disappear. The work provides a "nice mechanism for localized changes to a single set of nerve terminals," Kandel says.

Still, one mystery remained. Because most typical proteins degrade within hours, it was unclear how CPEB could maintain changes within the nerve terminal that last many years, as some memories do. But then Si noticed that one end of CPEB carries a sequence that resembles one found in prions. Prions are proteins that exist in two conformational states, one of which is soluble whereas the other is insoluble and long-lasting in cells. The insoluble form is thought to turn the soluble form into its insoluble state when the two forms come in contact. That's the mechanism suspected in mammalian prion diseases.

In the second paper, Si showed that CPEB acts like a prion—at least in yeast. He linked the gene for CPEB to the gene for an enzyme that produces a blue color whenever CPEB is active in bringing about mRNA's translation into protein. When put into yeast, this hybrid gene turned most of the cells blue, indicating the presence of active protein. But some cells remained white. Further work showed that the active (blue) form of CPEB behaves like a prion. It forms insoluble clumps and also converts the inactive (white) protein into the blue form when blue and white yeast cells mate.

Although nobody knows whether CPEB behaves the same way in neurons, Kandel, Si, and Lindquist speculate that small amounts of prion CPEB, produced in a stimulated nerve ending, may convert many more inactive proteins into active forms. The active forms would help activate mRNA and stabilize the synapse, forming the memory.

Now the challenge is to test this idea in *Aplysia* and then in fruit flies and mice, both of which contain CPEB, as do humans. If the results pan out, they could lead to a new molecular theory of memory and a radically improved reputation for prions.

–INGRID WICKELGREN

CHEMISTRY

Newcomer Heats Up the Race for Practical Fuel Cells

Powering cars with fuel cells is an inviting prospect. The devices siphon electricity from fuel efficiently and without pollution. But they still face a bumpy road: The fuel cells most carmakers are pinning their hopes on—called polymer electrolyte membrane (PEM) fuel cells—have considerable drawbacks. They're expensive and operate at low temperatures, which reduces their efficiency and makes their fuel-converting catalyst prone to being poisoned by traces of carbon monoxide (CO) often present in the fuel. Two years ago, a group led by Sossina Haile of the California Institute of Technology in Pasadena offered a potential solution. Haile replaced the polymer electrolyte with one made from a crystalline material called a solid acid, which promised to be cheaper and more tolerant of CO. But solid-acid fuel cells had their own issues. Chief among them: The hydrogen fuel powering the cells reacts with sulfur in the crystals, causing the material to disintegrate.

Now on page 68, Haile and colleagues report sidestepping this problem with a new material that also boosts the power output of their devices fivefold. That is still orders of magnitude below what state-of-the-art PEM fuel cells put out, so the new cells won't be powering minivans anytime soon. Nevertheless, the work is "quite interesting," says Robert Savinell, a chemical engineer at Case Western Reserve University in Cleveland, Ohio. Savinell notes that solid-acid cells may need smaller amounts of precious metal catalysts and be simpler to manufacture than PEMs, which together could dramatically lower their cost.

These days, fuel cells come in nearly as many varieties as the cars they strive to power. However, all work essentially the same way. A catalyst at a positively charged electrode, or anode, strips hydrogen or other fuel molecules of electrons. The positive ions left behind drift through an electrolyte toward a negatively charged electrode, called a cathode. The electrolyte is impermeable to electrons, so they must travel to the cathode through an external wire, where along the way they can power an engine. At the cathode, the electrons and hydrogen ions combine with oxygen from air, creating water.

Carmakers like PEM fuel cells in part because the electrolytes are highly conductive and therefore generate abundant power quickly. But they do so at a cost. The cells work best with hydrogen, which is difficult to store in large quantities. And because they require liquid water to help shuttle hydrogen ions through the electrolyte, they must operate below 100°C. At such low temperatures, precious-metal catalysts work slowly and can become inactivated by binding to carbon monoxide. In principle, solid-acid electrolytes could operate at higher temperatures. But for decades few researchers took them seriously because they dissolve in liquid water.

Check your mirror. Solid-acid fuel cells might someday give the polymer-based cells that power this Mercedes a run for their money.

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Two years ago, Haile's team tried to solve that problem by operating solid-acid fuel cells at about 250°C—hot enough to turn any stray water into harmless vapor. Unfortunately, hydrogen in the fuel reacted with sulfur in the solid acid, tearing apart the electrolyte and generating hydrogen sulfide, another catalyst wrecker. Haile's team considered replacing the sulfur with phosphorus by using cesium dihydrogen phosphate (CsH_2PO_4) as an electrolyte. But at high temperatures, the H_2 reacts with oxygen to form water, a change that causes the remaining solid to crumble. "We did not think you could use the phosphate compound," Haile says.

Now the researchers have discovered an elegant solution: fighting water with water. Adding a tiny amount of water vapor to their system with the phosphate electrolyte, they found, prevents hydrogen molecules from leaching out of the solid to form more water. The new solid-acid fuel cells still don't put out as much power as the PEMs do. But Haile suspects that her team can get much closer by making the electrolyte membrane thinner so that ions can cross more easily. If so, solid-acid fuel cells could become cheaper than their rivals. The cells also work well with alternative fuels such as methanol, which are far easier to transport and store than gaseous hydrogen. Those advantages could make solid-acid fuel cells inviting indeed.

–ROBERT F. SERVICE