Relating Direct Methanol Fuel Cell Performance to Measurements in a Liquid Half Cell - DTU Orbit (08/11/2017)

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Direct methanol fuel cells (DMFC) could act as a replacement for batteries in low power electronics. For instance, micro—DMFC's could be used to power hearing instruments[1]. The power output of a DMFC is limited by the sluggish kinetics of both the methanol oxidation reaction (MOR) on the anode and the oxygen reduction reaction (ORR) on the cathode. Thus far, to achieve high power densities with a single cell, the catalyst loadings have been increased much as possible (20 mg/cm2 PtRu/C on anode and 4 mg/cm2 Pt/C on cathode). More active catalysts would yield higher power densities which in turn would allow further miniaturization or powering more advanced and more power hungry devices. The activity of fuel cell catalysts is often probed in the form of thin films in liquid half cells. However, it is challenging to mimic the conditions in an actual DMFC. On the other hand, it can also be problematic to extract the catalyst activity from a fuel cell measurement. In this work, we attempt to narrow the gap between fuel cell testing and liquid half-cell measurements. First, by placing a custom reference electrode within the fuel cell, we can determine the potential at the anode and cathode under in-operando conditions. This in turn, allows us to directly correlate our measurements to those performed in a liquid half-cell at the same potential. For our half-cell measurements, we have tested different catalysts (Pt/C, PtRu/C) for the methanol oxidation reaction (MOR) and the oxygen reduction reaction (ORR) in the presence of methanol. By comparing the two measurements, we make recommendations for performing liquid half-cell measurements under realistic conditions. [1] J.H. Hales, C. Kallesøe, T. Lund-Olesen, A.-C. Johansson, H.C. Fanøe, Y. Yu, et al., Micro fuel cells power the hearing aids of the future, Fuel Cells Bull. 2012 (2012) 12–16. doi:10.1016/S1464-2859(12)70367-X.

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