Argonne NATIONAL LABORATORY

Chemical Engineering Division

Finding more durable, less costly fuel cell materials

One of the main barriers to the commercialization of polymer electrolyte fuel cell systems, especially for automotive use, is the high cost of the platinum electrocatalysts. Aside from the cost of the precious metal, concern has also been raised over the adequacy of the world supply of platinum, if fuel cell vehicles were to make a significant penetration into the global automotive fleet. In Argonne's Chemical Engineering Division, chemists are working toward the development of low-cost non-platinum electrocatalysts for the oxygen reduction reaction--durable materials that would be stable in the fuel cell's operating environment and retain high electrochemical activity over the design lifetime of the fuel cell. Although platinum is used in both the anode and the cathode of the fuel cell, developing alternative oxygen reduction catalysts for the cathode is the more challenging of the two.

Deborah Myer (group leader, hydrogen and fuel cell materials) prepares to test a non-platinum material sample for oxygen reduction reaction activity.

Argonne's approach involves two systems: bi-metallic base metal/noble metal systems, using conventional carbon and alternative supports, and metal centers attached to electronically-conductive polymer backbones. Results to date suggest that alloying carbon-supported ruthenium with select transition metals is a promising approach.

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For More Information

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How It Works

The platinum in polymer electrolyte fuel cell anodes acts as an electrocatalyst, helping to separate hydrogen into protons and electrons. On the cathodes, the platinum helps the oxygen, protons, and electrons combine to produce water.

Over time, the performance of polymer electrolyte fuel cells with platinum or platinum alloy electrocatalysts degrades. This has been attributed to a loss of the electrochemically active surface area of the platinum. One proposed cause is that platinum oxidizes and dissolves at high potentials often encountered at the cathode; such a process would be exacerbated with repeated cycling between high and low cathode potentials, which lead to platinum oxidation and reduction, respectively. The dissolved platinum then either deposits on existing platinum particles to form larger particles (often referred to as platinum ripening), or diffuses into an electrochemically inaccessible portion of the membrane-electrode assembly or ist support structure, such as the gas diffusion layer. Measurements indicate that dissolution of platinum increases with increasing potentials that are encountered on the cathode of the fuel cell at low power output (for example, during idling) and possibly during startup and shutdown.