Study the Effect of Electric Field on Polymer Electrolyte Membrane for Fuel Cell

Hamdy F. M. Mohamed*[1], Mohamed H. M. Hassanien[1,2], Asmaa G. R. Gomaa[1], Asmaa A. A. Aboud[1], Sara A. M. Ragab[1], Abdel-Rahman A. A. Ahmed[1], and Wessam R. M. Saeed[1]

[1]*Physics Department, Faculty of Science, Minia University, P.O. Box 61519, Minia, Egypt.*
[2]*Engineering New Department, Faculty of Engineering, Nahda University, P.O. Box 62513, New Beni Suef, Egypt.*

*e-mails: hamdy.farghal@mu.edu.eg & hamdyfm@gmail.com

The polymer electrolyte membrane is the central issue for the exhibition of the fuel cell. The perfluorosulfonic acid membrane (Nafion 112; trade name of DuPont Co) is well known as a polymer electrolyte membrane. The Nafion 112 membrane was placed in an electric poling system and the electric field (0, 40, 80, and 140 MV/m) was applied at a temperature of 90 °C. The heating of the membrane provides the molecular motion energy, and the electric field causes the polar sulfonic acid groups of Nafion to move along the electric field's direction. The electric field strength effect was investigated using various techniques such as Fourier transform infrared (FTIR), water uptake, wide-angle x-ray diffraction (WAXD), proton conductivity, thermogravimetric analysis (TGA), tensile test, and positron annihilation (PAL) spectroscopy. All of the above measurements and tests were carried out for comparison for the as received Nafion 112 membrane. The chemical structure of the membrane did not change with the electric field effect. The electric field decreases the degree of crystallinity while it increases water uptake, proton conductivity, thermal stability, mechanical strength, and hole volume size, (calculated from the PAL technique). The results from different techniques were correlated successfully [Fig.1]. In conclusion, the electric field at 90 °C extended all properties of the Nafion 112 membranes which can be improved the performance of the fuel cells.

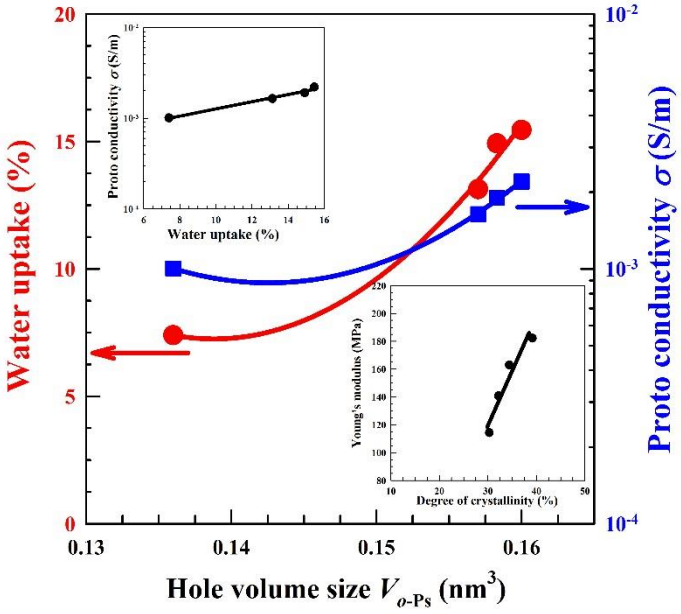

Fig. 1. Correlation between the hole volume size deduced from PAL parameter and both of water uptake and proton conductivity for Nafion 112 at different electric filed strengths and 90 °C.