Cell Performances and Properties of Nafion/Silica Composite Membranes

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INTRODUCTION

Making a composite membrane has been attracting much attention mainly hoping for improving the properties of the conventional perfluorosulfonic acid membrane[1)].

In this study, we evaluated water transport properties of Nafion/silica composite membranes and their MEA performances with high or low humidification. We also measured the mechanical properties of the composite membranes.

EXPERIMENTAL

Nafion/silica composite membranes were prepared by a sol-gel method[2)]. Firstly a Nafion (Du Pont N112) membrane swelled with 67vol% 2-Propanol/water was soaked in 25vol% Tetraethoxysilane/2-Propanol. Then it was vacuum-dried at room temperature overnight and at 130°C for 2hours.

After assembling MEAs, cell performances were evaluated at 80°C with high or low humidification(the bubbler temperatures:Air/H_2=50/85°C or 30/70°C).

The water diffusibilities and electro-osmotic drag numbers were measured separately.

The viscoelasticity and the creep characteristics were also evaluated.

RESULTS AND DISCUSSION

The silica content of the obtained composite membrane was about 10wt%.

The cell performances with low humidification are shown in Fig.1. The composite MEA keeps high voltage, while the Nafion MEA shows decreasing voltage because of dry-up of the membrane.

Fig.2 shows the flux of water diffusion when liquid water was supplied to one side while a dry gas to the other. The composite membrane has a higher water diffusion flux than the Nafion. The composite membrane also showed a lower electro-osmotic drag number. Promoting the water transport from the cathode to the anode, these two properties of the composite membrane created the MEA performance difference at the low humidification.

The composite membrane showed far less creep elongation than Nafion as shown in Fig.3.

From these results, the Nafion/silica composite membrane seems to have better properties for the fuel cells operated at higher temperature with no or low humidification. A network structure of silica in the ionic channel of Nafion seems to change the water transport properties and reinforce the membrane simultaneously.

REFERENCES

1. M. Watanabe, H. Uchida, Y. Seki, M. Emori and P. Stonehart, J. Electrochem. Soc., **143**, 3847 (1996)
2. K. A. Mauritz and R. M. Warren, Macromolecules, **22**, 1730 (1989)

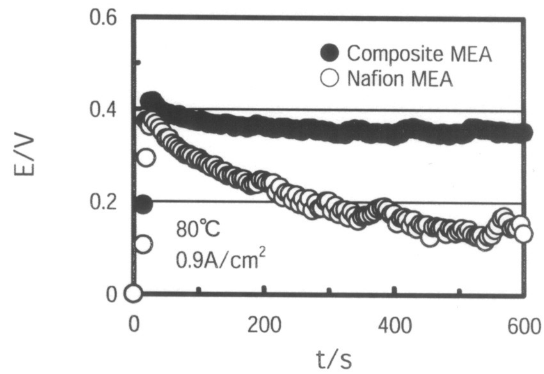

Fig.1. Cell performances with low humidification (the bubbler temperatures:Air/H_2=30/70°C)

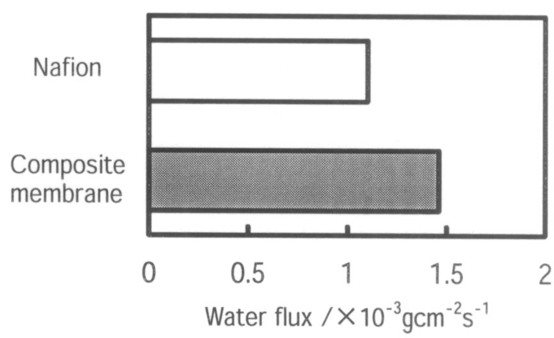

Fig.2. Flux by water diffusion

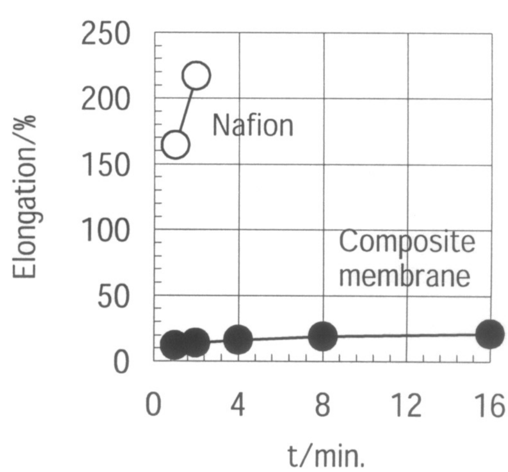

Fig.3. Creep properties at 160°C