3-D battery structure shows new twist in battery design

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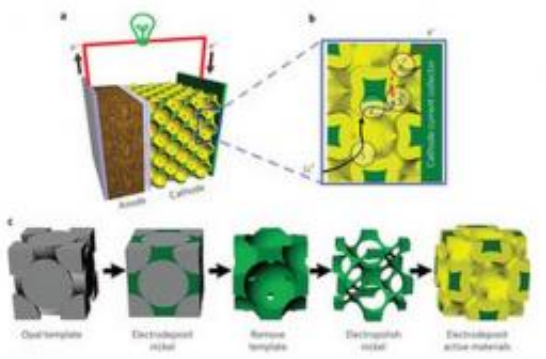

Bicontinuous battery electrode. Image: Nature Nanotechnology, doi:10.1038/nnano.2011.38

(PhysOrg.com) -- Battery life and driving range are two sticky phrases in discussions about why EVs have yet to hit mainstream use. Drivers still feel skittish about the idea of setting out on longer trips on batteries lasting too few miles and then losing time seeking a recharge. New developments in battery research may brighten the picture somewhat.

Eyes are trained on researchers at the University of Illinois at Urbana-Champaign, because they are doing research that may influence battery design.

Paul Braun, a professor of material science and engineering, working with graduate student Xindi Yu and postdoctoral researcher Huigang

Zhang, has come up with a 3-D nanostructure for battery cathodes. The result is a battery that can charge and discharge rapidly without compromising energy-storage capacity. Carry that into car talk, and it means a kind of battery that can be charged in as little time as it takes to fill up a car at a gas station. As important, the rapid charge and discharge method does nothing to diminish the battery capacity.

Drivers, if empowered with a five-minute charge capability, would think of the task of charging in the same way they would an internal combustion engine, said Braun. “You would just pull up to a charging station and fill up.”

The battery looks like a normal battery but the difference is inside. Braun and team wrapped a thin film into a 3-D structure and achieved high active volume and large current. Battery electrodes charged and discharged in a few seconds--ten to 100 times faster than equivalent bulk electrodes, in their demonstrations, but can perform normally in existing devices. Besides use in vehicles, the fast-charge battery design might also be useful in medical devices, lasers and military applications.

University of Illinois describes their process in more detail: They start off by coating a surface with tiny spheres and then pack them tightly into a lattice structure. The space between and around the spheres is filled with metal. Melting the spheres results in a spongelike 3-D scaffolding. The next step is electropolishing, a process that etches away the scaffold's surface, to enlarge the pores and make an open framework. The frame is coated with a thin film of the active material.

“The result is a bicontinuous electrode structure with small interconnects, so the lithium ions can move rapidly; a thin film active material, so the diffusion kinetics are rapid; and a metal framework with good electrical conductivity."

The group demonstrated both NiMH and Li-ion batteries, but any battery material, Braun said, that can be deposited on the metal frame can be used.

As such, Braun's work is not focused on pushing any specific battery product forward. "This is not linked to one very specific kind of battery, but rather it's a new paradigm in thinking about a battery in three dimensions for enhancing properties," he said. The work has been supported by the U.S. Army Research Laboratory and Department of Energy.

Earlier this year, the paper, "Three-dimensional bicontinuous ultrafast-charge and -discharge bulk battery electrodes," authored by Braun, Xindi Yu and Huigang Zhang, was published in *Nature Nanotechnology*.