Extended Surface Pt Electrocatalysts: Synthesis and Challenges in Fuel Cell Applications

*K.C.Neyerlin[1], Shaun Alia[1], Brian Larsen[1], Svitlana Pylypenko[2], David Cullen[3], David Diercks[2], Shyam Kocha[1], and Bryan Pivovar[1,]**

[1] National Renewable Energy Laboratory, [2] Colorado School of Mines, [3] Oak Ridge National Laboratory

National Renewable Energy Laboratory
Hydrogen Technologies and Systems Center
1617 Cole Blvd, Golden, CO 80401-3393
bryan.pivovar@nrel.gov

Pt remains a primary limitation for the widespread commercialization of fuel cell vehicles. US Department of Energy (DOE) catalyst targets suggest decreased loadings (0.25mg/cm^2) and improved durability (>5000 hours) are required to help enable commercial competitiveness. To date, approaches looking to replace Pt with a non-platinum-group metal have met with limited success. "Thrifting" of Pt (i.e., ultra-low Pt loadings) seems to be the most likely (near term) option for meeting cost, performance and durability targets.

A promising approach is that of preparing catalysts with extended surfaces of Pt as these materials have shown improvements in specific activity and durability, largely through the pioneering work of 3M[1], but also in other related structures[2]. We have specifically been targeting extended Pt surface nanostructures and have investigated multiple synthesis techniques including sputtering, chemical vapor deposition, atomic layer deposition, direct synthesis, and galvanic displacement with significant emphasis on the galvanic displacement process. The galvanic displacement process involves the displacement of less noble metal nanotemplates by Pt ions in solution. Our galvanic displacement efforts have focused on nanowires, nanotubes and nanoplates, made from templates of Ag, Cu, Ni and Co.

Electrochemical activity and durability of materials produced will be presented showing that mass activities as high as 900 mA/mg Pt (0.9V IR free) have been met and high surface areas, up to 90 m^2/g Pt, have been reached. Special attention will be focused on the implementation of Pt nanotubes synthesized from Ag nanowires and advanced characterization of these materials. Specific challenges of the materials used in synthesis and their optimization in electrodes will be presented.

References

1. Mark K. Debe, Alison K. Schmoeckel, George D. Vernstrom and Radoslav Atanasoski, *Journal of Power Sources*, 161, 1002-1011,2006.
2. Z. Chen, W. Li, M. Waje, Y. S. Yan, „Supportless Pt and PtPd nanotubes as electrocatalysts for oxygen reduction reaction", *Angew. Chem. Int. Ed.* 46, 4060-4063, 2007.