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Powering Up a New Breed of Batteries

Methanol, fuel-cell, hydrogen and better lithium-ion batteries are all in the offing to keep us computing longer.

No matter how portable gadgets become there's a time when they all must come back to earth: recharging time.

As a result, the quest for longer battery life still occupies much development time. For proof, just look at new technologies for mobile devices. Whether they are screens, processors, storage or other components, they usually share the advantage of lower power consumption.

Longer Life for Lithium

Much of the development work is focused on making batteries based on current technologies, such as lithium-ion, last longer, and an increasing amount of time is being spent looking into new technologies such as fuel cells.

Choosing Hydrogen

"Lithium-ion has been improving at a rate of about 9 percent per year since a decade ago when Sony introduced the first battery based on this technology," says Ric Fulop, co-founder of A123 Systems, a start-up that's developed a high-power battery. The company has attracted investments from Qualcomm and Motorola. Although it's initially focusing on high-current devices such as power tools, it sees opportunities in the electronics sector.

Fulop says lithium-ion capacities have increased from around 2.2Ah (ampere hours) a few years ago to about 2.6Ah, and there's room for continued improvement.

Representatives of Japan's Matsushita Battery Industrial said earlier this year that the company is working with Intel on a lithium-ion battery that will have a capacity of 2.9Ah. Scheduled to be available in April, it should keep a laptop running for about eight hours.

However, there are limits to the technology, Fulop says.

"You are reaching the limits and it's not going to get much better," he says. Making a better battery means messing with materials and that's a battle against nature. "You don't

have the same capability with materials science as Moore's Law. That's why the rate of improvement has only been 9 percent per year." Companies also are working on speedier recharging so devices are up and running again faster.

Toshiba's Projects

Toshiba has developed a prototype lithium-ion battery that can absorb about 80 percent of the battery's total power capacity in about one minute. That's much faster than the typical charging rate of 2 percent to 3 percent of total capacity per minute. The new battery could make it possible to quickly bring a dead laptop back to life.

Although lithium-ion remains the king in portable gadgets, one of the most talked-about new technologies is the fuel cell. These create electricity from a simple reaction, typically that of a methanol and water mixture and air. They're generating interest because they can provide a relatively large amount of power from a small amount of inexpensive fuel and are environmentally friendlier than other batteries.

Both Toshiba and NEC have demonstrated direct methanol fuel cells (DMFC) for use with laptop computers. A prototype unveiled by Toshiba at this year's Cebit show in Germany could power a small laptop for ten hours before it required a recharge in the form of a squirt of methanol, similar to the way a cigarette lighter is refueled. The Toshiba DMFC can provide about 20 watts of power, as can a similar prototype from NEC.

Lenovo and Sanyo also are working on a DMFC-based prototype, but plan to combine the fuel cell with a conventional lithium-ion battery. The fuel cell keeps the battery charged when the computer isn't working under load, and the battery releases this power when the system demands more than the 12 watts the DMFC can provide. Such a hybrid power source offers the best initial solution for DMFCs until technology improves, Sanyo says.

DMFCs also win over lithium-ion in other areas, says Jim Balcom, president and CEO of PolyFuel. The company supplies DMFC membranes to many of the major companies in the field. "Lithium-ion batteries don't do very well from a durability aspect," he says. "Most tend to decline to the point where, after a year or two, the energy capacity drops to about 80% of the original level and then falls quite steeply." PolyFuel has tested DMFCs based on its membranes that last 5,000 hours and is working on membranes that last longer.

Choosing Hydrogen

Not all fuel cell research is focused on DMFCs. Some companies are looking at fuel cells that use hydrogen instead of methanol, because they can deliver more power relative to size. This can be measured as the energy density.

Nippon Telegraph and Telephone's (NTT) prototype hydrogen fuel cell has an energy

density of 200 milliwatts per square centimeter: that means about nine hours of talk time for a 3G phone from the device, which is about the size of a pack of playing cards.

In contrast, DMFCs for laptop PCs have an energy density of about 70 milliwatts per square centimeter, and lithium-ion batteries used in modern cell phones are about 160 milliwatts per square centimeter, according to NTT.

The high energy density also has pushed Canon into hydrogen fuel-cell development for digital still cameras. It has a prototype that matches the power of lithium-ion batteries; the company's research goal is a fuel cell that offers between three and five times this amount of power.

Despite all this work and many demonstrations of working prototypes, fuel cells are not mere months away from commercialization.

"One of the biggest challenges is lack of standardization," says Sara Bradford, research manager for Frost & Sullivan's power supplies and batteries group in Dallas. Major vendors are using different types and amounts of fuel to power batteries of different sizes.

"This all just adds to the confusion for the average consumer," she says.

Other Efforts

Talks have begun on issues such as common refills, but agreement is yet to be reached. There also are regulatory hold-ups. Methanol is a highly flammable liquid, and carrying it on aircraft is highly regulated. As current regulations stand, it's impossible for passengers to carry on DMFCs--let alone use them in aircraft cabins. Hydrogen also has its problems, because the fuel has to be stored in compressed canisters, which require clearance for air travel, so commercialization is on hold. The International Air Transport Association is working on regulations that would allow DMFCs to be carried or used on planes, but they aren't expected to be complete until at least 2007.

Commercialization for military or industrial use will come before consumer use, with the military leading the pack, Bradford says. "They have the means to do it. Obviously, they have a lot of money to invest, but it also really revolves around the demand."

PolyFuel's Balcom agrees. He expects to see military and industrial fuel cells on the market in 2006 and 2007, with the first consumer products on sale a year later. Start-up Medis Technologies says it has a fuel cell that doesn't face the same regulatory or standardization problems. The company has developed a disposable alkaline-based fuel cell that it says is efficient, safe and inexpensive. It hopes to commercialize the cell, which will cost around $10 in bulk, in early 2006.

The device won't replace the existing rechargeable batteries in portable devices, but is intended to be used as a portable recharging station for times when the battery dies and a power socket isn't nearby. The Medis unit can charge an average cell phone about six to

eight times, or provide power for 20 to 30 hours of talk time before its fuel is spent. However, it can't be replenished.

Built-in Limits

But, no matter what happens with battery technology, perhaps the life of a laptop will never move much beyond eight hours. "The notebook guys don't want to give you more than eight hours," A123 Systems' Fulop says.

Battery lifetime is usually decided ahead of time, because PC makers fix the power consumption and battery life of their machines before they shop for a battery. Changes come only in the amount of power consumed per hour as better and more-energy-hungry components are fitted into the machines.