

Standardizing thin-film rotating disk electrode measurements of the oxygen reduction activity of Pt/C

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Platinum-based nanoparticles dispersed on high surface area carbon support continue to be the most common electrocatalyst material in practical proton exchange membrane fuel cells (PEMFCs) (1). The electrocatalysts are most extensively studied for their activity for the oxygen reduction reaction (ORR), which is a slow four-electron transfer reaction, resulting in high overpotentials at the PEMFC cathode, which consequently requires high loading of the costly Pt electrocatalyst. The activity and durability of electrocatalysts are often measured as thin-films cast on rotating disk electrodes (RDEs) in liquid electrolyte in a half-cell configuration (1-5), which has been shown to be predictive of the performance trends of practical catalysts in the catalyst coated membranes used in PEMFCs (1).

Since 2001, attempts have been made to establish standard RDE procedures and measurement parameters so that novel catalysts can be benchmarked versus an accepted Pt nanoparticle supported on high-surface-area carbon (Pt/C) (1, 3, 4, 6-8). Yet, our review of recent literature shows mass activity differences of up to two fold for the same commercially available ~50 wt % Pt/C electrocatalyst (TKK TEC10E50E) measured with RDE (7, 9-15). The wide discrepancies suggest that the determination of the ORR activity using RDE is still plagued with intricacies that have not been systematically cataloged.

In this talk, we will present our literature review findings and show that RDE activity results depend on many factors, especially ORR measurement parameters/protocol (temperature, oxygen partial pressure, potential scan rate, potential scan direction, etc). We will also show that the measured ORR activity is additionally dependent on the RDE thin film electrode morphology, its composition, the ink formulation, dispersion quality, and film deposition and drying, artifacts similarly encountered in the fabrication of catalyst coated membranes.

We will also demonstrate that using a standard test protocol, it is possible for 2 different labs to obtain the same ORR catalytic activity when testing a standard Pt/C electrocatalyst using the RDE thin-film electrode methodology.

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