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# Will Lithium-Ion Batteries Power the Future?

NOT ALL LITHIUM-ION BATTERIES ARE ALIKE. HAVE GENERAL MOTORS CORP. AND ITS BATTERY PARTNERS DISCOVERED THE 'MAGIC' ONE THAT WILL MAKE ELECTRIC VEHICLES PRACTICAL, AFFORDABLE, AND DESIRABLE? BY GARY WITZENBURG

**W**hat's the story on Lithium-ion batteries for electric vehicles? General Motors Corp. is racing full-speed ahead with suppliers to develop lithium-ion batteries for volume production of the 2011 Chevy Volt plug-in EV. Independent maker Tesla Motors is promising fast, expensive Li-ion-powered EV sports cars, followed soon after by luxury sedans. Ford, Chrysler, Nissan, and others are showing a variety of Li-ion concept hybrids while pursuing the battery technology with their own suppliers. Toyota is saying they're still too expensive and potentially dangerous.

Toyota's reservations may be genuine, or perhaps part of a strategic marketing plan, given the automaker doesn't have a plug-in hybrid in the pipeline. GM, meanwhile, has been very vocal about its ability to make the battery technology work. "The card we have up our sleeve in terms of advanced technology and propulsion is our E-Flex architecture and electric propulsion system," says Bob Lutz, GM's vice chairman of global product development. "But before we get to play that card, we need further advancements in battery technology. And we're making great progress there."

To get there, GM recently announced a new agreement with high-tech Li-ion battery maker A123Systems to co-develop its nanophosphate Li-ion chemistry for plug-in hybrids and other GM E-Flex variants. "This is a great strategic agreement," Lutz says, "and it will help us get E-Flex, and vehicles like the Volt, on the road sooner. Breakthrough battery technology will drive future automotive propulsion, and the company that aligns with the best strategic partners will win."

The message is that not all Li-ion battery chemistries are alike, but GM is betting that its version will win the race. The fact that GM and A123 are "co-developing" the cells hints that

production-ready packs may be close. The contract calls for running test vehicles by early 2008, and Lutz says he expects to have plug-in Volts in showrooms by late 2010. GM is working with other battery firms as well. "Believe me," he says, "electrically driven vehicles represent the next great paradigm shift in the automotive industry."

A123Systems of Watertown, Mass., which operates a large subsidiary in Ann Arbor, is a forerunner in nanophosphate-based cell technol-

ogy and the world's largest producer of batteries with nanophosphate chemistry. The company says its batteries provide a higher power output, longer life, and are safer than other lithium-ion chemistries. The company currently manufactures more than 10 million Li-ion cells annually, primarily for rechargeable power tools.



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"We're talking today about the Volt and implications that it will have on the electrification of passenger vehicles," says David Vieau, CEO of A123Systems, "but the technology goes a lot further than that. The weight, size, safety, and performance of these batteries have implications on all transportation, including hybrid buses, trucks, and aircraft." He adds that A123's batteries will degrade more slowly than others over time and will be less expensive, since they use no precious metals or rare materials.

A typical Li-ion laptop or cell phone battery

uses a cobalt oxide or lithium cobalt oxide cathode material based on particles between five and 10 microns in diameter. By contrast, A123's cells use a nanophosphate less than 100 nanometers in diameter. For perspective, a typical human hair is about 75 microns in diameter, and a nano is 1/1,000th of a micron.

"There are mechanical expansions and contractions as the battery cycles, and larger particles can fracture over time," Vieau says. "With a traditional Li-ion battery, you might expect to get 500 full charges and discharges before it begins to lose its capacity. With our technology, we've experienced 7,000 full charges and discharges. Our system has less mechanical strain for longer life, and its greater thermal stability over a broader temperature range improves the safety of the cell and predicts much longer calendar life — how many years it will last — which is different from cycle life. We've done accelerated life-testing that predicts more than 10 years."

Meanwhile, Toyota says media reports that it has delayed introduction of Li-ion batteries for its next-generation Prius and other hybrids are false. "We've said we're developing the next-generation Prius, and that we're developing Li-ion batteries," Toyota spokesman John Hanson says, "but we've never linked the two. [To report] that there's a delay on something we've never announced is troubling. We're heavily involved in lithium battery technology, and we think it has great potential for a battery system that will have the power density required for plug-in hybrids."

Conversely, Vieau believes A123 has a handle on the cost structure. "We looked at the price of the Prius [NiMH] battery system over the last few years, compared it to the system we're developing, and found we'd be favorable," he says. **db**