Batteries that Recharge in Seconds
A new process could let your laptop and cell phone recharge a hundred times faster than they do now.
By Katherine Bourzac

A new way of making battery electrodes based on nanostructured metal foams has been used to make a lithium-ion battery that can be 90 percent charged in two minutes. If the method can be commercialized, it could lead to laptops that charge in a few minutes or cell phones that charge in 30 seconds.

The methods used to make the ultrafast-charging electrodes are compatible with a range of battery chemistries; the researchers have also used them to make nickel-metal-hydride batteries, the kind commonly used in hybrid and electric vehicles.

How fast a battery can charge up and then release that power is primarily limited by the movement of electrons and ions into and out of the cathode, the electrode that is negative during recharging. Researchers have been trying to use nanostructured materials to improve the process, but there’s usually a trade-off between total energy storage capacity (which determines how long a battery can run before needing a recharge) and charge rates. “People solved half the problem,” says Paul Braun, professor of materials science and engineering at the University of Illinois at Urbana-Champaign.

Braun’s group has made highly porous metal foams coated with a large amount of active battery materials. The metal provides high electrical conductivity, and even though it’s porous, the structure holds enough active material to store a sufficient amount of energy. The pores allow for ions to move about unimpeded.

The first step in making the cathodes is to create a slurry of polymer spheres on the surface of a conductive substrate. Because of their shape and surface charge, the spheres self-assemble into a regular pattern. The Illinois researchers then use a common technique called electroplating to fill the space between the spheres with nickel. Next, they dissolve the polymer spheres, and most of the metal, to leave a nickel sponge that’s about 90 percent open space. Finally, they grow the active material on top of the sponge.

“it’s some distance to a product, but we have pretty good lab demos” with nickel-metal-hydride and lithium-ion batteries, says Braun. The Illinois group has made lithium-ion batteries that charge almost entirely in about two minutes. The method should be applicable to the cell sizes needed for laptops and electric cars, though the researchers have not made them yet.

“The performance they got is unprecedented,” says Andreas Stein, a professor of chemistry at the University of Minnesota. Stein pioneered the polymer-particle templating method that Braun’s group used. Braun’s work is described in the journal Nature Nanotechnology.

Jeff Dahn, professor of physics at Dalhousie University, is skeptical that these electrodes will ever end up in products. “When you look at the flow chart for making this structure, it’s pretty complicated, and that is going to be expensive,” he says.

Braun acknowledges: “There are lots of people coming up with elegant [electrode] structures, but
manufacturing them is tricky." He says, however, that his fabrication process combines existing methods that are currently widely used to make other products, if not to make batteries, and that it shouldn't be too difficult to adapt them. The process would add extra steps to making a battery, but these steps aren't particularly expensive or complex, Braun says.

Braun's group will next test the electrode structure with a wider range of battery chemistries and work on improving batteries' other half, the anode—a trickier project.

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