

## CHEMISTRY

# Ceramic Sponges That Sop Up Sulfur Could Boost Energy Technologies

Fuel cells and coal-burning plants may seem worlds apart technologically, but they share a common enemy: sulfur. Even a trace of it in the hydrogen gas that feeds fuel cells will poison the catalysts that convert hydrogen into electricity. Next-generation coal plants that will convert coal into a hydrogen-rich gas must also remove sulfur before the gas can be transformed into liquid fuels or used in fuel cells. Current technologies for capturing sulfur have made some progress, but often at a high cost. Now, new work with compounds called rare earth oxides could shift sulfur removal—and energy-generating technologies potentially stymied by sulfur—into high gear.

On page 1508, chemical engineer Maria Flytzani-Stephanopoulos and colleagues at Tufts University in Medford, Massachusetts, report turning a type of ceramic powder into a chemical sponge that quickly sops up sulfur and then can be “wrung out” and reused over and over. “It looks potentially important,” says Michael Krumpelt, a chemical technology scientist at Argonne National Laboratory in Illinois—provided, Krumpelt adds, that engineers can incorporate the new materials into a system that is simple and thus cheap.

The need for a cheap way to remove sulfur from fuel gases has spurred engineers for decades. In many countries, coal-fired electric plants are required to install smokestack scrubbers to reduce emissions of sulfur dioxide, a chief component of acid rain. And many developers would like to be able to use a wide range of hydrocarbon fuels as a feedstock for generating the molecular hydrogen that powers most fuel cells. But even the trace amounts of sulfur that remain create havoc. “It’s been a big problem,” says Sossina Haile, an expert on high-temperature solid oxide fuel cells at the California Institute of Technology in Pasadena.

One option for removing sulfur has been using another spongelike ceramic called zinc oxide, which readily grabs on to sulfur, converting the zinc oxide to zinc sulfide. But it’s far from a perfect solution. Once the outer surface becomes coated with zinc sulfide, the interior of the ceramic has trouble grabbing more sulfur. And zinc sulfide is not easily converted back to zinc oxide. So zinc oxide-based

filters must be replaced regularly.

Researchers have explored using lanthanum and other rare earth oxides for years. Like zinc oxide, these ceramics also readily grab sulfur, but unlike zinc oxide they can later release it, making them reusable. In previous studies, researchers have exposed the ceramics to sulfur for long periods, allowing gases to percolate completely through the crystalline



**Pure and simple.** Solid-oxide fuel cells, such as the ones in this 100-kilowatt heating plant in the Netherlands, require sulfur-free hydrogen.

structure of the material. But such heavily saturated ceramics give up their sulfur too slowly to be practical for real-world use, says Flytzani-Stephanopoulos.

For their current study, the Tufts researchers tried exposing their rare earth oxides to sulfur-bearing gases for relatively brief periods, so they became coated with sulfur only on their surface. They found that lanthanum-based oxides, in particular, both grabbed and released a full surface complement of sulfur in just minutes. Moreover, they could reduce the sulfur content in fuel streams to the parts-per-billion range—good enough to protect even the most sensitive fuel-cell catalysts. When the researchers ran their materials through about 100 such charging and discharging cycles, they found little change.

An industrial plant, Krumpelt says, would use multiple filters, switching back and forth so some sop up sulfur while others discharge it. In their paper, the Tufts researchers outline such a system for use with solid oxide fuel cells, which are being developed as backup power sources for hospitals and other industrial users. If such a design can keep fuel-cell catalysts working, it could go a long way toward making such fuel cells reliable enough to succeed in the real world.

—ROBERT F. SERVICE

## Polar Satellites Pared

The U.S. Department of Defense has dropped a number of climate sensors from a satellite program as part of a restructuring of the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) (*Science*, 2 June, p. 1296). Along with scaling the program back from six satellites to two, with an optional two more, the Pentagon stripped sensors that measure solar and Earth electromagnetic radiation—useful for detecting long-term heat trends—and an aerosol detector to better understand how clouds affect climate. “The community was depending on NPOESS for the continuity of a number of data sets,” says Roy Spencer of the University of Alabama, Huntsville. “A lot of scientists will be disappointed.”

In a 5 June letter to lawmakers, Pentagon officials say that the instruments eliminated could fly “if the sensors are provided from outside the overall program.” It also says the cuts will save \$2 billion on the program, which has been billions over budget and years late. Although the instruments “are not [relatively] expensive,” says Berrien Moore of the University of New Hampshire, Durham, NASA’s depleted budget may make that impossible. Congress will signal its response in pending agency budgets for next year.

—ELI KINTISCH

## Harvard OKs Research Cloning

Harvard University researchers have been given the go-ahead to use cloning to create disease-specific lines of human embryonic stem cells. At a 6 June press conference, scientists described plans to use somatic cell nuclear transfer—also referred to as research cloning—to study diabetes and blood and neurodegenerative diseases.

No fewer than five institutions and eight Institutional Review Boards approved the proposals. Private funding will support the work, which cannot be paid for with federal dollars. Researchers plan to use excess eggs from fertility clinics as well as fresh eggs from unpaid so-called compassionate donors.

Douglas Melton and Kevin Eggan of the Harvard Stem Cell Institute plan to create stem cell lines that will enable them to study diabetes in a dish. Eggan also plans to use the technique to study neurodegenerative diseases such as amyotrophic lateral sclerosis. George Daley of Children’s Hospital Boston is aiming for customized cell lines using skin biopsies from patients with sickle cell anemia and other blood diseases.

—CONSTANCE HOLDEN