POLY(ETHER SULFONE) - PROTON CONDUCTING POLYMERS FOR HIGH TEMPERATURE FUEL CELLS

Hungoo Cho, Youngkyu Chang, Zijie Lu, Mindaugas Rackaitis, Evangelos Manias, and Digby Macdonald

Department of Materials Science and Engineering
Pennsylvania State University
University Park, PA 16801

Due to its potential application for polymer electrolyte membrane fuel cells (PEMFC), Polyethersulfone (PES) has recently attracted a strong research attention [1,2]. The commercial PESs show good conductivities up to 120°C, but the mechanical properties deteriorate above 130°C, namely, the polymer film either completely dissolves or degrades in presence of water. For this reason, partial fluorination of Poly(arylene ether sulfones) (F-PES) was explored for stabilizing the polymer for use as a high temperature (>100°C) proton exchange polymer electrolyte membrane in advanced fuel cells. The base polymers were synthesized by polycondensation of hexafluoroisopropyliden diphenol, isopropyliden diphenol, and 4-fluorophenylsulfone. The degree of fluorination was controlled by the amount of 4-fluorophenylsulfone added, and two kinds of polymers were prepared in this work. The fabricated polymers were sulfonated to various degrees and thin membranes were prepared by solution casting. Diverse tests have been carried out to characterize the membranes in terms of thermal stability, ion-exchange capacity, water uptake and proton conductivity, as a function of relative humidity (R.H) at high temperatures. According to the thermogravimetric analysis, all sulfonated polymers were found to be thermally stable up to 250°C and the ion-exchange capacity varies from 0.9 to 1.78meq/g. The experimental results show that water uptake and proton conductivity depend in a complicated way on the combination of fluorination and sulfonation in the F-PES polymer. In particular, the highly sulfonated membranes exhibited the conductivity comparable to Nafion 117® under the same conditions of temperature and relative humidity (Figure 1).

The partially fluorinated PES described in this study shows reasonable promise as a candidate proton exchange membrane for high temperature PEM fuel cells, because it is possible to optimize the proton conductivity while maintaining the desired thermal stability and moderate swelling by controlling the degrees of sulfonation and fluorination.

The authors gratefully acknowledge the support of this work by the US Department of Energy (Contract No. DE-FC04-02AL67608 through a Subcontract from International Fuel Cells (Subcontract 3540OB).

1. A. Noshay, L.M. Robeson, J. Appl. Polym. Sci., 20, 1885 (1976)
2. J. Kerres, W. Cui, S. Richie, J. Polym. Sci., 34, 2421 (1996)

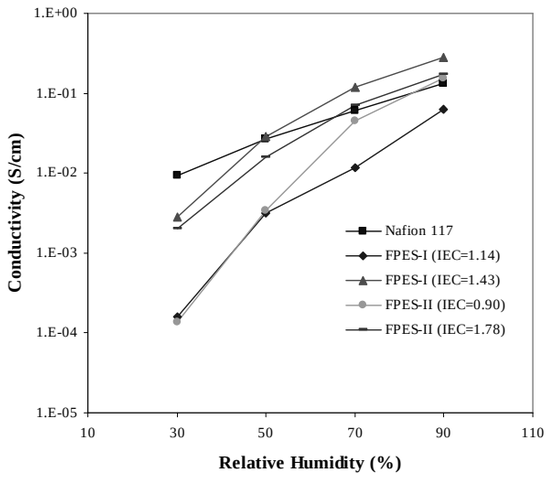

Fig.1 Comparison of the conductivity between Nafion 117 and sulfonated F-PESs, obtained by four probe method at 120°C (FPES-I : 50mol% fluorination, FPES-II : 30mol% fluorination)