Nafion Modified by Self-Assembled Polyaniline Multilayers for Liquid Feed DMFC

Yongku Kang[1,*], Dong Wook Kim[1], Jeongdon Kwon[1], Sunmi Park[1], Jong-Ho Choi[2], Yung-Eun Sung[3]

[1]Advanced Materials Division, Korea Research Institute of Chemical Technology, Daejeon, 305-606, Korea
[2]Department of Material Science and Engineering Gwangju Institute of Science and Technology, Gwangju 500-712, Korea
[3]School of Chemical Engineering, Seoul National University, Seoul, 151-742, Korea
(*email: ykang@krict.re.kr)

Introduction

The liquid feed direct methanol fuel cell (DMFC) is one of the promising candidates for the high energy density portable power source. However, methanol crossover the membrane must be overcome to develop a practical DMFC. The transported methanol through the membrane is oxidized by oxygen at the cathode leading to a significant decrease in cell potential and fuel efficiency. Development of new polymers as a proton conducting electrolytes in direct methanol fuel cells (DMFCs) is one of major topics of current research [1-3].

Nafion, a perfluorosulfonate membrane developed by DuPont, has been commonly employed in the fuel cell membranes owing to good chemical and thermal resistance and ionic conductivity. But, Nafion membrane is subject to serious methanol crossover, many researchers have studied on modification of the Nafion membranes.

In this work, we modified the Nafion membrane by depositing a very thin polyaniline multilayes on the membranes by means of self-assembly technique, in order to enhance the resistance to the methanol transport and the surface electronic conductivity.

Results and Discussion

The sulfonated polyaniline was alternately deposited with the cationic polyelectrolyte (partially doped polyaniline) and anionic polyelectrolyte (sulfonated polyaniline) on the Nafion films by means of the layer-by-layer self-assembly [4]. The multilayers were linearly build-up with the number of deposition cycles, which were monitored with UV/Vis absorption spectroscopy as shown in Figure 1. The methanol permeability of the Nafion membranes deposited with 10-bilayer of polyaniline was determined using a permeation cell, which consisted two compartments separated by proton conducting membrane. The methanol concentration in the receiving compartment of the permeation cell was measured by gas chromatography. Only 10 bilayer of polyaniline modified Nafion reduced ca. 30% of the methanol permeability compared with that of pristine Nafion. The methanol permeability was measured to be 1.2×10^{-6} cm^2/s.

The performance of the DMFC unit-cell was tested at 30 ^oC and 70 ^oC. Polarization curves and power densities at 30 ^oC are shown in Figure 2. The maximum power density of the unit-cell using polyaniline modified Nafion increased about 35% compared to that using pristine Nafion when 5M methanol was used as a fuel.

References

1. J.A. Kerres, *J. Membr. Sci*., **185** (2001) 3.
2. V. Tricoli, *J. Electrochem. Soc.*, **145** (1998) 3798.
3. B.S. Pivovar, Y. Wang, and E.L. Cussler, *J. Membr. Sci.*, **154** (1999) 155.
4. D.W. Kim, A. Blumstein, J. Kumar, L.A. Samuelson, B. Kang, and C. Sung, *Chem. Mater*., **14** (2002) 3925.

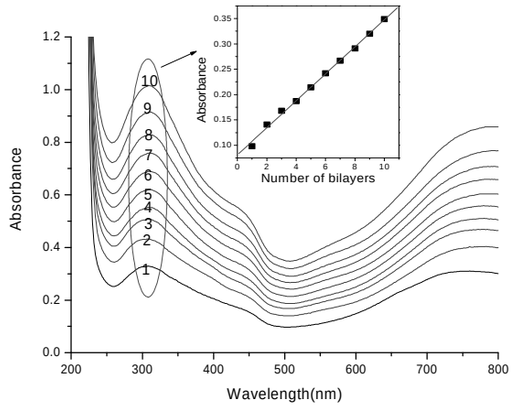

Figure 1. The absorption spectra of multilayered polyaniline modified Nafion films as a function of the number of bilayers.

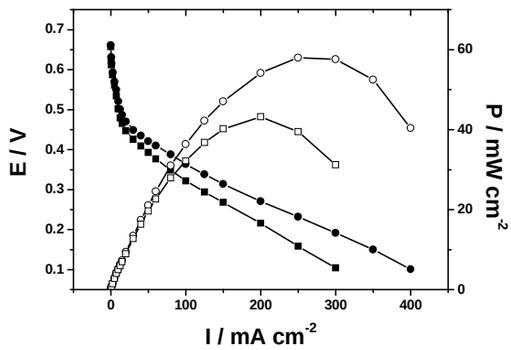

Figure 2 DMFC unit-cell performances using polyaniline modified Nafion (circle) and pristine Nafion (square). The cell operating temperature was 30 ^oC. Methanol concentration was 5 M.