Improvement of High Temperature Performance and Endurance with NTPA Membrane

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One of the most promising types of fuel cells, the proton exchange membrane (PEM) fuel cell, is currently being aggressively researched and developed. Operating PEM fuel cells at higher temperature will effectively alleviate carbon monoxide poisoning, increase energy efficiency and make the water management easy. Unfortunately, the present Nafion® membrane, as electrolyte medium for proton transport and barrier to avoid the direct contact between fuel and oxygen, loses ionic conductivity at temperatures above 100^0C due to membrane dehydration. At constant pressure, water vapor increasingly replaces reactants as temperature is increased, resulting in a reduced relative humidity if reactant pressures are to be held at appropriate levels. Also, the catalytic activity for oxygen reduction in the cathode is reduced as water is lost from the electrolyte.

Several years of research have been dedicated to improving cell performance at higher temperature. The University of Connecticut has reported a proton exchange membrane that provides excellent ionic conductivity at higher temperature. Phosphotungstic acid, as one solid proton conductor, and Nafion® were incorporated into the porous structure of Teflon® to decrease polymer water vapor pressure. This provides more water-independent ionic conduction and helps achieve good performance at higher temperature. Recently, the method to prepare NTPA composite membrane has been further modified to improve reproducibility. As large as $300 cm^2$ membranes have been fabricated with these improved characteristics. Tests demonstrate that this higher temperature NTPA membrane with modified preparation meets the requirements of fuel cell operation such as low internal resistance loss at higher temperature under ambient pressure, good mechanical properties at reduced thickness, and low cost potential. Fig.1 compares performance of NTPA MEAs at 80^0C and 120^0C under ambient pressure to Nafion® 112 MEAs at the same conditions.

Based on our current technique of higher temperature NTPA MEAs, efforts have been conducted to improve stability and reliability. Fig.2 shows the stability test result of two $25 cm^2$ cells at 105^0C or 120^0C on air. Resistance was recorded by current interrupt method. The almost constant values of membrane resistance indicate membrane stability during the complete operating time. It demonstrates that the in-house NTPA membrane has very good stability and ability to retain water at higher temperatures.

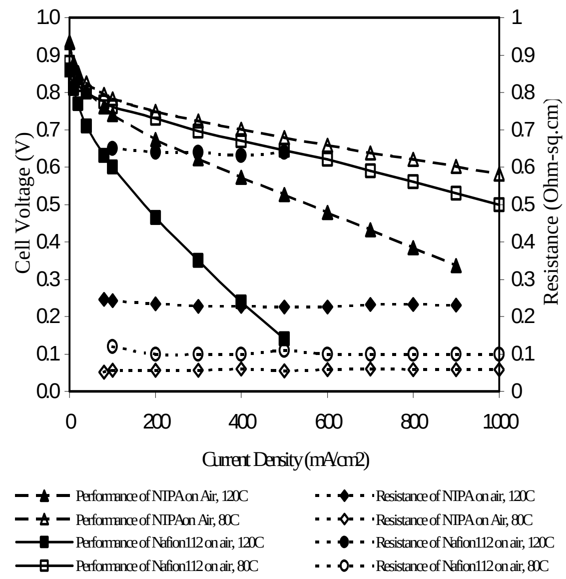

Fig.1 Improvement of Performance at High Temperatures

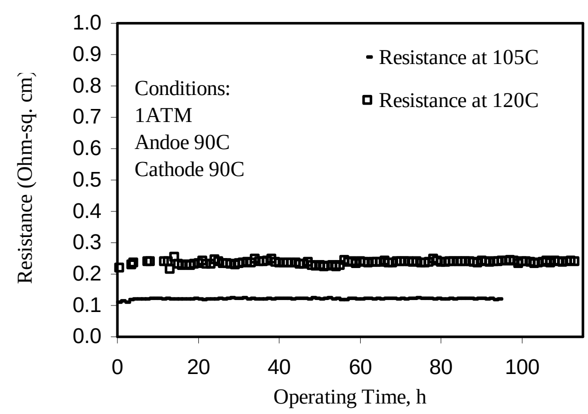

Fig.2 Stability Tests of NTPA MEA