NANOMATERIALS COULD SOUP UP SUPERCAPACITORS IF PRICE IS RIGHT

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Feb. 11, 2004 – It's a battery! It's a power pump! It's Super Capacitor!

Supercapacitors work like short-acting, but high-power, batteries. While the first supercapacitor was sold in 1978, improved performance and lower prices in recent years are expanding the market for them. That has caught the attention of companies working on nanomaterials.

Photo courtesy of Maxwell Technologies

Supercapacitor maker Maxwell Technologies, has relationships with 10 nanomaterials companies.

Leo O'Connor, director of research for Technical Insights, reports that researchers at NEC Corp. (Nasdaq: NIPNY, News, Web) in Japan are working on carbon nanohorns for electrodes in supercapacitors and fuel cells. Scientists in Singapore have developed a new carbon structure they called nanowalls that could boost supercapacitors.

To understand how such nanomaterials could advance these devices, a few words first on how "supercaps," as they're called, work:

Conventional batteries store a lot of energy, but discharge power at a relatively low level; traditional capacitors provide a burst of power but don't hold much energy. Supercapacitors are something of a crossbreed: they can both store a cache of energy and release it in pulses of strong power.

A supercapacitor could, for example, help a hybrid gas/electric vehicle accelerate, especially in high load situations like a standing start. Oshkosh Truck Corp. in Wisconsin is reportedly working on a prototype for a hybrid garbage truck that would use supercapacitors in its electric drive system.

Supercaps can also absorb a lot of energy quickly, such as when a hybrid vehicle's brakes recapture energy while stopping. Smaller supercapacitors already give some digital cameras the quick boost they need when snapping a picture, or provide the power pulses for mobile phones.

Australian firm cap-XX Pty Ltd., for example, produces power-packed supercapacitors the size of postage stamps for use in applications such as portable electronics. Bigger supercapacitors may function as part of backup power systems for buildings and businesses.

According to consultant and supercapacitor expert John R. Miller of JME Inc., the devices have several advantages over batteries. They can be charged and discharged almost indefinitely. Rechargeable batteries wear out after repeated charging and can be damaged by overcharging. Supercaps can also operate in low or high temperatures, aren't affected by shock and can't explode, as batteries sometimes do.

In many instances, a supercapacitor is intended to work with a battery, handling peak loads to increase the time between charges or allow the device to use smaller batteries. The battery recharges the supercapacitor, which can store its energy cache for days or months, depending on design and application.

Today, the electrodes in many supercapacitors are composed of a simple and dirt-cheap material called activated carbon. Produced from coal, sawdust, or even coconut husks by companies such as MeadWestvaco Corp., hundreds of millions of tons of it are produced every year to purify water and air, and reduce auto emissions.

Some experts contend that activated carbon is a very simple nanomaterial. Composed of a microscopic honeycomb of random pores ands particles, activated carbon offers tremendous surface area for an electrolyte solution to interact with. "There's almost a football field of area in one teaspoon," Miller said.

Cooper Electronic Technologies in Boynton Beach, Fla., makes supercapacitors with a novel material, carbon aerogel, that also could be described as a nanostructured material. As the foam-like substance dries, it forms an airy web of nanoscale carbon particles and pores that is highly conductive.

But the most powerful supercapacitors prototypes have been built using multiwall carbon nanotubes by companies such as Hyperion Catalysis International Inc. (Profile, News, Web) in Cambridge, Mass.

Hyperion isn't planning to commercialize its approach, but as Miller explained, an electrode made with such tubes has its entire surface exposed directly to the electrolyte, whereas in activated carbon, the electric charges in the electrolyte have to move through the pores.

In the meantime, controlling the precise size and distribution of pores in activated carbon may be an avenue for nanoengineering to squeeze more performance out of existing materials.

While most newer nanomaterials are too expensive to displace activated carbon in mass-market supercapacitors, Miller noted that space, military and niche applications may be a market where size and weight savings from using more expensive nanomaterials are more critical than device costs.

At University of Texas at Dallas, a team lead by Ray Baughman (News, Web) has produced fibers from carbon nanotubes that when woven into threads can function as a supercapacitor.

Baughman explained that the nanotube threads could serve double duty as a supertough fabric protecting soldiers or military vehicles while also storing energy for electronic systems. While he declined to name the company, he said work is under way to commercialize the supercapacitor fabric.

Nanopowders-maker NEI Corp. in Piscataway, N.J., is also working at the intersection of supercaps and nanotech. NEI is part of an Energy Department project for a hybrid battery/supercapacitor technology that might be useful in applications like power tools.

Between 1999 and 2002, U.S. Nanocorp. Inc. in Farmington, Conn. worked on a $900,000 grant from the National Institute of Standards and Technology to develop nanostructured materials for another device that was part supercapacitor and part battery. The device performed well, according to Nanocorp CEO David Reisner, but projects closer to commercialization took precedence.