ELECTROCHEMICAL INVESTIGATION OF DIRECT FORMIC ACID FUEL CELL

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Direct methanol fuel cell suffers from two major disadvantages: the high methanol crossover through the Nafion-based membrane and low catalytic activity. The replacement of methanol by formic acid is an alternative way to improve the fuel cell's performance. Compared with methanol, formic acid is less poisoning to Pt-based electrocatalysts and can reduce fuel crossover by the repulsive effect of the anionic sulfate groups within the membrane. [1]

Electro-oxidation of formic acid on platinum surface has been studied extensively in the past decades. However, most of these studies were conducted using conventional electrochemical methods, which may not adequately describe the multiple processes with different time constants. Electrochemical impedance spectroscopy (EIS) based technique, on the other hand, allows for the separation of different rate processes at different frequency domains and therefore is used for the identification of reaction mechanism in this work.

Experiments were first conducted to examine the crossover current of formic acid through Nafion 115 membrane as a function of temperature in a 5 cm^2 single fuel cell test station. The result (Fig. 1) shows a much smaller crossover current for formic acid, and the increase of the crossover current with temperature is also not as significant as the methanol one. Detailed electrochemical impedance measurements were then conducted using rotating disk electrode to investigate the potential effect on the impedance pattern of formic acid oxidation on Pt/C surface. It can be seen from Fig. 2 that impedance patterns show different potential dependence at different potential range, as a result of changes of the surface coverage and rate-determining step. An impedance model based on kinetics analysis was developed to qualitatively simulate the impedance patterns, through which, the possible reaction mechanism that can agree with the experimental observation is proposed.

References

[1]. M. Weber, J. T. Wang, S. Wasmus, and R. F. Savinell, J. Electrochem. Soc. 143 (1996) L158.

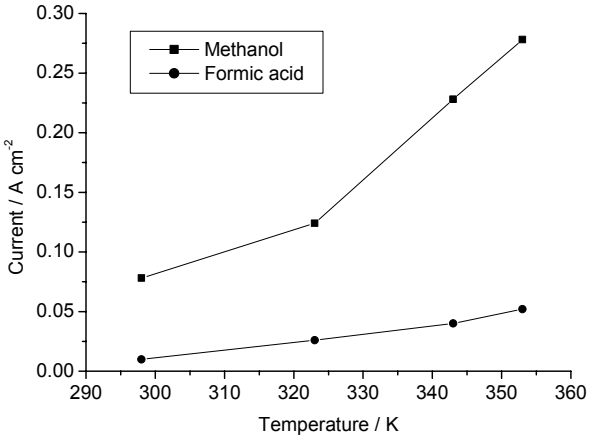

Fig.1 Crossover current for formic acid and methanol through Nafion 115 membrane as a function of temperature.

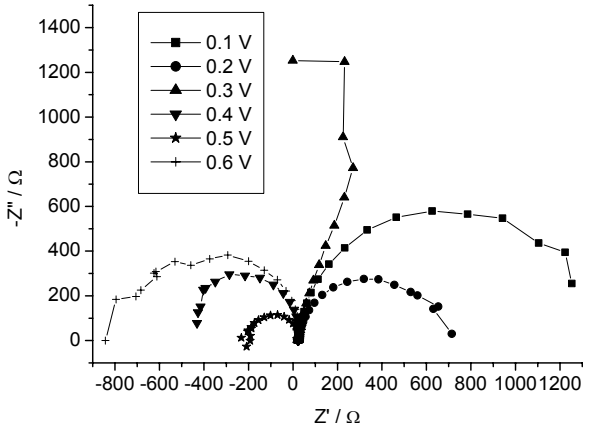

Fig. 2 Experimental impedance plots for formic acid oxidation on Pt/C as a function of potential.