일반강연 A-5

술폰화 폴리스틸렌-디비닐벤젠/테플론 복합막의 연료전지 특성연구

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Sulfonated Poly(styrene-divinyl benzene)/PTFE Composite Membranes for Fuel Cell

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1. Introduction

Proton-exchange membranes have attracted much attention in the past few decades due to their important application in fuel cell systems. The mainly used proton-exchange membranes are perfluoropolymers such as DuPont's Nafion® and Asahi Chemical's Aciplex® because of their high performance including high proton conductivity & mechanical strength, and excellent thermal & chemical stability. However, some weakness such as high preparation cost, low conductivity at high temperature, and high methanol permeability limits severely their practical application. Therefore, many efforts have been done for the development of membrane materials of low-cost and high performance. Composite

membranes would be good candidates to substitute for the perfluoropolymer membranes because they can reduce cost & methanol permeability, and enhance mechanical & electrochemical properties. The composite membrane 'Gore-select®', where Nafion® solution is impregnated in porous polytetrafluoroethylene(PTFE), can be an excellent example. It can be an alternative way to develop the new composite-type membranes containing less expensive fluorine-free or partially fluorinated materials. Accordingly, there are many reports about this type of composite membranes. In this study, we prepared sulfonated polystyrene-divinyl benzene (PS-DVB/PTFE) composite membranes and studied their performance for fuel cell application.

2. Experimental

Porous PTFE membrane was used as a support material for sulfonated PS-DVB/PTFE composite membrane. Styrene, divinyl benzene(DVB) and AIBN were used as a monomer, a crosslinker and initiator, respectively. PTFE membrane was impregnated with different ratios of styrene-divinyl benzene monomer mixtures and polymerized with the aid of PET film and a specially designed reaction vessel. Then, sulfonation was conducted with mixture of chlorosulfonic acid and 1,2-dichloroethane to give the composite membranes. The chemical and physical structures of the composite membranes were characterized by FT-IR and SEM. Ion exchange capacity(IEC), ion conductivity and methanol permeability were studied as functions of weight ratio of styrene/DVB.

3. Result & Discussion

Methanol permeability and ion conductivity of sulfonated PS-DVB/PTFE composite membranes were measured as a function of the ratio of styrene)/DVB and were compared with Nafion®117. The methanol permeability decreased with decreasing the ratio of styrene/DVB because of higher crosslinkng and lower sulfuric acid

groups($-SO_3^-H^+$) formed in the pores of composite membranes. As shown in Fig. 1, the value of methanol permeability of the membranes prepared were 4.4×10^{-7}, 3.7×10^{-7}, 1.3×10^{-7}, and 1.0×10^{-7}㎠/s according to the ratio of styrene/DVB of 95/5, 93/7, 90/10, 85/15 wt.%, respectively. As Nafion®117 showed 1.02×10^{-6}㎠/s, methanol permeability of all the composite membranes were much lower than that of Nafion®117, presumably due to the chemical structure difference. As shown in Fig. 2, ion conductivity decreased with decreasing the ratio of styrene/DVB, like the methanol permeability behavior. The value of ion conductivity of the membranes were 0.11S/cm(25℃), 0.09S/cm(25℃), 0.09S/cm(25℃), and 0.08S/cm(25℃) according to the ratio of styrene/DVB of 95/5, 93/7, 90/10, 85/15 wt.%, respectively, which are higher than that of Nafion®117(0.0824S/cm).

4. Conclusions

The sulfonated PS-DVB/PTFE composite membranes with different ratio of styrene/DVB were synthesized successfully. The composite membranes developed showed lower methanol permeability and higher ion conductivity than Nafion®117.

5. Reference

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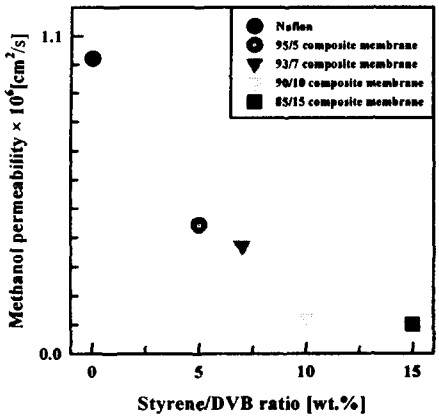

Fig. 1 Methanol permeability of SPS-DVB/PTFE composite membranes as a function of the ratio of styrene/DVB.

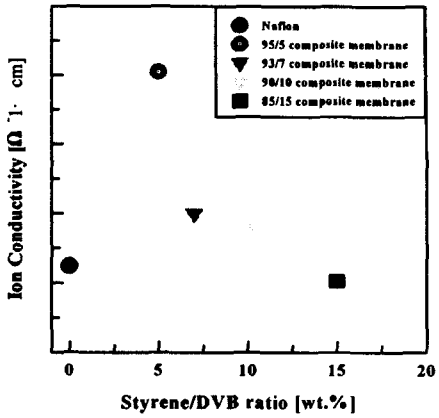

Fig. 2 Ion conductivity of SPS-DVB/PTFE composite membranes as a function of ratio of styrene/DVB.