

The Effects of Polymer Electrolyte Fuel Cell Fabrication on Pt and Pt alloy Electrocatalysts

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There have been numerous studies in the past decade elucidating the effects of fuel cell operating conditions on the degradation of high surface area carbon-supported Pt and Pt alloy nanoparticle electrocatalysts.^{1,2} These studies have mainly utilized *ex situ* microscopy techniques or *in situ* evaluation of electrochemically-active surface area and electrocatalytic activity.³ There have been relatively few studies on the effects of the various steps in the membrane-electrode assembly (MEA) preparation process on the physical and chemical properties of the catalyst and on electrochemical utilization of the Pt surface area.⁴

In this paper we report on studies using small angle X-ray scattering (SAXS), ultra-small angle X-ray scattering (USAXS)⁴, and X-ray fluorescence spectroscopy (XRF) to determine Pt or alloy particle size, Pt and carbon support particle and agglomerate size, and alloy composition, respectively. The penetrating nature of high energy X-rays allows these properties to be determined not only for the dried catalyst-ionomer inks and for the MEAs, but also for the solvent-containing inks.⁴

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References

1. S. Chen, H.A. Gasteiger, K. Hayakawa, T. Tada, Y. Shao-Horn, "Platinum-Alloy Cathode Catalyst Degradation in Proton Exchange Membrane Fuel Cells: Nanometer-Scale Compositional and Morphological Changes", *J. Electrochem. Soc.* **157** (1) (2010) A82-A97.
2. F.A. de Bruijn, VAT Dam, GJM Janssen, "Durability and degradation issues of PEM fuel cell components", *Fuel Cells* **8**(1) (2008) 3-22.
3. Y. Shao-Horn, W.C. Sheng, S. Chen, P.J. Ferreira, E.F. Holby, D. Morgan, "Instability of supported platinum nanoparticles in low-temperature fuel cells" *Topics in Catalysis* **46**(3-4) (2007) 285-305.
4. F. Xu, H.Y. Zhang, J. Ilavsky, L. Stanciu, D. Ho, M.J. Justice, H. I. Petrache, J.A. Xie, "Investigation of a Catalyst Ink Dispersion Using Both Ultra-Small-Angle X-ray Scattering and Cryogenic TEM" *Langmuir* **26** (2010) 26 (24), 19199-19208.