Electrochemical Studies on Medium Temperature Proton Exchange Membrane Fuel Cell Electrode

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A fuel cell has been attracting a significant attention as a future energy device, because of its high efficiency and environmental friendliness. It has various applications such as portable and stationary power generation and transportation. Among them, transportation application is the most promising market in near future.

Low temperature proton exchange membrane fuel cell (LT-PEMFC) using Nafion membrane has been extensively studied for transportation application.[1,2] However, it faces the challenges of tolerance to fuel impurities, water management and heat rejection. Therefore, operation at higher temperature of 120°C and lower relative humidity (RH) of 40% is encouraged. In the current study, sulfonated electrolyte membrane was used to assemble MEA, and the cell voltage as well as impedance measurements were conducted at different RH and pressurization conditions at the operating temperature of 120°C.

Fig. 1 compares the voltage values of a cell that was operated at 120°C under various conditions of RH and pressurization. At a given RH, the cell voltage values increased with increase of pressurization, and the magnitude of voltage increase depended on the RH values.

For more thorough investigation on cell performances under various conditions, electrochemical impedance spectroscopy analysis was performed. From the impedance spectra, the resistances and capacitances were extracted using equivalent circuit model, and five main components of ohmic resistance (R_Ω), anode resistance (Ra), anode capacitance (Ca), cathode resistance (Rc), cathode capacitance (Cc) were determined.

Among the five components, Rc and Cc were more influenced by RH and pressurization level, which were shown in Fig. 2 and 3. It indicates that cathode reaction is more sensitive to environmental conditions such as RH and pressurization. Rc was lowered with increasing RH and pressurization level. Cc increased with increasing RH, but decreased slightly with increasing pressurization. The increased RH offers more water content for electrochemical reaction, which lowers the resistance and capacitance. On the other hand, the increased pressurization increases O_2 concentration in the neighborhood of Pt electrocatalysts and it reduces the reaction resistance.

The results on the effects of RH and pressurization level on performance of cells that are operated at 120°C will be applied in designing high performance electrodes for MEAs which can operate at 120°C and low RH conditions. To improve the cell performance, the increase in water content and O_2 concentration in catalyst layer at a certain RH and pressure is required and novel approaches for increasing water content and O_2 concentration will be discussed in the presentation.

Reference
1. V. Mehta and J.S. Cooper, *J. Power Sources*, **114**, 32 (2003).
2. S.-Y. Ahn, S.-J. Shin, H.Y. Ha, S.-A. Hong, Y.-C. Lee, T.W. Lim, and I.-H. Oh, *J. Power Sources*, **106**, 295 (2002).

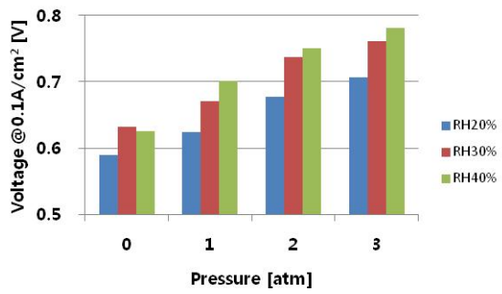

Fig. 1. Effects of RH and pressurization level on cell performance at 120°C.

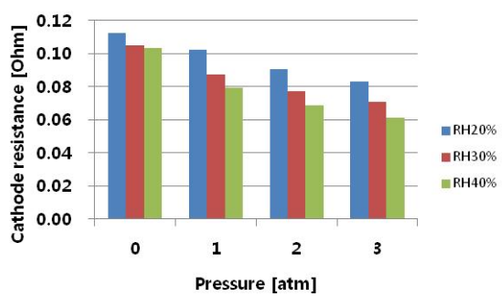

Fig. 2. Effects of RH and pressurization level on cathode resistance at 120°C.

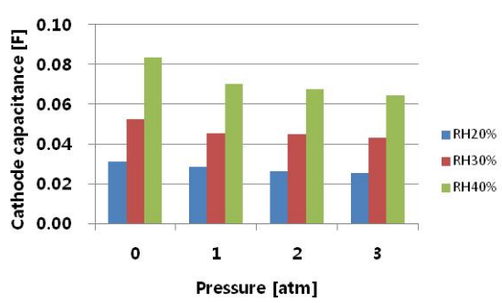

Fig. 3. Effects of RH and pressurization level on cathode capacitance at 120°C.