STRUCTURAL AND ELECTROCHEMICAL CHARACTERIZATION OF ULTRA-LOW PLATINUM, CARBON SUPPORTED ELECTROCATALYSTS FOR PEMFC

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Introduction

One of the major issues delaying the mass introduction of PEMFCs for compact, residential and automotive applications is the high cost of platinum and the relatively large amounts of Pt currently required to meet the performance requirements as cathode electrocatalyst for the oxygen reduction reaction (ORR). *Superior Micro Powders* (SMP) has implemented its spray-based approach [1] for electrocatalyst synthesis to produce high dispersion ultra-low-Pt-content electrocatalysts which are able to deliver higher power densities at ultra-low-Pt-loadings in MEA structures.

Experimental

The analyzed catalysts are 5, 10, 20 and 40 wt. % Pt supported on carbon blacks such as Vulcan XC-72, Shawinigan black and Ketjenblack. Extensive characterization of each electrocatalyst's structure was performed using electrochemical and structural (CO chemisorption, XRD, XPS, TEM) methods.

The MEAs were prepared by the technique as described in detail previously [2] and tested in a single MEA hydrogen/air (oxygen) PEMFC. The platinum loading was varied between 0.05 and 1 mg Pt/cm^2 for the cathode side and between 0.05 and 0.2 mg Pt/cm^2 for the anode.

Results

TEM microphotographs and Pt cluster size distributions show that for Vulcan XC-72 and 10 wt.% Pt concentration, an average Pt crystallite size of d_{av} = 1.8 nm was determined for the SMP electrocatalyst (Figure 1). This result shows that SMP spray generation method produces electrocatalysts with high Pt dispersion. The high Pt dispersion in combination with the unique secondary structure of the SMP electrocatalysts is the major factor contributing to the high performance of the SMP electrocatalysts in ultra-low-Pt-loading MEA structures.

As an example of the electrochemical performance of an extremely low Pt loading MEA structure, Figure 3 shows the polarization curve obtained with 5 wt.% Pt/ C as cathode electrocatalyst at 0.1 mg Pt/cm^2 loading. The overall performance shows the applicability of such ultra-low-Pt-loading MEAs for compact and residential applications.

Detailed analysis of the structure of different wt.% Pt electrocatalysts and their optimal loading in MEAs will be presented.

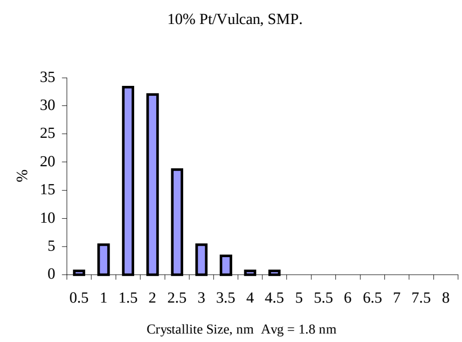

Figure 1. Platinum cluster size distribution as determined by High Resolution TEM.

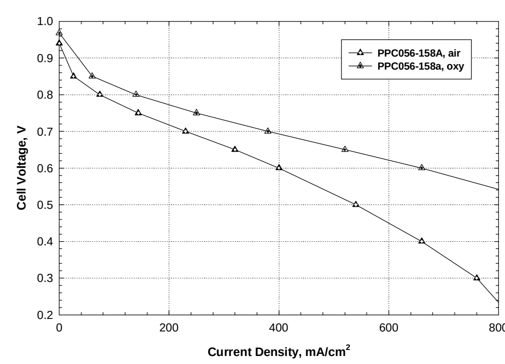

Figure 2. Polarization curve for 0.15 mg Pt/cm^2 (0.1 mg Pt/cm^2 in the cathode layer) total loading achieved with 5 wt.% Pt/C SMP electrocatalyst.

References:

1. T. T. Kodas, M. Hampden-Smith, J. Caruso, D. J. Skamser, Q. H. Powell, Metal-Carbon Composite Powders, Methods for Producing Powders and Devices Fabricated from Same, Patent Number US6103393
2. S. Gamburzev, A. John Appleby, K. Kunze, P. Atanassova, P. Atanassov, M. Hampden-Smith, T. Kodas, Performance of PEMFC with Improved Pt Supported on Carbon Catalyst, *The Proceedings of 197th ECS meeting, May 14-18, 2000, Toronto, Abs. 88*

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