The Effect of Membrane Properties on Water Transport in PEMFCs

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The proton exchange membranes are usually base on the polymer backbone attached with negatively charged groups. An improved perfluorinated sulfonated copolymer, Nafion®[1], membrane manufactured by Dupont generally used as the benchmark membrane for proton exchange membrane fuel cells. A Nafion® membrane exhibits good thermal and chemical stability. Also it shows high proton conductivity under hydrated state but dramatically decreases with temperature above 90˚C because of the loss of absorbed water in the membrane[2].

The limitations to commercial use is poor conductivity at low humidity and elevated temperature, chemical degradation at elevated temperatures and the most importantly membrane cost. The challenge is to produce a cheaper material for PEMFC membrane that can satisfy the thermal and chemical stability, and high conductivity. Presently, one of the most promising candidates is the use of hydrocarbon polymer for polymer backbones[3].

The alternative material poly(arylene ether ketone sulfone)[3] multiblock copolymer, 6FK-BPSH100, developed by McGrath's research group[4,5] was used to study in this work. Fig. 1 shows the chemical structure of 6FK-BPSH100. The membrane was casted and characterized by Braff and Mittelsteadt[6]. Fig. 2 shows the membrane characterization results between hydrocarbon membrane and Nafion® membrane. The results show that for the water content of both membranes have similar results. But for the membrane water diffusivity and the electro-osmotic drag coefficient, the values of Nafion® membrane are higher than hydrocarbon membrane. Furthermore, under high humidity condition, hydrocarbon membrane shows better proton conductivity than Nafion® membrane.

Fig. 3 shows performance comparison between Nafion® and hydrocarbon membranes at 80˚C and 95% relative humidity for both anode and cathode inlet gas. The results show that hydrocarbon membrane gives higher performance than Nafion® membrane at high humidity condition. The water transport through membrane is determined by the combine effect of electro-osmotic drag and water diffusion of water. For this particular operating condition, less water can transport to cathode side of hydrocarbon membrane compared to Nafion® membrane, thus preventing water flooding in cathode side as shown in table 1.

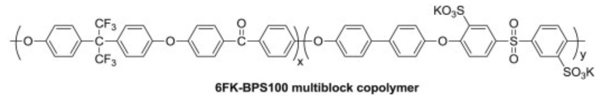

Figure 1. Chemical structure of 6FK-BPSH100[1]

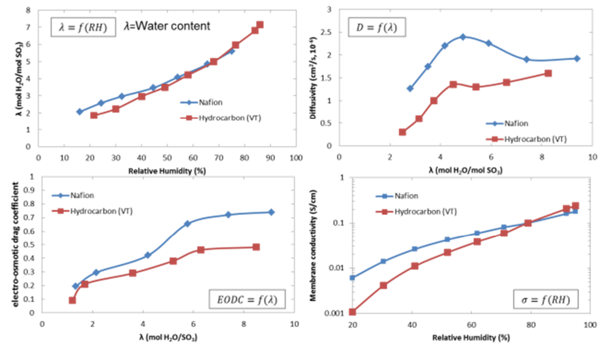

Figure 2. Comparison of membrane properties between Hydrocarbon and Nafion® membrane.

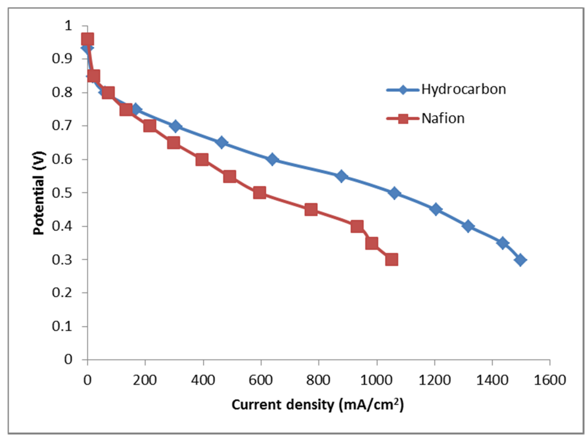

Figure 3. Polarization curve of Hydrocarbon and Nafion® membrane at 95% RH for both anode and cathode inlet.

Table1. Water balance experiment result between Nafion® and hydrocarbon membrane

	i A/cm^2	%RH	Anode Water Balance (mg/sec)			Cathode Water Balance (mg/sec)			
			Water in	Water out	Cross to Cathode	Water in	Gen.	Water out	Cross from Anode
NRE	**0.8**	95	2.21	1.35	0.86	7.03	1.87	9.80	0.86
HC	**0.8**	95	2.21	1.68	0.53	7.03	1.87	9.44	0.54

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