Macroscopic Modeling of Degradation and Performance Concerns in Proton-Exchange-Membrane Fuel-Cell Catalyst Layers

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It is well known that for optimal performance of polymer-electrolyte fuel cells (PEFCs), the design of the catalyst layers is critical. Even though these layers are the thinnest in a PEFC, they are arguably the most important and least understood. In many respects, making catalyst layers is a black art, where the exact microstructure and its effects are unknown. Through modeling, it is possible to ascertain the important phenomena occurring in the catalyst layers, which leads to improved performance and understanding.

In the catalyst layers, all of the various phases in a PEFC exist. Thus, there is membrane, gas, liquid, and solid (mainly carbon). In addition, there are electrocatalysts where the charge-transfer reactions take place. An accurate model of a catalyst layer requires that all of these phases and their various interactions be modeled from a physical perspective.

In this talk, recent work describing the modeling and diagnostics of catalyst layers will be discussed. The focus will be on the implications of low Pt loadings including the use of very thin nanostructured catalyst layers. In addition, degradation studies including that of modeling of hydrogen crossover and carbon-corrosion effects on catalyst layers and cell performance will be discussed.

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