

O214 Influence of ionomer content in catalyst layers on the performance of passive DMFC

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1 Introduction

The explosive growth of portable and wireless consumer electronics has spurred the development of new power source technologies having increased power and energy density. Micro-direct methanol fuel cells are a primary solution to these increased demands because of its high theoretical energy density and ease handling. The reaction and the mass transport as well as ohmic over-voltages of the DMFC are affected by the ionomer content in the catalyst layer where the ionomer prepares the active reaction sites; the so-called three phase boundary, also the addition of the ionomer affects the mass transport. Under passive conditions, the resistance to mass transport was very high in comparison to that in the active cells. The optimum ionomer content is expected to be lower than that under the active conditions to enhance the mass transport. This study has been carried out to clarify the optimum ionomer content in a passive DMFC using the black catalyst, Pt Ru at the anode, Pt at the cathode.

2 Experimental

Catalyst ink was prepared by dispersing an appropriate amount of the black catalyst in a solution of de-ionized water, isopropyl alcohol, and a 5wt% Nafion solution (Wako, Inc.). The ink was then precipitated on the surface of the carbon cloth with the MPL using a micropipette to form the catalyst layer. The catalyst loading was around 4 mg/cm^2 in each electrode. For the anode, five different electrodes containing 10, 15, 20, 30 and 40wt% of the ionomer were prepared while the ionomer content in the cathode catalyst layer was fixed at 30 wt%. For the cathode, four different electrodes containing 10, 15, 20 and 30wt% of the ionomer were prepared and the ionomer content in the anode catalyst layer was fixed at 20wt%. MEA fabrication and apparatus used were described in our previous reports [1,2]

3 Results and Discussion

Based on the CO stripping area, both the ECSA and the catalyst utilization were calculated and plotted versus the

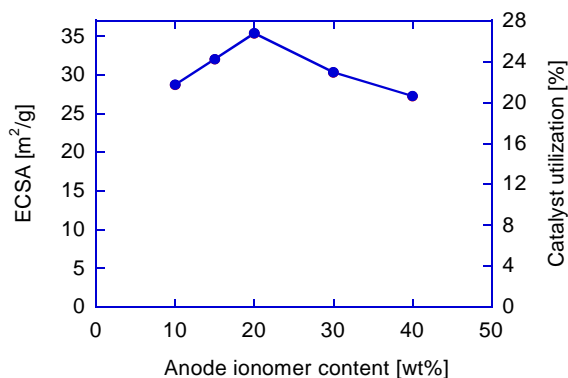


Fig. 1 The effect of the ionomer content on the ECSA and the catalyst utilization of the different anodes.

ionomer content as shown in Fig. 1. The electrode with 20wt% ionomer had the highest ECSA and the highest

catalyst utilization. With the increasing ionomer content from 10 to 20wt%, the contact between the catalyst and ionomer increased, therefore, the apparent proton conductivity of the catalyst layer increased, and more catalyst contributed to the electrochemical reaction thus the ECSA increased and the catalyst activity increased. At the higher ionomer content of 30 wt% or 40wt%, the ionomer forms a thick layer on the catalyst agglomerates thus the access of the reactants or the products to or from the catalyst active reaction sites decreased, therefore, the ECSA and catalyst utilization decreased.

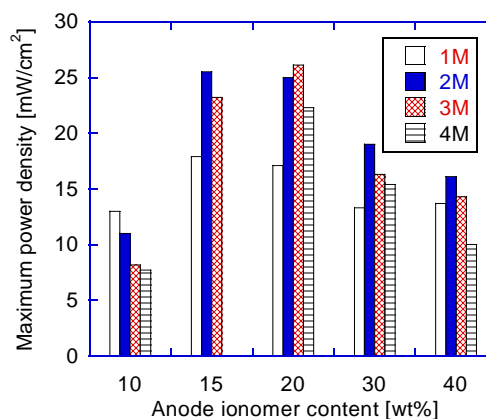


Fig. 2 The effect of the ionomer content in the anode catalyst layer on the maximum power density at different methanol concentrations.

Fig. 2 shows the maximum power density of each methanol concentration versus the ionomer content. It was clear from the figure that the highest power density of 26.5 mW/cm^2 was obtained with 20wt% at 3M, and the optimum methanol concentration was varied from one MEA to another in which it was 1M at 10wt%, 2M at 15wt%, 30wt%, and 40wt% and 3M at 20wt%. The variation in the optimum concentration with the changing ionomer content would be related to the different resistances of the anodes to the methanol transport. At the low ionomer content, large size secondary pores formed between the catalyst agglomerates, therefore, methanol easily transported to the electrolyte membrane and a high MCO took place. With the increasing ionomer content, the catalyst dispersion improved and the size of the secondary pores significantly decreased therefore, MCO decreased.

Summary

Under passive conditions, the effect of the ionomer content on the mass transport was very critical for the cell performance and greater than that of the ECSA. The optimum ionomer content, 20wt%, in the anode and cathode were lower than those used in the active cell

References

- [1] M. A. Abdelkareem, N. Nakagawa, J. Power Sources 165 (2007) 685-691.
- [2] M. A. Abdelkareem, N. Morohashi, and N. Nakagawa, J. of Power Source 172 (2007) 659-665.

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