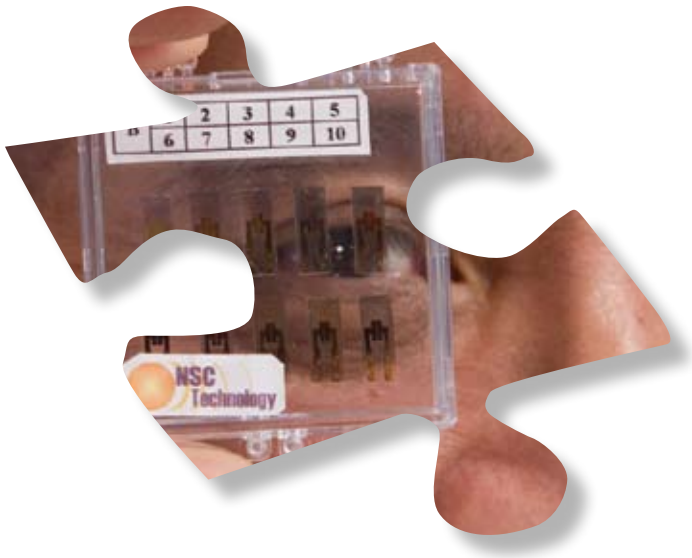
Platinum ambition:

FUEL CELLS GET PERFORMANCE BOOST



Golden goose eggs and the Midas touch are the stuff of fairy tales, but the cool reality of platinum-based catalysts is a major part of C.J. Zhong's research into next-generation fuel cells that could help break America's dependence on petroleum products.

Zhong says hydrogen-powered fuel cells work something like a conventional battery, with one major exception: they never run out. The fuel cell has two electrodes, an anode and a cathode, separated by a membrane. Oxygen passes over one electrode and hydrogen over the other.

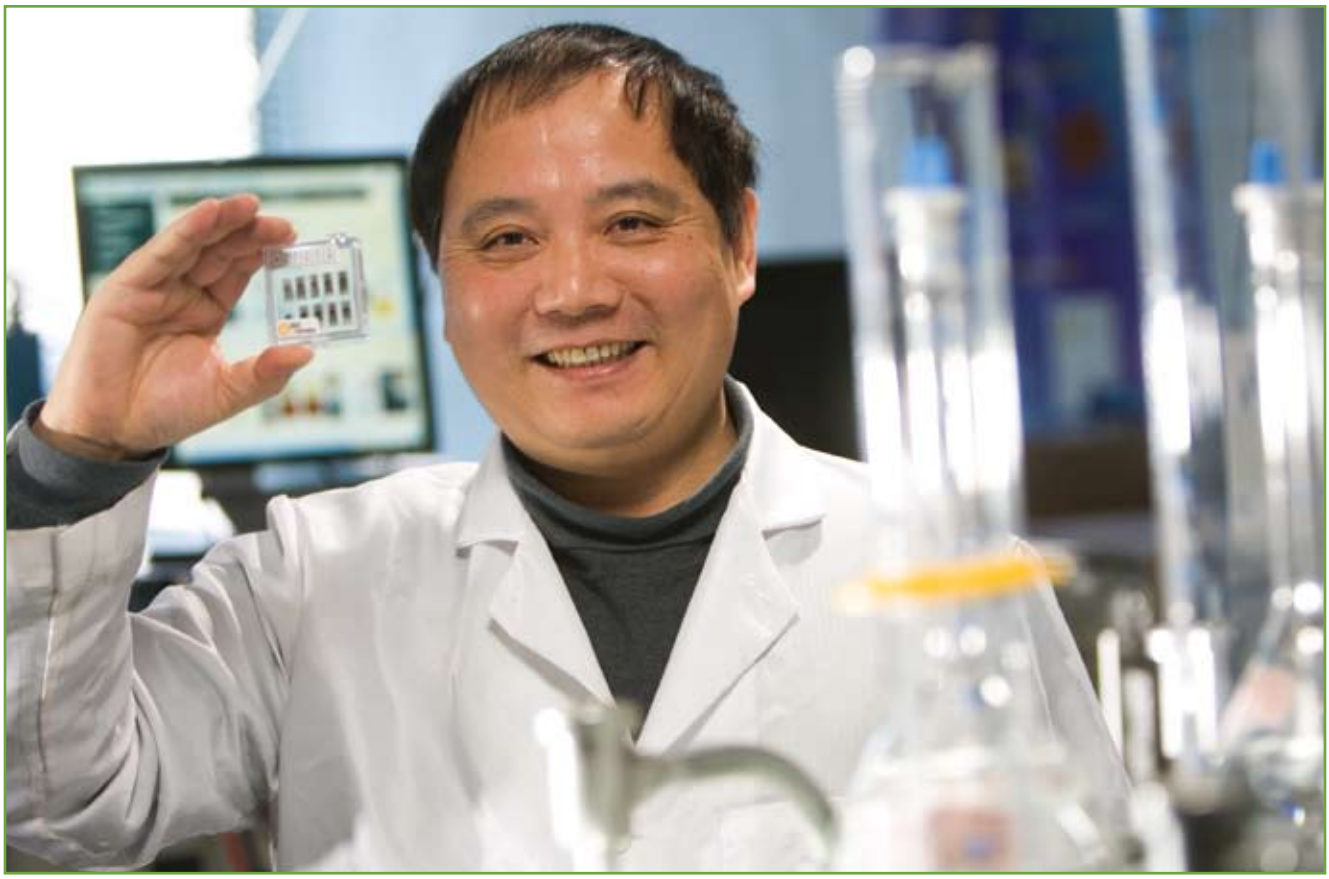
The hydrogen reacts on a catalyst on the electrode anode that converts the hydrogen gas into negatively charged electrons (e^-) and positively charged ions (H^+).

The electrons flow out of the cell to be used as electrical energy. The hydrogen ions move through the electrolyte membrane to the cathode electrode where they combine with the reduced oxygen species to produce water. It's an approach that scientists agree will ultimately produce clean and low-cost energy.

And, of all metals, the catalyst platinum turns out to be the best at speeding up the necessary chemical reaction within hydrogen-powered fuel cells. But, platinum's superior ability to catalyze the combination of the oxygen from the atmosphere with hydrogen, which can be released from a water-electrolyzer that has been exposed to sunlight, is offset by both economics and chemistry, Zhong explained.

"Platinum is expensive, twice the market price of gold, and there is also a limited quantity, which further drives up the price," he said. "Reforming of natural gas is one of the main sources of hydrogen, but that process also creates carbon monoxide as a by-product and carbon monoxide also destroys the platinum's catalytic activity."

Zhong's research into refining platinum's capacity as a fuel-cell catalyst has several goals. Besides reducing the amount of platinum used in the catalyst, he is also



C.J. Zhong

exploring how to increase its activity and stability. Improving its stability is key because consumers will reasonably expect the fuel cell to last at least two to three years before any maintenance.

Discovering a new catalyst material is challenging, he said, and in addition to doing that, his research will be more productive by focusing on reducing platinum load with increased activity and stability, because the catalyst could work better when there is less platinum present.

This metallic marvel currently comprises about 30 percent of the cost in manufacturing fuel cells. Zhong is well aware of the consumer mindset that demands a low price point before adopting a new technology, no matter how much people would prefer to switch from carbon-based fuel sources to the so-called "hydrogen economy."

To reduce the cost of fuel cells that use platinum catalysts, Zhong is pursuing two distinct avenues of research. The first focuses on alloy creation, in which less expensive metals such as nickel and iron are added to the platinum. Carbon is also added to the mix because it disperses the catalysts so that more surface areas can be exposed.

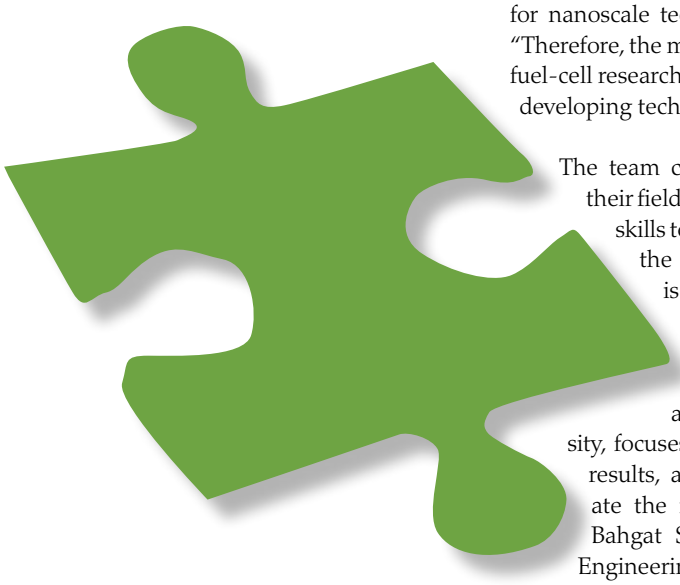
The second technique exploits the latest advance in the growing field of nanotechnology for the design and fabrication of nanostructured catalysts.

"It's partially about surface area," Zhong said. "When you use nanoparticles of platinum, you increase the surface areas significantly without increasing the total amount of platinum."

To advance his research in this project, Zhong received a major National Science Foundation (NSF) grant in September

2007, valued at $1 million over four years. It represents the first award from the NSF's Nanoscale Interdisciplinary Research Team (NIRT) program won by Binghamton University.

"NIRT's goal is to find societal benefits for nanoscale technology," Zhong said. "Therefore, the major focus of our team's fuel-cell research involves the use of this developing technology."



The team comprises specialists in their field who contribute specific skills to the research outside of the basic chemistry, which is Zhong's expertise. For example, Susan Lu, System Science and Industrial Engineering at Binghamton University, focuses on statistics from test results, and can thereby evaluate the reliability of fuel cells. Bahgat Sammakia, Mechanical Engineering, also at Binghamton, is expert in materials characterization and electronics packaging, coordinating equipment and research facility use. A fellow chemist from Southern Illinois University in Carbondale, Lichang Wang, has significant experience in molecular modeling and computational chemistry of the nanoscale catalysts under consideration.

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The NIRT grant provides more resources that will sustain the team for a longer time, which allows it to conduct more in-depth research of nanotechnology into a critical area of fuel-cell development, Zhong added.

The government is willing to invest in this area of alternative energy research, whether as tax breaks to hybrid car owners or NSF grants to scientists such as Zhong and his team, because the payback in environmental protection is so significant. Fuel cells produce the most environmentally friendly by-product of any energy source: pure water that can be returned to the earth or air without detriment.

"Money spent up front is worth it to them because it represents a clean technology," Zhong said.

While hydrogen-fueled power sources are now mostly engineered for use in automobiles, they have enormous potential to run factories and other large facilities, he added.

Zhong notes that estimates for producing commercially viable fuel cells range from an optimistic five years to a more realistic 15.

Industry sources, notably automobile manufacturers such as Honda, are also contributing to the research for lower cost yet effective fuel cells.

"No car company can afford not to do fuel-cell technology research," Zhong said.

"Remember what happened to Kodak and photographic film. Once, they set the standard and were the industry leaders. Now, others have taken the lead in the era of digital cameras," he added. ■

— Katherine Karlson