Electrochemical detection of methanol electrooxidation product generated at Pt/C micropowders by using a porous/disk-dual microelectrode

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Investigating a methanol electrooxidation mechanism, i.e., study of reaction intermediates is indispensable to improve the direct methanol fuel cell (DMFC) performance. Electrochemical detection of the intermediates using an interdigitated Pt microarray electrode has been recently reported. However, there has been no report detecting the intermediates generated at powder Pt/C catalyst used in commercial DMFCs, based on electrochemical techniques. In the present study, we have constructed a new electrode of porous/disc-dual microelectrode (P/D-ME) that combines features of porous microelectrode (PME) and dual microelectrode. By using the P/D-ME, a reaction intermediate of methanol electrooxidation at the Pt/C and Pt-Ru/C catalysts was detected.

P/D-ME has Au generator (φ 50 μm) and Pt collector (φ 50 μm) electrodes at the tip. Au and Pt wires were separately inserted into a theta glass capillary, and heat-sealed by decompressing the glass inside. After polishing the tip of the electrode, Au electrode was etched in 1M HCl, resulting in a 20μm-depth cavity for the Pt/C powder catalyst. After packing the Pt/C Powder in the cavity (see Fig. 1), current-potential (I-V) curves were measured in 5M CH3OH + 0.1M H2SO4 solution by utilizing a dual-potentiotstat. For the electrochemical measurement, a Pt foil and an Hg/Hg2SO4 were used as a counter electrode and a reference electrode, respectively.

Figure 2 demonstrates I-V curves of methanol electrooxidation at the P/C-containing P/D-ME. The generator current response well reproduces that reported at the PME filled with Pt/C. Therefore, the current peak at the generator of Fig. 2 stands for a methanol electrooxidation. As seen in Fig. 2, when the collector potential is fixed at –700 mV vs. Hg/Hg2SO4, the most clear current response at the collector corresponding to the generator current is observed. When we take the result of Pt microarray electrode into account, the observed collector current will represent an electroreduction of protons produced by methanol oxidation at the P/C generator. We will also discuss the methanol electrooxidation mechanism from potential-dependent collection efficiency.

References