Sulfur-aluminum supercharges a new battery

Alkaline batteries, so the TV ads claim, keep on "going, and going, and going." Now, an experimental battery may keep on going, going, going even longer than the alkalines.

The new battery uses sulfur and aluminum to store charge, more than doubling the discharge time of a typical D-cell flashlight battery, says Stuart Licht, a chemist at Clark University in Worcester, Mass. Compared to other consumer batteries, such as those used in cars or radios, the experimental sulfur-aluminum aqueous cell holds more energy per pound, discharges longer, weighs less, and uses fewer noxious chemicals, Licht told a meeting of the American Chemical Society in Chicago last week. Licht and Dharmasena Peramunage, now at EIC Laboratories in Norwood, Mass., also report on the new battery in the Aug. 20 SCIENCE.

"This battery stores 220 watt-hours per kilogram and discharges up to 17 hours," says Licht. "In comparison, a good quality alkaline battery — a D-cell for a flashlight — stores 95 watt-hours per kilogram and discharges for about 6.5 hours. So far, we've only accessed 25 percent of our battery's theoretical capacity, which is over 900 watt-hours per kilogram. But we're confident we can get much more" than 25 percent.

The new battery uses a solid sulfur cathode to supply positive charge and an aluminum anode for negative charge. But there's a trick involved: To get solid sulfur (an insulator at room temperature) to conduct electricity, Licht and Peramunage bathed it in an aqueous polysulfide solution saturated with sulfur. To help the aluminum anode, they used a strong alkaline solution. The result: large stored charges and strong current flow.

"Sulfur and aluminum are wonderful chemicals for batteries," Licht says. "Aluminum is the most abundant metal in the Earth's crust, and we have piles of sulfur extracted from fossil fuels. They're both plentiful, cheap, lightweight, environmentally safe, and easy to work with."

Other types of batteries — such as lead-acid, nickel-cadmium, lithium, and sodium-sulfur systems — all have drawbacks, Licht contends. "Lead-acid and nickel-cadmium pose environmental problems, and they're heavy, so a car can't go far between recharges. Both sodium and lithium batteries explode if water touches them. And sodium-sulfur batteries operate above 600°F, with safety and cost constraints." In contrast, he adds, the sulfur-aluminum cell runs at room temperature, storing seven times as much charge per pound as a lead-acid battery.

To be useful for electric vehicles, says Licht, a battery must win on two fronts: energy and power. The energy storage capacity measures how much charge it holds — the automotive equivalent of the size of the gas tank. Power measures how well the battery delivers "juice" to the engine for quick starts and fast acceleration. Licht says that, in theory, his battery does well in both areas, "with enough energy per pound to move a car several hundred miles before recharging — much farther than the 80 miles now possible with other batteries."

This galvanic tale is still unfolding. "We're only in the beginning stages, building tiny experimental cells," Licht says. "There's a long way to go before our battery reaches the marketplace."

— R. Lipkin

Measuring the deflection of light by Earth

Dedicated to the highly accurate measurement of star positions, distances, and velocities, the Hipparcos satellite for nearly four years gathered data on more than 100,000 stars. But earlier this year, the spacecraft began to show the effects of prolonged exposure to radiation, and the steady stream of data flowing to Earth abruptly stopped. Unable to continue operating the satellite, the European Space Agency (ESA) in Paris ended communication with Hipparcos on Aug. 15.

Although this step marked the end of the satellite's mission, the huge volume of data relayed to Earth by Hipparcos provides the raw material for a variety of astronomical analyses and investigations. Among the possibilities is an opportunity to test Einstein's general theory of relativity in a realm not previously accessible to experiment.

In the Sept. 1 ASTROPHYSICAL JOURNAL LETTERS, Andrew Gould of the Institute for Advanced Study in Princeton, N.J., proposes a scheme by which Hipparcos data on star positions could be analyzed to detect the minuscule deflection of starlight caused by Earth's gravity.

"The question of whether general relativity is the true theory of gravity remains an open one," Gould asserts. "In the final analysis, this is an experimental question. [General relativity] should be subjected to as many tests as possible on as many scales as possible."

When Albert Einstein first proposed his general theory of relativity, he predicted that a light ray passing through a gravitational field would be deflected by an angle that depends on the mass of the body responsible for the field. In 1919, a team led by British astronomer Arthur Eddington dramatically confirmed Einstein's prediction by measuring the shift in apparent star positions caused by the sun as light from these stars grazed the sun's edge during a solar eclipse.

Since then, measurements of light and radio-wave deflections caused by bodies as large as a cluster of galaxies and as small as Jupiter (SN: 11/9/91, p.294) have extended the range of masses over which general relativity appears to hold. Because Jupiter is about 300 times more massive than Earth, detecting Earth's effect on starlight would provide a new test at the lower end of this range.

Gould's calculations indicate that the Hipparcos measurements of the relative positions of pairs of stars were sensitive enough to exhibit the expected gravitational deflection caused by Earth. He estimates that the resulting angular deflection roughly equals the angular width of a baseball on the moon, as seen from Earth. Although the gravitational bending of light from a single, typical star would be too small to discern, combining the measurements for all 100,000 stars would reveal Earth's effect, Gould concludes.

Michael A. C. Perryman of ESA and his co-workers have already used Hipparcos data to determine the light deflection caused by the sun far more precisely than was possible in previous experiments. They found that their measurements agree with theoretical predictions to within 0.7 percent.

— I. Peterson

Simple test for Alzheimer's

A skin test may someday solve one of the great frustrations facing physicians, researchers, and people suffering from memory loss: how to tell for sure whether Alzheimer's disease is responsible for an individual's forgetfulness. Doctors now diagnose this disease by eliminating all other possible causes, including old age, and can confirm that diagnosis only by examining the patient's brain after death.

Now neurobiologists have discovered that a particular "channel" molecule that allows potassium ions to move in and out of cells is missing or nonfunctional in people with Alzheimer's.

These ions play a key role in the formation of memories. So René Etcheberrigaray of the National Institute of Neurological Disorders and Stroke in Bethesda, Md., and his colleagues evaluated these channels in skin cells called fibroblasts, taken from people with and without Alzheimer's.

Those with the disease may also fail to move another key ion, calcium, the team reports in the Sept. 1 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES. Working with colleagues from Cornell Medical College's Burke Medical Research Institute in White Plains, N.Y., the researchers evaluated skin cells from 50 people and were able to pick out the 15 with Alzheimer's disease. They caution, however, that they need to verify this test in many more people. □