Electrochemical Impedance of PEM Fuel Cells at Elevated Temperatures and Various Relative Humidifies

[1]H. Xu, [2]Y. Song, [1]H. R. Kunz, and [1]J. M. Fenton
1 Department of Chemical Engineering
2 Environmental Research Institute
University of Connecticut
Storrs, CT 06269, USA

Proton Exchange Membrane (PEM) fuel cells are often operated at low temperatures (<80°C) and 100% relative humidity (RH). However, PEM fuel cells operated elevated temperatures (>100 °C, atmospheric pressure a therefore low RH) have significant advantages over lo temperature PEM fuel cells as CO poisoning at the ano is effectively alleviated. However, the change temperature and RH will also influence many paramete of a PEM fuel cell, such as cathode catalytic activity, a membrane and electrode resistance. Therefore, it is ve instructive to understand these changes before furth improving the performance of a PEM fuel ce Electrochemical impedance spectroscopy is a powerf method for investigating the electrical behavior different interfaces. In fuel cells, considerab applications have been focused on measuring membra resistance[1]. There are few studies that measure electro resistance and evaluate oxygen reduction kinetics. In th study, impedance spectroscopy was applied to measu electrode resistance and catalytic activity at vario temperatures and relative humidities. The obtain information will help us further understand highe temperature operation.

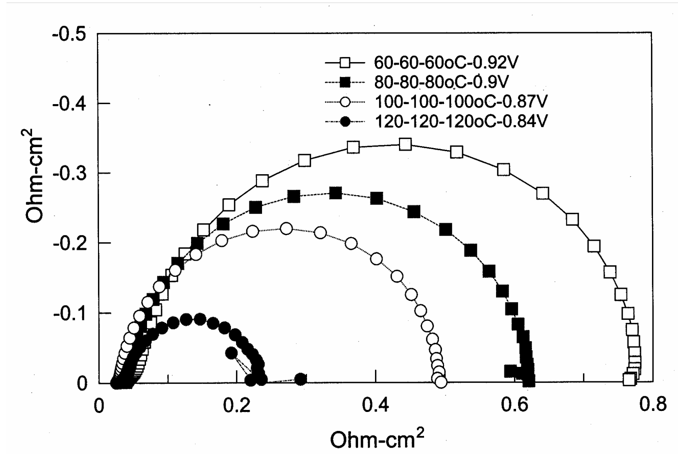

Figure1 AC impedance as a function of cell temperature at 100%RH. Measurements were taken: 0.92Vat 60°C, 0.9V at 80°C, 0.87V at 100°C and 0.84V at 120°C. Amplitude: 10mV. Frequency: 0.1-10^5Hz

Figure 1 shows impedance data at 100% RH with vario temperatures. There are four semi-arcs, which represe four conditions: 60/60/60°C ($T_{cell}/T_{anode\ humidifier}/T_{cath}$ $_{humidifier}$), 80/80/80°C, 100/100/100°C and 120/120/120° All four measurements were taken at 0.3V over-potenti All four semi-arcs have almost the same low intercep which indicate membrane resistance does not chan much with cell temperature at 100% RH. However, t high intercepts are quite different for these fo conditions; as the cell temperature increases, the hi intercept decreases. The difference between the low a high intercept gives cathode polarization, which is measurement of oxygen reduction kinetics. The lower t cathode polarization resistance, the faster the reactio From 60 to 120°C, the reaction rate is much improved. comparison to membrane resistance, cathode polarizati resistance is predominant.

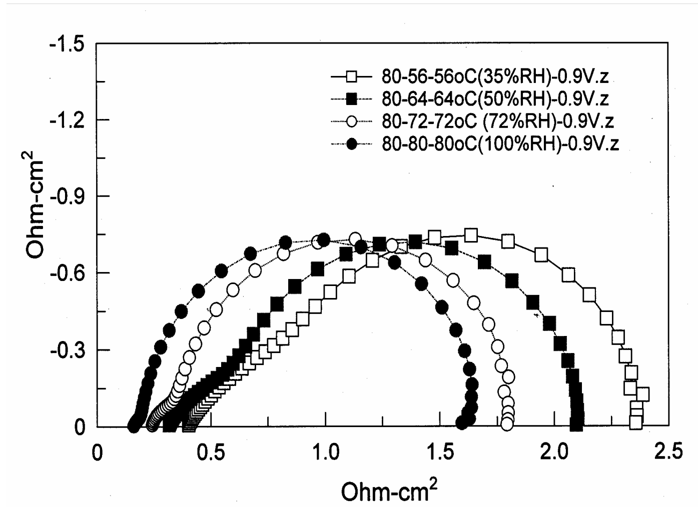

Figure2 AC impedance as a function of RH at 80°C. Measurements were taken at 0.9V. Amplitude: 10mV. Frequency: 0.1-10^5Hz

Figure 2 shows impedance spectroscopy at 80°C wi different RH. The four arcs correspond to 35% RH (80/56/56°C), 50% RH (80/64/64°C), 72% RH (80/72/72°C), and 100% RH (80/80/80°C), respectively. All four measurements were taken at 0.9V cell voltage. The electrolyte resistance increases as the RH decreases, as reflected in the low intercepts. The cathode polarization resistance decreases sharply when the RH is first increased, then changes little after the RH is above 70%. This indicates catalytic activity increases with RH in the range of 0~70%. This tendency can be explained by changes of proton activity and platinum surface area with RH[2]. It is also shown that, at low RH 35% and 50%, the low intercept has a 45 ° slope. This slope is due to the cathode ionic resistance. This 45° slope will be eliminated by decreasing the catalyst loading in an on-going study.