386d High Temperature Proton-Exchange Membranes for Fuel Cells

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In recent years, great progress has been made on the development of proton-exchange membrane fuel cells (PEMFCs) for both mobile and stationary applications, especially for fuel cell cars. Dupont's Nafion® or other perfluorinated sulfonic acid membranes are currently popular membranes for low temperature PEMFCs due to their good proton conductivity, mechanical strength and chemical stability. However, some disadvantages, such as high cost, low proton conductivity at high temperatures (above 100^{o}C), and strong dependence on humidity, have seriously limited the industrial application of these membranes. It is desirable for a PEMFC to operate at high temperatures (above 120^{o}C) and low humidities (about 30%). High temperature operations can increase the anode's tolerable level of CO in the fuel and accelerate the reaction rates at the anode and cathode. Thus, it is necessary to develop alternative membranes that have low cost and good performance at high temperatures.

Sulfonated polyimides (SPIs) are promising materials for high temperature PEMs because of their many desirable characteristics including excellent mechanical and thermal properties as well as chemical stability. In the present study, novel proton-exchange membranes were synthesized from the sulfonated polyimide copolymers. Hydrophilic soft segments of oligomeric aliphatic polyester were copolymerized into the SPIs system to increase the water retention of the membrane at high temperatures and low humidities. The novel SPI membranes synthesized have exhibited good thermal stability, comparable proton conductivity to Nafion at low temperature (70^{o}C) and high humidity (RH = 100%), and better conductivity than Nafion at high temperature (160^{o}C) and low humidity (RH = 12%). In addition, the materials for the membrane preparation are all very cheap in comparison with those for perfluorinated membranes. Thus, this kind of membrane can be much more cost-effective than Nafion.