EFFECT OF TiO_2 ADDITION TO THE ANODE OF DIRECT METHANOL FUEL CELL

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INTRODUCTION

Pt-Ru alloy is commonly used as an anode for direct methanol fuel cell (DMFC). It is well known that CO poisoning is prevented by a bifunctional mechanism of this alloy, which the water is activated by Ru and CO is oxidized on a neighboring Pt atom[1]. Since TiO_2 exhibits high hydrophilicity, it is expected to enhance this mechanism by adsorbing water adjacent to the reaction site. The elementary process can be clarified by investigating the polarization dependence of AC impedance spectrum[2]. The effect of TiO_2 addition to the anode of DMFC was studied.

EXPERIMENTAL

Pt-Ru/C was used for the anode and Pt/C was used for the cathode. The mixture of catalyst, butyl acetate and Nafion solution was painted on the carbon paper. TiO_2 sol was spincoated in between the anode layer. The painted carbon paper was cut and hot pressed to the electrolyte membrane. Electrodes with the same dimension as the working electrode were positioned on both sides of the electrolyte as tentative reference electrodes.

The cell was set in an apparatus and was located in a thermostatic oven. Methanol and water were mixed and supplied to the reactor in vapor phase. Current density vs. terminal voltage was measured using a potentiostat. Voltage between the working and the reference electrodes on each side was also measured. AC impedance was measured with a potentiostat and an impedance analyzer.

RESULTS

Figure 1 shows the overpotential vs. current density of the anodes with various TiO_2 content. The overpotential of the anode with 8% TiO_2 showed the lowest overpotential. To clarify the electrode process, AC impedance was measured. The spectrum of the anodes were deconvolved into two semicircles using an equivalent circuit program. Each semicircle represents a reaction step with a different time constant. The dependence of the interfacial resistance of the anode to the TiO_2 content in the low frequency range and the high frequency range are shown in Fig. 2 and 3. The low frequency range process is related to an electrochemical reaction process, and the high frequency range process is related to a proton conduction process[2]. At 0mV, the interfacial resistance of the anode with TiO_2 addition is lower than that without TiO_2. However, at 240mV, the interfacial resistance of the anode with 12 and 16% addition is higher than the others. This indicates that the addition of TiO_2 enhances the anodic reaction but an excess addition of TiO_2 suppresses the anodic reaction.

ACKNOWLEDGEMENTS

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[2] H. Fukunaga, T. Ishida , N. Teranishi , C. Arai and K. Yamada, Electrochimica Acta, 49 (2004) 2123

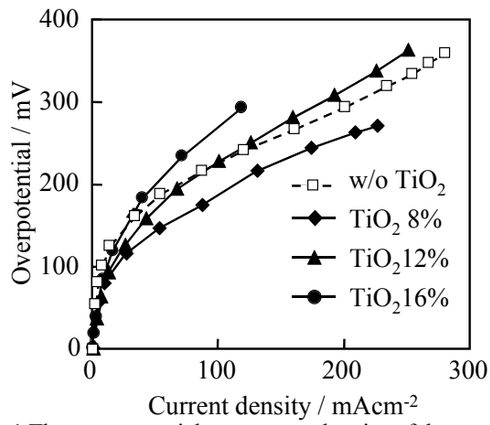

Fig.1 The overpotential vs. current density of the anodes with various TiO_2 content.

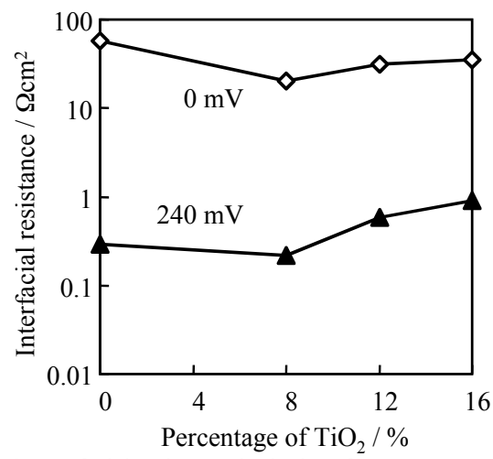

Fig. 2 Interfacial resistance in the low frequency range as a function of TiO_2 content at 0mV and 240mV.

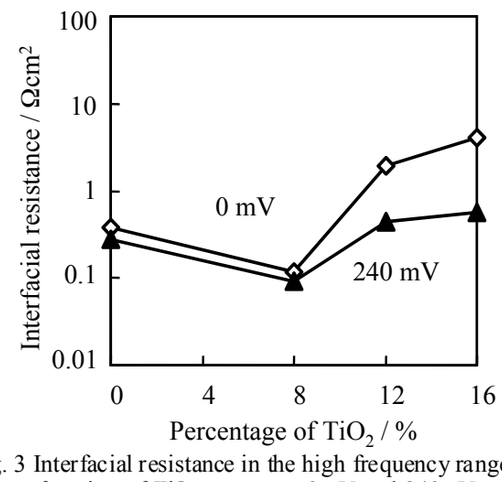

Fig. 3 Interfacial resistance in the high frequency range as a function of TiO_2 content at 0mV and 240mV.