



The Electrochemical Society
Seminar Notice: May 5, 2010

Scientific Breakthroughs for Fuel Cell Cathode Catalysts: Motivations and General Concepts

James Waldecker

*Fuel Cell and Hydrogen Storage Research Department
Research & Innovation Center – Ford Motor Company*

Cost and durability are the most important vehicle-related barriers to automotive fuel cell commercialization. The cathode catalyst layer is the system component that has the most direct influence on whether these barriers are overcome. While conventional nanoparticle-based Pt/C catalysts have demonstrated area-specific activity of 150-400 $\mu\text{A}/\text{cm}^2_{\text{Pt}}$, certain single crystal orientations, as well as catalysts containing flat Pt surfaces, have shown much higher specific activity. This higher activity, in the context of a high surface area support, could enable lower Pt loading and lower cost. Furthermore, nanoparticle catalysts are known to allow lower potentials for dissolution. An ab-initio calculated Pourbaix diagram was generated and shows the much higher thermodynamic propensity for dissolution associated with smaller nanoparticles. The carbon black support, which is often used with Pt nanoparticles, is associated with corrosion that could be eliminated with use of a novel support. In light of the disadvantages associated with Pt-based nanoparticles, calculations were done to find whether nanoparticles could realize a theoretical minimum for Pt loading. These calculations presumed specific activities reported in the literature for Pt and Pt alloys nanoparticles. For extended or bulk-like materials, specific activities were used that had been reported for specific crystal orientations of Pt and Pt alloys with surface segregation. In order to derive mass activity, mass-based surface areas ($\text{m}^2/\text{g}_{\text{Pt}}$) were derived from nanoparticle sizes or - for bulk-like catalysts - from the assumptions of a relatively low surface area support and minimization of Pt atomic depth. The number of nanoparticles or the roughness of the bulk-like surface was then adjusted to provide sufficient power density. Calculations showed that both Pt alloys and bulk-like materials were theoretically capable of providing cathode loadings $< 0.15 \text{ mg}_{\text{Pt}}/\text{cm}^2$. Unalloyed Pt nanoparticles, however, were not capable of approaching such a low loading, and were dismissed as a possible catalyst for a commercialized fuel cell system. While Pt alloy nanoparticles could enable low Pt loading, data have shown that under electrochemical cycling in the presence of oxygen and water, most higher activity Pt alloy nanoparticles will not remain stable.

Date: Wednesday, May 5th, 2010
Location: Lawrence Technological University
21000 West Ten Mile Road, Southfield, MI 48075
Building #5 (Taubman Welcome Center), 4th Floor, Room 406
Use Parking Lot A, C or D (Lots C & D are accessed off NW Highway)
Time: 5:30 pm Reception / 6:30 pm Dinner / 7:30 pm Speaker
Price: \$20 Members / \$22 Guests / \$10 Students **Payment:** Cash or Check
RSVP by: Wednesday, April 28, 2010 to Kent Snyder (ksnyde13@ford.com)
<http://www.electrochem.org/ecs/sections/detr/detr.htm>



