Chemical Engineering Division

Learning why platinum fuel cell electrocatalysts degrade

Polymer electrolyte fuel cells (currently of great interest for both transportation and stationary use) commonly use a platinum catalyst in the anodes and cathodes (electrodes) to promote the reactions that generate electrical energy. Over time, fuel cell performance decreases, and it is believed that this is because the platinum dissolves away, resulting in a decrease of the electrochemically active surface area of the catalyst.

Researchers in Argonne's Chemical Engineering Division are studying the stability of platinum to determine how and why this occurs. Several factors are believed to be involved in the platinum dissolution processes, including the nature and form of the electrolyte, the oxidation state of the platinum, the electrode potential and variation of the potential over the duty cycle of the fuel cell, and temperature. A better understanding of how platinum behaves could lead to improvements in its performance, thus requiring less of it for sustained performance over the lifetime of the fuel cell, until more cost-effective alternative materials can be found.

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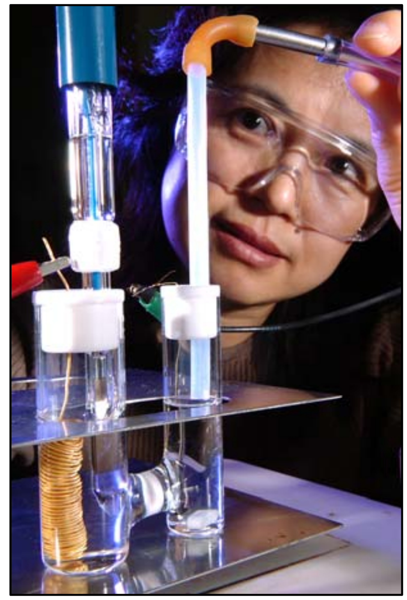

Chemist Xiaoping Wang measures the stability of a platinum cathode electrocatalyst.

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.