Characterization of MEAs fabricated by a carbon support with the nano-channel structure

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Introduction

Polymer electrolyte fuel cells (PEFCs) have been paid great attention for practical application of FCVs in 2015. However, PEFCs have some problems to be solved, such as improvement of cost and durability. In our laboratory, Mesoporous Carbon (MC) with the nano-channel structure whose diameter is ca.10 nm has been developed and Pt catalysts were successfully deposited into the pores of MC. Half-cell evaluation of Pt deposited MC (Pt/MC) indicated that its ORR activity and durability was improved comparing to conventional Pt deposited carbon black[1]. Therefore, the objective of this research is to develop MEAs with Pt/MC and evaluate its performance toward practical use.

Experimental

Pt deposited electrode catalyst materials were synthesized by platinum (Ⅱ) acetylacetonate as a precursor. Two types of carbon materials, MC (made in our lab) and vulcan carbon black (purchased), were used in this study, and named as Pt/MC and Pt/VC, respectively. Percent of Pt on the carbon was controlled around 30%.

In regard to MEAs, small MEAs with a diameter of 8 mm were made as shown in Fig.1. The dispersion, composed of electrode catalysts and Nafion®, was spray-printed on the surface of Nafion® membrane, followed by hot-pressing carbon paper on both sides. Here, Pt amount each side was kept as 0.3 mg/cm^2. By controlling mixing methods and the ratios of Nafion® and catalysts, the effect of IV characteristics was examined.

Results and Discussion

In case of MEAs with same Nafion® ratio (28 wt%), IV performance was rather lower for Pt/MC than for Pt/VC. SEM observation revealed that gas channels were not enough formed as indicated in Fig.2a, which probably prevented essential mass transfer within the MEA. Decreasing amount of Nafion® to 14wt% led to improvement of its structure in Fig.2b, even though optimization of Nafion® amount is further essential for sufficiently exhibiting the performance.

During the evaluation of MEAs with Pt/MC, we found that existence of water in MEAs affected very much even though the nano-channels themselves were hydrophobic. We thought that this was due to hydrophilic properties of the MC particle surface, which was derived from ball-milling of MC. Therefore, by making more hydrophobic surface through the heat treatment, successful water drain was attempted. As a result of this approach, IV performance was improved. Effects of mixing methods of electrocatalyst dispersion and conditioning requirements before IV measurements are also reported.

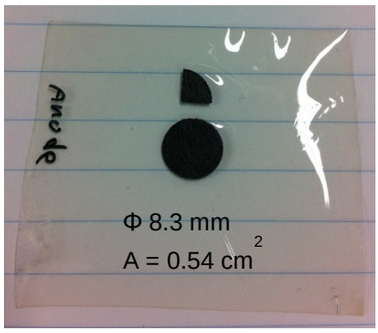
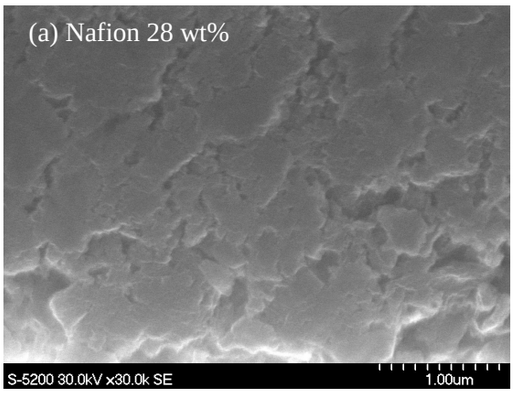


Fig.1 A photograph of a MEA made in our lab



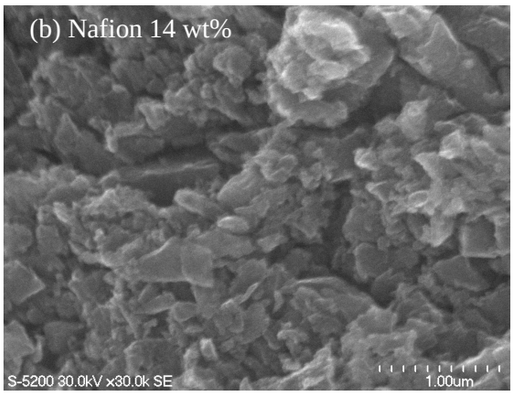


Fig.2 SEM images of the cross-section at the cathode of MEAs fabricated by Pt/MC with different amount of Nafion® : (a) 28 wt% and (b) 14 wt%

[1] Hayashi, A., et al., J. Phys. Chem. C, **2009** 113(28) 12149.