179g Nafion-Mo2 (M= Zr, Si, Ti) Nanocomposite Membranes for Higher Temperature Operation of PEM Fuel Cells

Nikhil Jalani and Ravindra Datta

Nafion- MO2(M = Zr, Si, Ti) nanocomposite membranes were synthesized with the goal to increase the proton conductivity and water retention by the membrane at higher temperatures and lower relative humidities (120 oC, 40% RH) and also to improve the thermo-mechanical properties [1-2]. The main obstacles to commercialization of PEM fuel cells are mostly related to the proton conducting materials, typically solid polymer electrolytes such as Nafion. These membranes are expensive, mechanically unfavorable at high temperature, and conduct protons only in the presence of water, which limits the fuel cell operating temperature to 80 oC. This in turn results in low fuel cell performance due to low electrode kinetics and less CO tolerance. The operation of fuel cells at high temperature (above 100 oC) provides many advantages such as improved kinetics at the surface of electrode, which is especially important in methanol and CO-containing reformate feeds, and efficient heat and water managements. But, another problem above 100 oC is the reduction of electrochemical surface area of the electrodes due to shrinkage of electrolyte (Nafion membrane) in electrodes.

Sol gel approach allows incorporation of inorganic oxides within the pores of Nafion membrane with sub-micronic particle size. The membranes synthesized by this approach were completely transparent and homogenous as compared to membranes prepared by the casting method which were cloudy due to the much larger particles. The results obtained so far have shown higher conductivity and water uptake as compared to unmodified membrane. At 90 oC and 120 oC, the Nafion- MO2 sol-gel composites exhibited higher water sorption than Nafion membrane, which was our design objective [3-4]. On the other hand, at 90 oC and 120 oC, the highest conductivity was exhibited by the Nafion- ZrO2 sol-gel composite with a 10 % enhancement at 40 % RH. In addition, the TGA and DMA analysis showed better thermo mechanical properties for composite membranes over Nafion. These membranes were then also tested in actual fuel cell operating conditions. Finally, efforts were put in developing a better procedure for preparing Pt/C electrodes for PEM fuel cells. The effect of different electrolyte equivalent weight was tested in fuel cell environment. Some of these results will be presented, along with our future goals for developing stable CMEAs for PEM fuel cells.

References:

1.N. H. Jalani; K. Dunn, and R. Datta, Electrochimica Acta, under review (2005).

2.T. Thampan, N. H. Jalani, P. Choi, and R. Datta, J. Electrochem. Soc., 152(2) A316(2005).

3.N. H. Jalani and R. Datta, J. Membr. Sci., accepted (2005).

4.N. H. Jalani; P. Choi, and R. Datta, J. Membr. Sci., available in press, xxx (2005).