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Neutron imaging and performance of PEM fuel cells with nanostructured thin film electrodes at low temperatures

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Nanostructured thin film (NSTF) electrodes hold great promise for reduced cost (better performance at lower precious metal loadings) and greater durability over conventional Pt/C electrodes.[1] However, the thin electrode structure poses challenges for water removal, especially during low temperature operations.[2] Several strategies have been suggested to improve water management in NSTF-based systems with the most effective being the preferential removal of the water through the anode side of the fuel cell.[3] In this paper we will present high resolution neutron imaging results of water in the various components of two NSTF MEAs using two different GDL combinations. We will also discuss the performance of these fuel cells at sub-freezing temperatures and compare them to the performance of MEAs using conventional dispersed Pt/C catalysts.

The MEA used in this study had a 0.15mg/cm^2 PtCoMn NSTF cathode, 0.05mg/cm^2 PtCoMn NSTF anode and 24 µm 825EW electrolyte. The two GDL combinations used were a) baseline: 3M 2979 GDL at both the cathode and anode and b) modified: 2979 cathode GDL and MRC MS3BE-040US anode backing with 3M hydrophobization and microporous layer. While the high temperature performance of either GDL combination was comparable, the low temperature performance of the modified GDL was significantly better as illustrated in Figure 1. The water profiles of these two GDL combinations is illustrated in Figure 2 where it is seen that the modified GDL combination has significantly less water in the cathode GDL and MEA. Impedance measurements (not shown) also illustrated decreased mass transport losses in the MEA using the modified GDL. These results confirm that improved water removal through the anode side of a cell using NSTF electrodes can result in better performance during low temperature operation.

NSTF based MEAs were also subjected to isothermal operation and passive cool downs to sub-freezing conditions. Performance and durability results from these sub-freezing experiments will also be presented. While the water/ice holding capacity of the NSTF MEAs was lower than conventional dispersed catalyst electrodes, their durability was comparable to the best dispersed catalyst electrodes tested.

References

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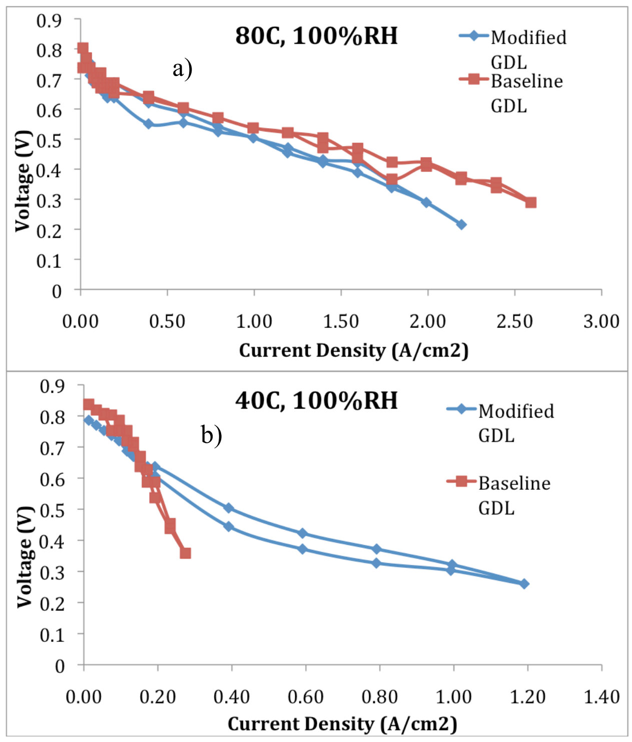

Figure 1. Performance of NSTF based MEAs at a) 80 °C, 100 % RH and b) 40 °C, 100 % RH with 2 different GDL combinations

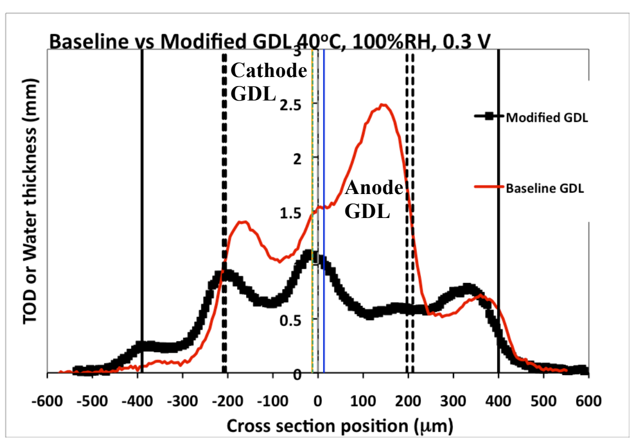

Figure 2. Water profile across NSTF based MEAs using 2 different GDL combinations