Measurement of proton resistance in cathode catalyst layers and its correlation with the ionomer-to-carbon ratio

Daniel R. Baker, Michael W. Murphy, Wenbin Gu, Yuxiu Liu, Hubert Gasteiger

Ohmic resistance to proton transport in the cathode electrode can be a major source of voltage loss in PEM fuel cells, especially under dry operating conditions. An experimental method for measuring the proton sheet resistance in the cathode, using either H_2/N_2 or H_2/O_2 on the anode/cathode, was developed in reference [1], based on impedance modeling developed in reference [2]. In this talk, we focus on the system using H_2/N_2, and refine the measurements and modeling to improve the accuracy and versatility of the method. Special electrodes were prepared from ≈ 50% Pt/Vulcan and 1100 Equivalent Weight ionomer (Dupont), with uniform ionomer distributions and ionomer-to-carbon (I/C) ratios ranging from approximately 1.2 down to 0.3. The proton sheet resistances were measured at four different values of relative humidity (RH). The dependence of sheet resistance on I/C and humidity will be discussed, and evidence will be shown for a critical percolation threshold near I/C=0.3, below which proton conductivity vanishes. A brief discussion of impedance spectra for electrodes with non-uniform ionomer distributions will illustrate via simulation how to interpret such spectra.

[1] R. Makharia, M. F. Mathias, D. R. Baker, *J. Electrochem. Soc.*, *152* (2005) A970.

[2] M. Eikerling , A.A. Kornyshev, *Journal of Electroanalytical Chemistry* 475 (1999) 107–123.