Membrane-Electrode Interfacial Degradation in Nafion based PEMFCs and DMFCs

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To date, the performance optimization of polymer electrolyte membrane fuel cells (PEMFCs) has centered on membrane properties and electrode structure.[1-3] However, under operating conditions that include thermal cycling, high temperatures or liquid methanol feed, the stability of membrane-electrode interface is also a concern, not only for initial performance but also long-term stability.[4-6] Here, we present a systematic investigation of interfacial issues of Nafion based membrane electrode assemblies (MEAs). To probe the interfacial compatibility of Nafion MEAs, we studied equivalent weight (EW) effects on performance.

Figure 1 shows high frequency resistance (HFR) as a function of membrane thickness for MEAs made from Nafion 1100 EW membranes bonded with Nafion 1100 EW or 1200 EW electrodes operating under (a) H_2/air and (b) 0.5 M MeOH/air conditions. The y intercept corresponds to non-membrane resistances from flow fields, current collectors, electrodes and gas diffusion layers. The membrane-electrode interfacial resistance can be estimated by subtracting the electronic resistance of cell components from the non membrane resistance.[4-6] The higher intercept for cells with 1200 EW Nafion electrode binder, in both H_2/air and MeOH/air modes, suggests higher interfacial membrane resistance, while differences in interfacial resistance between on methanol and hydrogen will be presented elsewhere. [7]

The inferior interfacial compatibility of Nafion 1100 EW membrane with Nafion 1200 EW electrodes also adversely affects the long-term performance of the cell. Figure 2 shows that HFR increases at an accelerated rate (2x) for the 1200 EW electrode compared to the 1100 EW electrode. Long term durability and performance greatly depends on the membrane interfacial stability. Careful design and selection of membrane and electrode materials is essential for good interfacial compatibility and long cell lifetimes. More data using different EW membranes and performance will be discussed.

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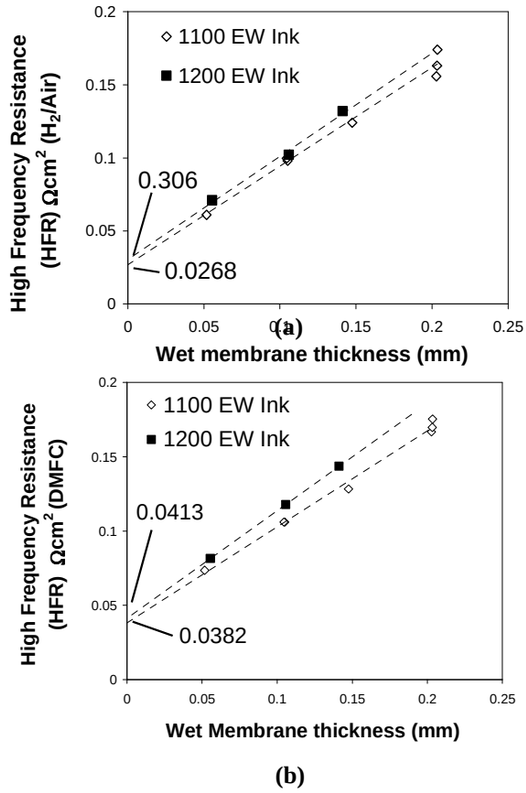

Figure 1. *High Frequency Resistance (a) H_2/air, and (b) 0.5M MeOH/air of Nafion of different thickness bonded with Nafion ink of 1100 and 1200 EW inks.*

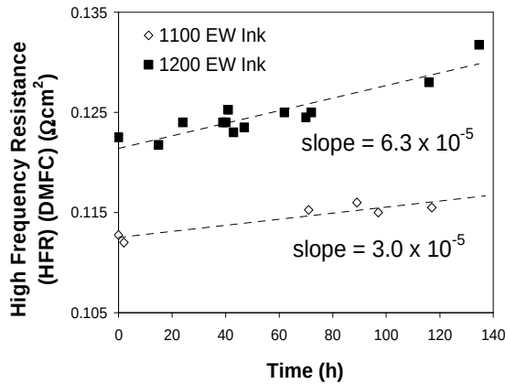

***Figure 2**. Change of high frequency resistance with time for 1100 EW and 1200 EW Nafion solution electrode binder (N1135).*