Anode Pressurization of PEM Fuel Cells at Elevated Temperatures

H. Xu, H. R. Kunz, J. M. Fenton
Department of Chemical Engineering
University of Connecticut
Storrs, CT 06269, USA

PEM fuel cells operated at elevated temperatures (120 - 150 ^{o}C) can greatly alleviate CO poisoning [1]. However, at elevated temperature and ambient pressure, the cells must be operated at low relative humidity (RH), which significantly increases membrane and electrode resistance. To operate PEM fuel cells at elevated temperature and high RH, extra work is needed to pressurize the anode and cathode reactant gases. This will decrease the efficiency of the PEM fuel cell system. However, a hydrocarbon-fuel processor in series with a PEM fuel cell can produce reformed gases at high pressure with a high relative humidity without compression of gasses. The water in the anode compartment will transport through the membrane and into the cathode structure decreasing the cell resistance. The purpose of this work is to study the effect of anode pressurization on the cell resistance and performance for pure hydrogen and for simulated reformate.

In this study, commercial Pt supported on carb (Tanaka, 46.6wt%) was used for the cathode catalyst a Pt-Ru black (Alfa Aesar, 50:50 atom ratio) was used f the anode catalyst. Nafion®-Teflon®- Phosphtungstic Ac (NTPA) membranes, developed by Ionomem Corp. usi the UConn technology, were used because of their hi conductivity, stability and performance operating higher temperatures [2]. The cell was run at 120^{o}C a 150^{o}C with different RHs at the anode.

Figure 1 shows the effect of anode pressurization on t cell resistance of a 1.7mil (43 μm) thick NTF membrane. The control is 120/90/90 (cell/anode/cathode), which has atmospheric pressure a 35% RH on both sides. The resistance is 0.33 Ohm-cn When the anode saturator is increased to 110^{o}C (72%R P_{anode}= 1.7 atm) while keeping the cell temperature at 1 ^{o}C and the cathode at the same temperature a atmospheric pressure, the resistance decreases to 0. Ohm-cm^2. Anode pressurization also results in a lower resistance, 0.29 Ohm-cm^2, at 150/126/90^{o}C (50% RH in anode and 15% in cathode). Even without any humidification in the cathode, 150/126/dry condition, the resistance is 0.38 Ohm-cm^2, very close to that at 120/90/90^{o}C.

Figure 2 shows the performance at different conditions. The cell voltage is 0.56V at 400mA/cm^2 for the control 120/90/90^{o}C. For 120/110/90^{o}C, the voltage increases to 0.65V at 400mA/cm^2. For 150/126/90^{o}C, the voltage is 0.45V at 400mA/cm^2. The performance at 150/126/90^{o}C does not increase as expected, even though the resistance is lower than that at 120/90/90^{o}C, as shown in Figure 1. This could be due to high cathode resistance and serious cathode polarization. Modification of the cathode structure is therefore needed to further improve the performance. Further research will introduce 1% and 2% CO simulated reformate into the pressurized anode compartment.

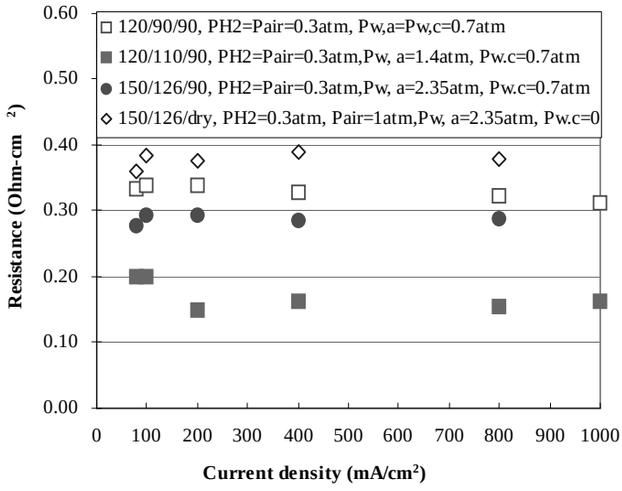

Fig. 1 Effect of anode pressurization on cell resistance

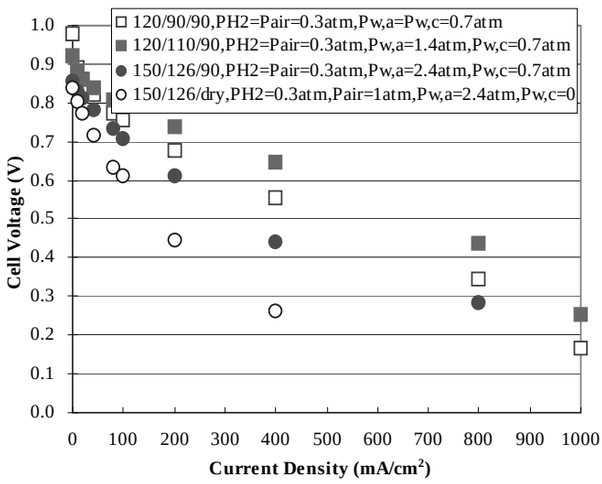

Fig. 2 Effect of anode pressurization on cell performance

Pressure", in press, *J. Electrochem. Soc.*, 2004.

2. Song, Y, Bonville, L, Carley, L. R., Farris, P. Trahiotis, M., Wei, Y., and Li, J., Kunz, H. R., Fenton, J. M., The Electrochemical Society Meeting, Paris, France, Spring 2003, extended Abstracts 03-1, Abstract Number 1181.