Investigation of CO-Tolerance of PEMFC at Elevated Temperature and Ambient Pressure Conditions

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The proton exchange membrane (PEM) fuel cell is an efficient electrical power source when using hydrogen as the fuel. However, practical use of the PEMFC is impeded by deactivation of the Pt based anode electrocatalyst by trace levels of carbon monoxide (CO). Such traces are present in the H_2 feed stream from hydrocarbon reforming even after a preliminary purification step.

Presently, most efforts to solve this problem use alloyed catalysts that have better CO tolerance than Pt. Under low temperature conditions, a serious performance drop still occurs even when using the best Pt-Ru alloy catalyst[1][2].

Since CO adsorption on the catalyst is an exothermic reaction, CO coverage on the catalyst decreases with rising temperature. More catalytic sites are available for hydrogen adsorption and oxidation, and CO tolerance of the catalyst will be enhanced at elevated temperature (>100ºC)[3]. However, the high resistance of the popularly used Nafion® membrane due to dehydration prevents the investigation of CO polarization at elevated temperature and atmospheric pressure (low relative humidity) conditions. Recently, a Nafion®-Teflon®-$Zr(HPO_4)_2$ composite membrane with low resistance has been developed at the University of Connecticut for elevated temperature and atmospheric pressure operation. Experimental results indicate that at 105ºC (1atm) and 120ºC (1atm) operating conditions, cell performance loss due to the presence of CO is reduced dramatically compared to operation at 80ºC, demonstrating improved CO tolerance.

In this work, CO tolerance of Pt-Ru/C (ETEK, wt40%, Pt/Ru=1/1) at elevated temperature and ambient pressure conditions was studied using a complete single cell. Hydrogen was fed to the cathode (Pt/C) which served as both a reference and counter electrode, and a mixture of hydrogen and carbon monoxide was fed into the anode (Pt-Ru/C). Anode polarization was measured on the MEA at 80ºC, 105ºC and 120ºC with 1 atm system pressure. Figure 1 shows anode polarization data at 80ºC. Electrochemical impedance spectra studies of electro-oxidation of H_2 and H_2/CO mixtures on the Pt-Ru/C electrode was also performed at the same conditions.

Reference:

1. Ruichun Jiang, Yongchao Si, H. Russell Kunz, James M. Fenton, 2002 ECS and ISE Joint International Meeting, Salt Lake City, UT, USA, Oct. 20-24, 2004.

2. C. He, H. Russell Kunz, and James M. Fenton, *J. Electrochem. Soc*., in press.

3. Shimshon Gottesfeld , Tom A. Zawodzinski, Polymer Electrolyte Fuel Cells, Advances in Electrochemical Science and Engineering, Vol. 5, 1997, WILEY-VCH.

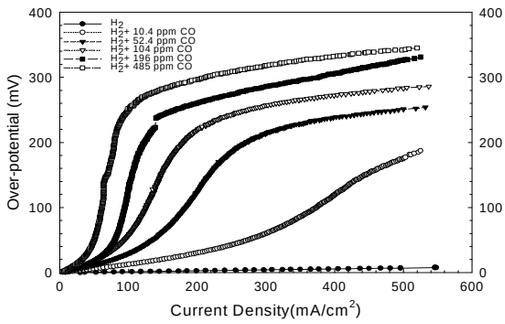

Figure 1. Hydrogen Polarization of 40% wt Pt-Ru/C (Pt/Ru = 1/1) with H_2 containing CO (0 to 485 ppm) at 80 °C (100% R.H.).