost and performance targets. New custom membrane materials will be developed to address current performance and cost requirements and enable broader commercialization of high performance fuel cells.

Key Words: Fuel Cell, Proton Exchange Membrane, Polymer Electrolyte Membrane, Hydrogen, Ionomer, Clean Energy.