An Investigation of Ionic Conductivity of the PEMFC by AC impedance Spectroscopy

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The transport rate of protons to catalyst sits is greatly enhanced by impregnating a proton-conducting ionomer such as Nafion® in the catalyst active layer of the cathode of a polymer electrolyte membrane fuel cell (PEMFC). In this study, there were four different sources of perfluorosulfonated acid (PFSA) solution evaluated for quality control, and various ionomer loadings were applied and examined to determine the optimum ionomer impregnation content.

Hand-made gas diffusion electrodes with a Pt loading of 0.48 mg/cm^2 from E-TEK division of De Nora North America Inc, were used as both the cathode and anode. The experiment was carried out with both air and low pressure pure O_2. The AC impedance and *in situ* cyclic voltammetry (CV) were conducted by a Gamry PC4/750 model DHC2 potentiostat. Different amounts of PFSA in the range of 0.33 to 1.13 mg/cm^2 (dry weight) were tested in this study.

PFSA ionomer quality has a large effect on PEM FC performance. From AC impedance measurement, ionomers 1 & 2 have better FC performance than ionomers 3 & 4. Good performing ionomers exhibit both better ionic conductivity and O_2 diffusion property.

The increase of ionic conductivity in the active layer of an air cathode with an increase in the ionomer loading was revealed from both impedance data and surface area measurements.

The AC impedance spectroscopy is a convenient tool for PEMFC performance evaluation. The 2nd semicircle observed in air feeding is associated with O_2 diffusion resistance in the catalyst layer.

Improvement of the accessibility of the total catalyst surface with the increase of Nafion ionomer loading was noted from both the capacitance and CV tests.

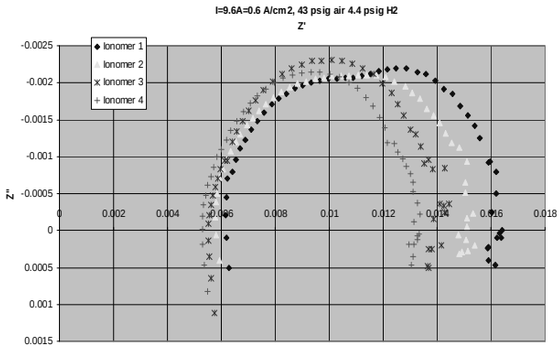

Figure 3. AC impedance spectrum at 0.6 A/cm^2 with air cathode feeding with PFSA loading of 0.6 mg/cm^2.