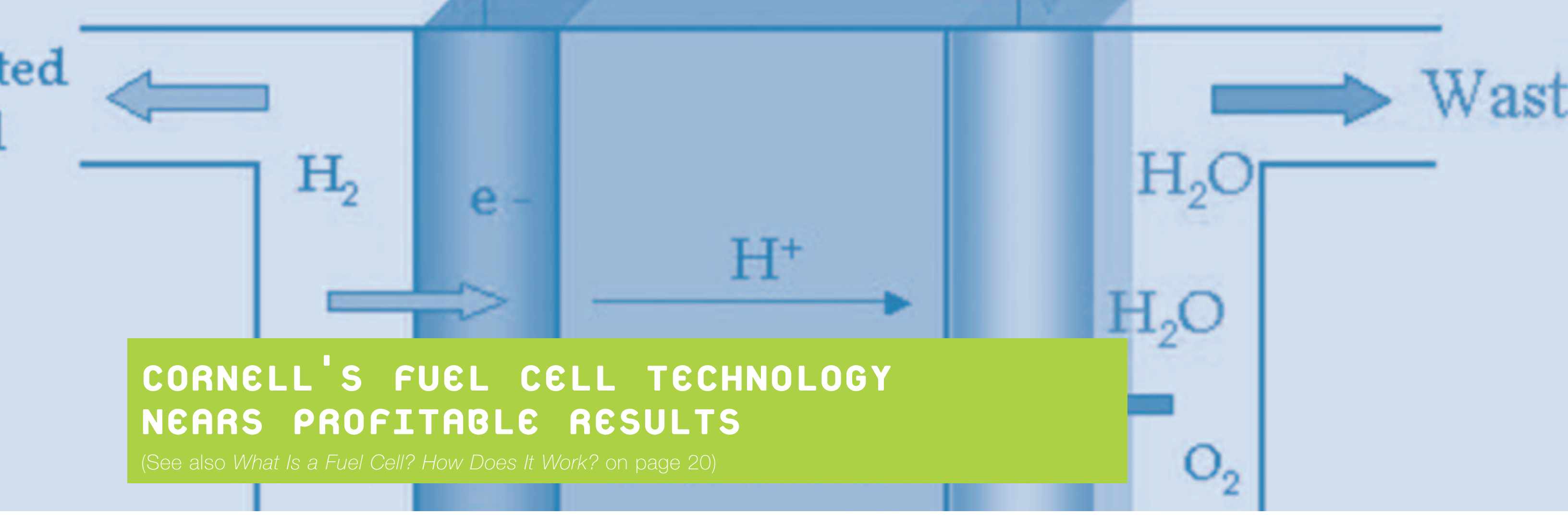
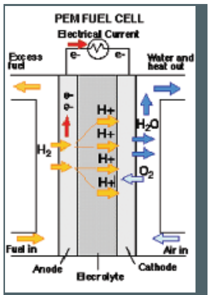


Cornell's Fuel Cell Technology Nears Profitable Results

(See also *What Is a Fuel Cell? How Does It Work?* on page 20)

The catalyst on fuel cell electrodes is where electricity is created as a fuel, such as hydrogen or methanol, and then is oxidized electrochemically.

In 2001, while Frank J. DiSalvo and Héctor D. Abruña, Chemistry and Chemical Biology, were discussing the research of Abruña's group on catalysts for fuel cells, DiSalvo made a recommendation that would change the course of both their research efforts and lead to the creation of the Cornell Fuel Cell Institute. Sean Smith, a doctoral candidate working with Abruña, had made a surprisingly efficient new catalyst for fuel cell electrodes by depositing atoms of bismuth on the surface of the platinum. DiSalvo suggested trying an ordered-intermetallic compound made from platinum and bismuth (PtBi) instead. The initial test results of the new catalyst with formic acid were so promising that both research groups, Abruña's and DiSalvo's, worked intently at discovering new intermetallic catalysts.



PEM Feul Cell

The catalyst on fuel cell electrodes is where electricity is created as a fuel, such as hydrogen or methanol, and then is oxidized electrochemically. Platinum is an excellent catalyst for fuel cells, but it has two serious flaws. First, it is extremely expensive. But even more problematic, platinum is extremely sensitive to carbon monoxide (CO). CO poisons platinum catalysts by strongly bonding to the platinum and preventing the fuel from reaching the catalytic surface and oxidizing. This is not a problem in fuel cells operating at high temperatures, but it is a problem in PEM (polymer electrolyte or proton-exchange membrane) fuel cells, which operate at temperatures below 200°C.

PEM fuel cells are the focus of significant commercial and academic research because they are attractive for portable applications such as power supplies for cell phones and laptop computers. They are also of great interest to automakers. Exposure to an environment rich in CO will shut down a pure platinum catalytic electrode in a matter of seconds. Platinum alloys poison much more slowly, but exposure to CO, even in the low concentrations found in hydrogen, still causes them to relatively quickly lose much of their ability to catalyze a fuel. The new intermetallic catalysts from Cornell do not seem to poison at all, and therefore lose none of their ability to oxidize fuel over time. This gives them a significant advantage over existing catalysts.

Frank DiMeo/CU

Héctor Abruña

Until DiSalvo and Abruña, researchers had not explored the use of ordered-intermetallic compounds in catalytic electrodes for fuel cell electrodes. The reason for the oversight may have been that most catalyst researchers did not fully appreciate the difference between ordered-intermetallic compounds and alloys. Ordered-intermetallic compounds are structured materials in which two or more elements are chemically bound in a specific three-dimensional arrangement, resulting in a consistent structure throughout the material (in the case of PtBi, it means that Pt atoms alternate with Bi atoms in all directions). Alloys, on the other hand, are solid solutions of two compatible metals. Previously, fuel cell catalyst research had focused on alloys of platinum and materials close to it in the periodic table such as ruthenium and osmium. These alloy catalysts work well, but their structure is random which affects their effectiveness.

Until DiSalvo and Abruña, researchers had not explored the use of ordered-intermetallic compounds in catalytic electrodes for fuel cell electrodes.

The Department of Energy (DOE) was shown preliminary results of tests of the electrochemical activity of PtBi and several other catalysts made by DiSalvo and Abruña's research groups, including PtBi2 and PtPb (platinum-lead), both of which outperform PtBi in converting fuel into electricity. The results were so favorable that the DOE awarded Cornell University $2.25 million over three years to establish a multidisciplinary research center to explore new materials for fuel cells, the Cornell Fuel Cell Institute (CFCI). This funding was bolstered recently when Cornell partnered with the Rensselear Polytechnic Institute (RPI), the lead institution, to receive a five-year grant of $1 million from New York State to establish a CAT (Center for Advanced Technology) in Energy Efficiency. The themes of the CAT are fuel cells and efficient lighting. The fuel cell theme gets $350,000, of which Cornell receives $250,000.

Frank DiMeo/CU

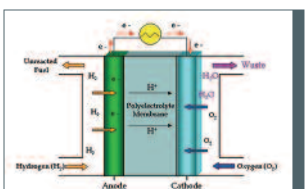
Frank DiSalvo

> The scientists of the CFCI believe that new materials are needed to fully realize the potential of fuel cells to become a primary source of power for mobile electronics and motor vehicles.

The DOE generously funded the CFCI and its materials-based research efforts because, despite more than a decade of intense engineering efforts, the performance of fuel cells still falls short of what is necessary to ensure their widespread use and adoption. The scientists of the CFCI believe that new materials are needed to fully realize the potential of fuel cells to become a primary source of power for mobile electronics and motor vehicles.

> The CFCI works closely with several companies with an interest in fuel cells, including MTI Micro Fuel Cells in Albany, New York, the General Motors Research Center in Honeoye Falls, New York, and the Ford Motor Company.

CFCI's current efforts are focused on finding new ordered-intermetallic catalysts and developing new materials for the electrodes, both anode and cathode, and the proton-exchange membranes. CFCI researchers are also developing new methods for the efficient production and realistic testing of new materials. Some of this work is close to demonstrating profitable rewards as CFCI switches to using combinatorial methods to make and test ordered-intermetallic compounds for catalytic properties.



Polyelectrolyte Membrane

The CFCI provides an exciting opportunity for scientists at Cornell to work closely with industry to solve problems of direct commercial value and of urgent national and international interest. Any new intermetallic catalyst created by the CFCI has the potential to make a significant commercial impact through immediate adoption by companies and incorporation into their products. Because fuel cells are more efficient and far less polluting than current systems providing power to homes, electronics, and automobiles, their widespread adoption will have a significant impact on the quality of our lives.

The CFCI works closely with several companies with an interest in fuel cells, including MTI Micro Fuel Cells in Albany, New York, the General Motors Research Center in Honeoye Falls, New York, and the Ford Motor Company. Discussions are already underway with one company interested in licensing the ordered-intermetallic catalyst technology for the purposes of making and selling catalysts for fuel cells and other uses.

With such a high-powered group of scientists collaborating on finding material solutions to the problems of fuel cells, many more commercially valuable technologies are likely to be developed at the CFCI over the next few years. The future is bright and it is highly possible that the CFCI and Cornell University will be instrumental in bringing about a revolution in power by enabling fuel cells to achieve the low cost and high performance necessary for widespread adoption. Now, Cornellians, this would be something to write home about!

Scott S. Macfarlane, Senior Licensing Associate
The Physical Sciences
The Cornell Center for Technology, Enterprise, and Commercialization (CCTEC)

For more information:

Cornell Center for Technology, Enterprise, and Commercialization (CCTEC)
20 Thornwood Drive, Suite 105
Ithaca, New York 14850
(607) 257-1081, Fax: (607) 257-1015
www.cctec.cornell.edu