Effect of PEFC Water Management on Oxygen Transport Resistance in Ultra-low Loading Catalyst Layer

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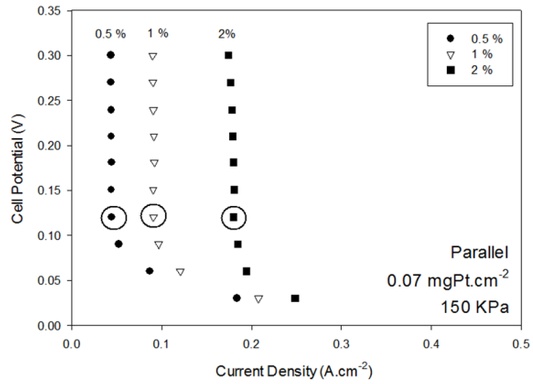
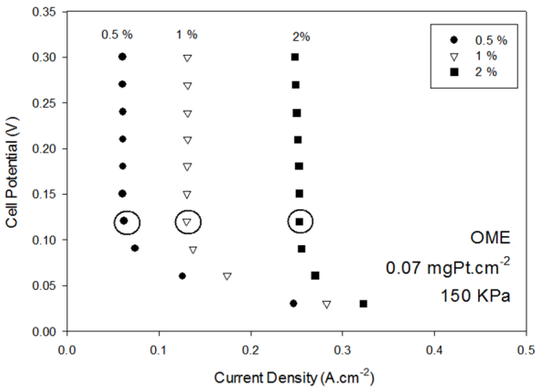
Exceeding the 2015 Department of Energy (DOE) target in terms of stack power density of 0.9 W/cm^2 has been demonstrated [1,2], but continued improvement in performance and price reduction are necessary. One strategy for achieving price reduction is the decrease of total platinum (Pt) loading from 0.4 – 0.25 mgPt.cm^{-2} to ultra-low loading of 0.1 mgPt.cm^{-2}. High performance low Pt loading electrodes are therefore an area of intense research.

The concurrent need to reduce precious metal loading while increasing power density has highlighted the issue of oxygen transport in low Pt loaded electrodes. Recently, a number of automotive companies and membrane electrode assembly (MEA) developers have published results in which a resistance of unknown origin, was shown to directly or indirectly scale with Pt loading. A lack of understanding of the mechanism responsible for such resistance is noted, and several possible theories have been presented.

In this work, limiting current measurements were used to evaluate oxygen transport resistance in the catalyst layer of a PEFC using two different flow field architectures, as shown in Figure 1, at 80^{o}C. The pressure independent oxygen transport resistance in the electrode was evaluated with a conventional parallel channel/land architecture, and an open metallic element (OME) flow field known to dramatically improve mass transport and mitigate flooding. Two different cathode Pt loadings (0.4 and 0.07 mgPt.cm^{-2}) were tested. The compounded effect of the flow field and Pt loading is used to identify the nature of the observed resistance. By varying gas pressure and using different low oxygen concentrations, the total oxygen transport resistance is divided into intermolecular gas diffusion (pressure dependant) and a pressure independent component, Knudsen diffusion or dissolution film resistance.



a)



b)

Figure 1. Limiting current measurements at 80^{o}C at a cell operating pressure of 150 kPa, for different flow field architectures, under various oxygen concentrations with a cathode catalyst loading of 0.07 mgPt.cm^{-2}. a) Parallel flow field b) open metallic element flow field.

References

1. A.K. Srouji, L.J. Zheng, R. Dross, A. Turhan, M. M. Mench. J Power Sources, 218 (2012) 341.

2. A.K. Srouji, L.J. Zheng, R. Dross, A. Turhan, M. M. Mench. J Power Sources, 239 (2013) 433.

Acknowledgments

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