Carbon Nanotubes Improve Fuel Cells

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A group of scientists has created a new, improved fuel-cell electrode that is very lightweight and thin. Composed of a network of single-walled carbon nanotubes, the electrode functions nearly as well as conventional electrodes but renders the entire fuel cell much lighter. The research is an important step toward lightweight power supplies, which are becoming necessary as electronic devices get ever smaller and more streamlined.

The research was performed by scientists from the Max Planck Institute for Solid State Research and the University of Darmstadt, both in Germany, and is described in the March 5, 2008, online edition of *Applied Physics Letters*.

“Fuel cells that are light and small have been proposed as energy conversion devices in various portable appliances, such as cell phones, cameras, and notebook computers. Since the space and weight of the devices are key requirements, the energy density they provide should be maximized,” said the paper's corresponding scientist, Martti Kaempgen, now a researcher at the University of California at Los Angeles,* to *PhysOrg.com*. “In this context, carbon nanotubes have an advantage over other materials.”

The nanotube networks form the fuel cell's gas diffusion electrode, a layer of a porous material that allows gas and water vapor to pass through to the catalyst layer. In the catalyst layer, which typically consists of platinum particles, the protons and electrons of the gaseous reactant material—i.e. the fuel cell's fuel—are separated, and the

electrons become electricity.

Earlier approaches utilizing carbon nanotubes in fuel cells have not taken full advantage of this material, only used as an additive to improve some of the properties of conventional electrode materials. But, until now, carbon nanotubes haven't been recognized as having the potential to replace the entire electrode.

Typically, carbon without any crystalline structure, known as amorphous carbon, is used in fuel cells because of its large surface area and porosity. Networks made of pure, single-walled carbon nanotubes boast the same properties, but weigh far less. They are ten times thinner and lighter than traditional electrodes. In addition, the long, thin shapes of the nanotubes give them a high conductivity—more than one thousand times larger than that of amorphous carbon. This is high enough that the current collector, another component of fuel cells, can be replaced as well.

The ability of a single material to perform several essential functions in a fuel cell leads to a much simpler fuel cell architecture.

The researchers tested the new electrode inside a home-made fuel cell using both hydrogen and oxygen gases as the fuel.

Though the overall performance of the electrode isn't all that impressive, “It is still comparable to conventional amorphous carbon types,” says Kaempgen. “And the lower performance is likely due to the preparation of the catalyst, which has yet to be optimized.”

*Kaempgen participated in this research while a Ph.D. candidate at the Max Planck Institute.

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