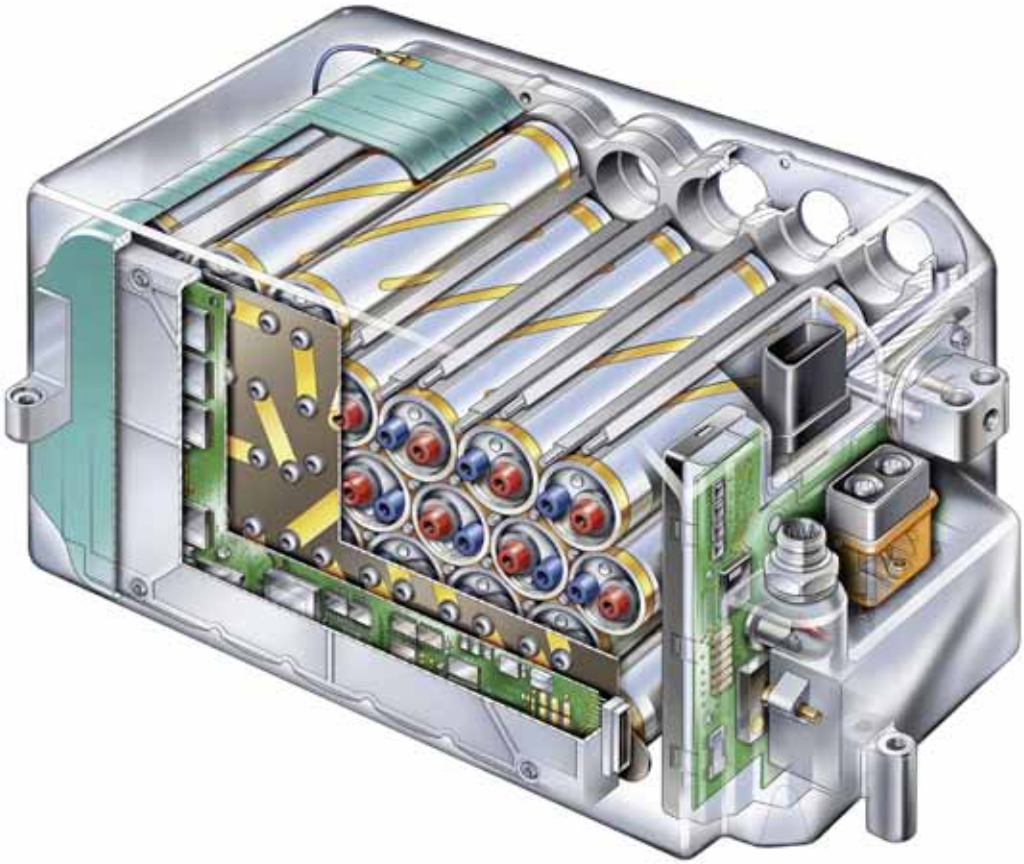
Energy|Environment

Battery guru: Consolidating cell types, materials will take time



Mercedes-Benz's S400 Hybrid features a small lithium-ion battery pack comprised of 32 nickel-cobalt-aluminum cells manufactured by Saft. The 120-V, 0.9 A·h air-cooled pack is assembled by Continental.

For automakers to truly leverage production volumes to lower the cost of hybrid and EV batteries, as product developers need, the industry must reduce the proliferation of battery cell types and configurations. While many experts agree on this, they also say don't expect technology consolidations anytime soon.

"We now have three very different battery types—pouch, prismatic, and cylindrical—being used by the auto companies and, looking ahead, I'm not sure any of them will become the preferred type," noted Dr. Menahem Anderman. "But it's fair to say the industry doesn't yet have to arrive at a winner."

As an independent observer of the advanced automotive battery industry and founder of the firm **Total Battery Consulting**, Anderman is respected for his frank analyses of battery technology and electrified-vehicle progress, and a frequent speaker at **SAE International** conferences. *SAE VE* interviewed him at the Shanghai Vehicle Battery and Electric Motor Summit in late 2011, an event Anderman chaired, where the topic of cell standardization was widely discussed.

Having the three main cell configurations increases the number of variables—and that's a dilemma, he said.

"When a car company calls battery makers for requests for proposal for a certain cell size, which has to do with cell capacity and dimension, they want to see that size from three, four, or five suppliers," Anderman explained. "So the best way to get cost down is to limit the number of cell sizes and allow the cell maker to get to really high volumes, in order to optimize manufacturing and reduce cost for a particular cell."

If the industry needs, for example, five or six cell sizes—two for HEVs, two for plug-in hybrids (PHEV), and two for EVs—and each size is available in pouch, prismatic, and cylindrical types, that's 18 different configurations. For car makers, 18 cell configurations might be the minimum number needed to field a competitive mix of electrified vehicles, but the cell maker must focus on two or three cell sizes to get volume and reliability up and cost down.

Anderman agrees that at some point there will be less proliferation of cell types for automotive use. He noted that for the computer industry, the reason lithium-ion costs came down is because all the major players stuck with the 18650 cell (which he helped develop).

"The reason the 18650 came about was that three of those cells take up the same space as the nickel-metal hydride cells they replaced," he said. "This new cell configuration came in through the back door. Nobody was sitting around asking, 'What should be the ideal lithium cell size for a computer?' It actually came as a replacement for nickel-metal hydride."

As a result, volumes quickly rose and cost dropped because the 18650 then represented the new standard cell size for 90% of the computer market.

Dr. Menahem Anderman, speaking at the SAE Shanghai Battery and EV conference, said NMC cathodes and metal "can" packaging are emerging as preferred cell specifications. (Lindsay Brooke)

Sanyo's two-cell strategy

Then came nickel-metal hydride's (NiMH) move into hybrids. The standard cell size became 6 A·h, and if the car companies needed more capacity, they were willing to change the voltage (which changed the motor voltage and the controller) knowing that the most expensive component of a hybrid system is the cell.

"The thought at the car companies was, 'Let them produce one cell size at very high volume, so that if I need 2 kW·h I will get a 400-V system and if I need 1 kW·h I'll get a 200-V system—but in both cases I'll buy a 6 A·h cell,'" he recalled. "That's how NiMH vol-

ume increased and cost came down."

In Anderman's scenario for lithium-ion, automakers need cells designed for HEVs (4-6 A·h), PHEVs (10-25 A·h), and EVs (50-A·h and up). But having six sizes, with each size available in three different configurations, is simply too many cells. He said top executives at **Sanyo**, the world's largest lithium battery producer, told him the company is only developing two automotive-size cells for the near-term future—5-A·h cells for HEVs, and 21-A·h for PHEV and EV.

"Two sizes, that's it—if you want it, this is what they offer," he noted. "But concentrating on those two cells, Sanyo will get performance and reliability up and cost down. Later they'll develop probably an EV cell, similar to the PHEV cell but higher energy or a different cell size."

High-voltage (5-V) electrolyte is a potential "showstopper" among new cell technologies, Anderman believes.

Sanyo's 21-A·h cell was designed for **Toyota**'s new PHEV architecture. The company also offered the same cell to **Audi** (who is buying it), as well as offering it to **Ford**, he said. **Toyota**, **Hitachi**, and some other leading battery makers have the same philosophy as Sanyo—limit the complexity and focus engineering resources on fewer cells and fewer configurations.

"Doing that will get quality, performance, and reliability up and their costs down," Anderman explained. "Because they think within 10 years they might have a billion-dollar market they can profitable on. And if there is no billion-dollar market, they're not interested to begin with!"

The NMC movement

In Anderman's latest forecast, nickel-manganese cobalt (NMC) and the cylindrical metal "can" appear to be emerging as the predominant cathode material and battery-cell package, respectively, for automotive use going forward. Battery companies that started with nickel-cobalt aluminum (NCA) have migrated or are in the process of migrating to NMC because they made more development progress with it and have found its inherent safety "is a little easier to manage."

Likewise, several companies that started with the lower cost, very safe lithium-manganese oxide (LMO), including Hitachi and **GS Yuasa**, migrated to LMO/NMC blends and are now moving to NMC to achieve greater energy density.

"I see movement from both directions to NMC," he said. "There's a lot of development going on in NMC in the consumer-battery market as well. Some can go to 4.3 V, where you get another 5% capacity without additional cost."

Anderman talked about the potential for "game changing" cell chemistries and other battery technologies, noting that for any innovations currently in development to enter production by 2020, they would have to be validated and signed off less than 18 months from now.

"To be in production in 2019 requires having a plant producing battery cells by 2017," he noted. "Something like metal-air batteries are not going to happen within 10 years' time.

I think silicon anodes [being developed to potentially replace traditional graphite anodes] also are not going to make it for automotive—the technology has been in development for 10 years and is barely getting into small cells."

He reckons the biggest opportunity for new automotive battery technology by 2020 is the 4.8-V-to-5-V cathode. A lot of development currently is focused on this, the potential "showstopper" being high-voltage (5-V) electrolyte.

"But I have not seen a breakthrough there yet, so I cannot give you a schedule for it," Anderman chuckled.

Lindsay Brooke