

Silica coating of PEM fuel cell Pt/carbon electrocatalysts to enhance durability upon operation

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Proton Exchange Membrane Fuel Cells (PEMFCs) are electrochemical devices that produce electricity (and water as a byproduct) from the chemical reaction of hydrogen and oxygen, where hydrogen is oxidized at the anode and oxygen is reduced at the cathode. Both reactions need to be catalyzed to overcome their slow kinetics, particularly the oxygen reduction reaction (ORR). Platinum supported on carbon black (Pt/CB) is the primary catalyst used in practical PEMFC applications due to its high activity. PEMFCs have shown great promise in applications such as transportation and stationary power generation¹.

However, the harsh operating conditions—high potentials and acidic environments—accelerate the catalyst degradation by processes such as carbon corrosion, Pt sintering and dissolution. These degradation mechanisms compromise the catalyst's stability and reduce the long-term efficiency of the fuel cell. In this matter, it becomes necessary to focus on enhancing the stability of both the catalyst nanoparticles and the support material.

As a possible solution, the use of silica-coating method to increase the stability of the support has been well studied in the literature^{2,3}. By covering the Pt/C catalyst with a porous silica layer, one could prevent the particles from dissolution and sintering by forming a protective barrier, leading to an increase in the catalyst stability over time, while the porosity of the layer ensures access to the underlying Pt particles for the reactants. Carbon Xerogels (CXs) are promising candidates as catalyst supports as it is possible to control their meso/macroporosity. This control enables optimization of the mass transport properties of the catalysts⁴.

This project aims at developing silica-coating methods for Pt/CX catalysts, with a focus on achieving controlled layer thickness, together with uniformity of the coating and pores structure. The catalysts were characterized for their electrochemical and surface properties using nitrogen physisorption, mercury porosimetry, electron microscopy, and accelerated stress tests (ASTs) on Rotating Disk Electrode systems. Ultimately, the most promising catalysts will be integrated into a membrane-electrode assembly (MEA) for performance evaluation.

References

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