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The system design of membrane-electrode-assembly for anion exchange membrane fuel cell

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1.　Introduction

Polymer electrolyte fuel cells (PEFCs) are rapidly developed by using proton exchange membrane, especially Nafion. However it still depend grievously on noble metal catalysts, typically Pt. the benefits of alkaline fuel cells (AFCs) are enumerated as that non-noble metal catalysts, such as Ag could be used in order to enhance electro-kinetics and reduce the cost of MEA. However carbonate precipitation will happen and cause the degeneration of MEA. Combining the advantages of AFCs and PEFs, anion exchange membrane fuel cells (AEMFCs) have been developed recently. It is reported that the performance of AEMFCs immersed in liquid fuel approached near to that of PEFCs [1], however considered the fuel permeation, gas fuel was preferred. In contrast to PEFCs, water is reacted in cathode and generated in anode. Water behavior in membrane reflects the significance of MEA, however the properties of membrane, such as electro-osmosis coefficient and water diffusion coefficient have not reported [2].

Our study is to establish of AEMFCs system design methodology, propose the optimal MEA, and clear the mechanism of water behavior in MEA by combining of both modeling and experimental approaches.

In this study, pore-filling membrane was designed as the anion exchange membrane to control water movement through membrane, and fuel cells performances were tested.

2.　Experimental method

2.1. Permeability and conductivity of anion exchange pore-filling membrane

3-trimethylammonium propyl methacrylamide chloride (MAPTAC) was filled in pore-substrate and co-polymerized with acrylamide in different ion exchange capacity, followed by methanol and $H_2^{18}O$ permeability analysis. The OH- conductivity with different humidity was tested by impedance.

2.2. Fuel cell performances test

Carbon-supported Pt catalyst powder was used as the catalyst for both anode and cathode. Poly (vinylbenzyl chloride) (p-VBC) was used as the electrolyte polymer. The humidified H_2 and O_2 were supplied to the anode and cathode sides with flow rates of 100 and 500 ml/min, respectively. And cell temperature was 50℃.

3.　Results and discussion

3.1. Permeability and conductivity of　membrane

Anion exchange membranes (AEMs) exhibit a lower methanol and $H_2^{18}O$ permeability alongside Nafion-117. The permeability was also affected by
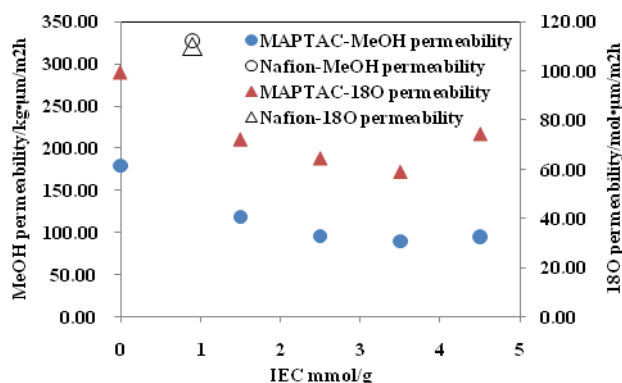

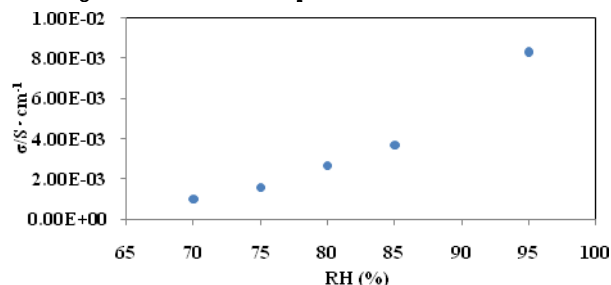Fig.1. Methanol and $H_2^{18}O$ permeabilities with different IEC

Fig.2. OH- conductivity with humidity

IEC both methanol and $H_2^{18}O$ because of the different degree of swelling (Fig.1.).

OH- conductivity was influenced by humidity remarkably which was tested by using MAPTAC membrane (IEC=4.5mml/g) (Fig.2.).

3.2. Result of I-V performance

Based on the pore-filling membrane, the current density of AEMFCs approached to 200mA/cm². The performance test of AEMFCs was successful. The cell performance could be controlled by membrane properties.

[1] O. Savadgo, et al., *Electrochem.　Com.* **2**(2000)697

[2] J.R.Varcoe, et al., *J. Phys. Chem. B* **110**(2006)21041

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