# EFFECTS OF SURFACE MODIFICATION OF A POLYMER ELECTROLYTE MEMBRANE ON THE FUEL CELL PERFORMANCE

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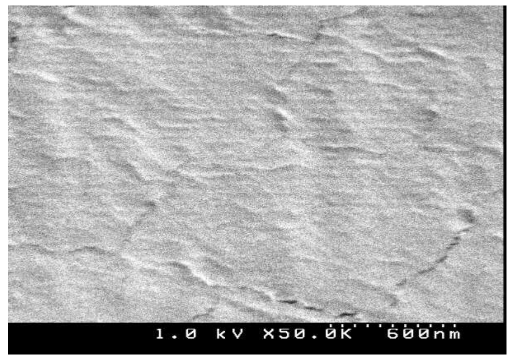
Polymer electrolyte membrane fuel cell (PEMFC) is considered as a clean and efficient energy conversion device for mobile and stationary applications. Among all the components of the PEMFC, the interface between the electrolyte and electrode catalyst plays an important role in determining the cell performance since the electrochemical reactions take place at the interface in contact with the reactant gases. Therefore, to increase the interface area and obtain a high-performance PEMFC, particle size of the electrode catalysts has been reduced below 2 nm. On the other hand, the interface area can be increased by roughening the membrane surface. In this work, to enhance the interface area, surface of the electrolyte membrane was roughened by ion beam bombardment. Before coated with catalyst slurry to fabricate a membrane-electrode assembly (MEA), cathode side of Nafion 112 membrane was bombarded by Ar ions.

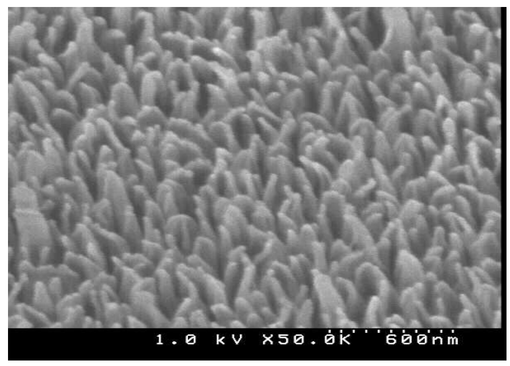
Fig. 1 shows surface morphology of non-treated and surface-treated membrane at ion energy of 1 keV and ion dose density of $5 \times 10^{16}$ ions/cm$^2$. The membrane surface was clearly roughened by the ion bombardment, which could lead to an increase in the interface area between the electrolyte and catalysts.

Fig. 2 presents performance of the single cells fabricated using non-treated Nafion 112 and the surface-treated membrane with various cathode platinum loadings. Anode platinum loading was 0.3 mg/cm$^2$. For the surface-treated membrane, the single cell exhibited the best performance at cathode platinum loading of 0.2 mg/cm$^2$, 600 mA/cm$^2$ at 0.641 V, which was comparable to the performance of the single cell with non-treated membrane at platinum loading of 0.4 mg/cm$^2$, 600 mA/cm$^2$ at 0.637 V. Those results imply that by modifying surface of the electrolyte membrane, platinum loading can be reduced by 50 % without performance loss.

To optimize the surface treatment condition, effects of ion energy and ion dose density on characteristics of the membrane/electrode interface were examined by measuring the cell performance, impedance spectroscopy, and cyclic voltammograms. Surface of the modified membranes were characterized using scanning electron microscopy, atomic force microscopy, and X-ray photoelectron spectroscopy.




(a)




(b)

Fig. 1 SEM images of the membrane surface (a) before and (b) after ion beam bombardment at ion energy of 1 keV and ion does density of $5 \times 10^{16}$ ions/cm$^2$.

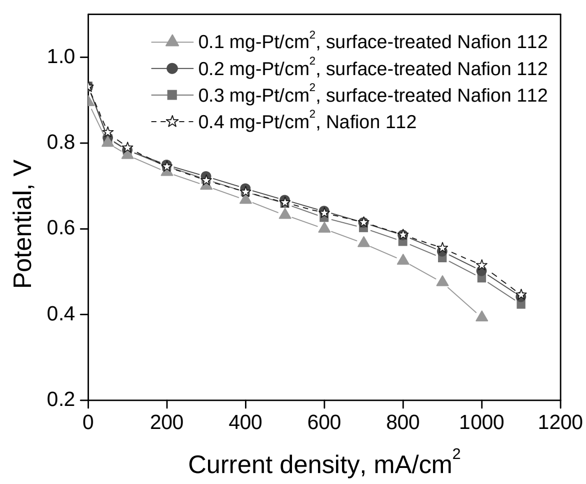



Fig.2 Performance of the single cells fabricated using non-treated Nafion 112 and the surface-treated membrane with various cathode platinum loadings. Anode catalyst loading was 0.3 mg-Pt/cm$^2$. Operating temperature = 80 $^o$C, operating pressure = 1 atm, stoichiometry of $H_2$/Air = 1.5/2.0, saturator temperature of anode/cathode = 80/65 $^o$C.