25 battery breakthroughs for gadgets, electric cars & the grid

By Katie Fehrenbacher Nov. 23, 2011, 12:00am PT No Comments

A lack of progress for battery technology is (arguably) the single biggest barrier for gadgets, electric vehicles and the power grid. But there continues to be innovation, like last week researchers at Northwestern University unveiled technology that can boost gadget battery life by ten and charge a battery in minutes instead of hours. And there's hundreds of researchers, entrepreneurs, universities and large companies working on battery breakthroughs. Here's 25 you should know about:

1). Seeo: Seeo was founded in 2007 and formerly based in Berkeley, which is home to Lawrence Berkeley National Laboratory, where Mohit Singh, Seeo co-founder, and his fellow co-founders, Hany Eitouni and Nitash Balsara, first developed the technology. The company has now moved to Hayward, Calif., and the company's innovation is to produce lithium ion batteries using a dry polymer electrolyte, instead of a more conventional liquid electrolyte (typically made up of a lithium salt in an organic solvent). The electrolyte is the medium that shuttled lithium ions back and forth between the cathode and the anode to charge and discharge the battery cell.

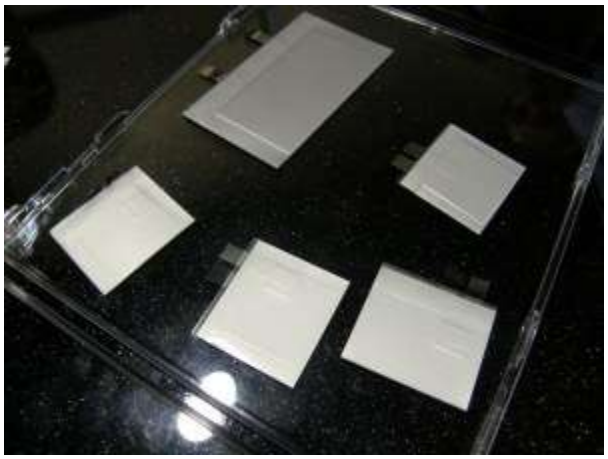
Seeo's dry polymer electrolyte battery could lead to a longer battery life because it's not flammable like the liquid electrolyte and sustains virtually no loss of capacity under prolonged exposures to high temperatures. While Nissan and General Motors say the batteries in their electric vehicles are good for 100,000 miles today, Seeo's goal is to double that mileage. Using the polymer can also lead to a battery cell that can achieve 250 Wh/kg (a measure of energy density), compared with the less than 200 Wh/kg commonly found in lithium-ion cells today. Seeo recently started up a pilot production line that can produce 4 megawatt hours worth of battery cells per year. The company is backed by Khosla Ventures, GSR Ventures and a grant from the Department of Energy.

2). Pellion: This could be the world's first commercial magnesium battery, which could be developed with better performance and cost than current lithium-ion batteries. The company has an investment from Khosla Ventures and according to the ARPA-E site, Pellion was spun out of MIT, and "will leverage high throughput computational materials design, coupled with accelerated materials synthesis and electrolyte optimization to identify new high-energy-density magnesium cathode materials and compatible electrolyte chemistries."

3). Liquid Metal Battery: When Bill Gates backs your company, people pay attention. Earlier this year Gates gave Liquid Metal Battery seed funding for technology that sandwiches molten salt between two layers of liquid metal. The technology is the brainchild of MIT Professor Donald Sadoway (see our 15 Questions for the Don of Liquid Metal Batteries) and hopes to deliver a stable, low-cost, large-scale grid battery. The group has been building the battery at larger and larger sizes to prove the concept, from "shot glass" scale, to hockey puck, to pizza, and eventually to ping-pong table-sized.

In addition to Gates, the project received an ARPA-E grant of $6.9 million, and Sadoway said the funds helped the team move much more quickly, including expanding company operations to hire more staff, students and post-docs. The project also received $4 million from oil company Total.

4). Sakti3: Sakti3, based in Michigan, is developing battery cells with a solid-state electrolyte, and is backed by Khosla Ventures, General Motors, and Itochu. Sakti3's technology stems from research led by CEO Ann Marie Sastry, who heads up the University of Michigan's energy systems engineering program, and the tech is supposed to double the energy density of a battery compared with existing lithium ion batteries.



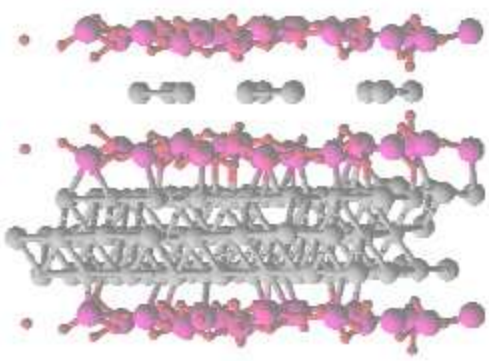
Planar Energy System's Thin Film Batteries

Last month Sastry said that Sakti3 is "making battery cells on equipment that literally used to make potato chip bags, which is pretty cheap, but not low tech." And the company hopes to have prototypes later this year.

5). Planar Energy Devices: Earlier this year the Economist noted that Planar Energy was about to complete a pilot production line that would print its lithium-ion batteries onto sheets of metal or plastic. The company makes thin-film batteries that are supposed to be able to charge in seconds, have a high energy density and capacity, last 400-500 life cycles and be safer than traditional lithium-ion batteries.

Planar was founded in 2007 as a spin-out from the National Renewable Energy Laboratory, and the company is backed by Battele Ventures and Innovation Valley Partners.

6). Aquion Energy: Aquion Energy is using basic materials (sodium and water) that are widely available (and edible!) to build modular batteries that can provide a slew of services for a cleaner power grid at a relatively low cost. Aquion executives believe these bulk storage devices will help solar and wind power give expensive natural gas "peaker" plants a run for their money as the go-to choice for meeting electricity needs during periods of highest demand.



Crystal structure of layered system
ZrO2 | Pt QW | ZrO2 | 3Pt3 QDs | ZrO2

Founded in 2007, the company is backed by Kleiner Perkins Caufield & Byers and Foundation Capital. Aquion hopes to break ground on a 500 megawatt-hour manufacturing facility during the second quarter of 2012, and bring this facility online in 2013. That will depend on financing, of course.

7). QuantumScape: QuantumScape is an early stage battery startup that is commercializing technology from Stanford University, and which was founded, and is being led by Infinera co-founder and CEO Jagdeep Singh, and backed by Kleiner Perkins Caufield & Byers and Khosla Ventures. The stealth company is trying to create batteries that have the density of fossil fuels, and could one day 

change the economics of electric cars and grid storage. The company's technology uses a new method for stacking trace amounts of materials together, which can lead to high energy and power densities, and also higher cycle life than standard lithium ion batteries.

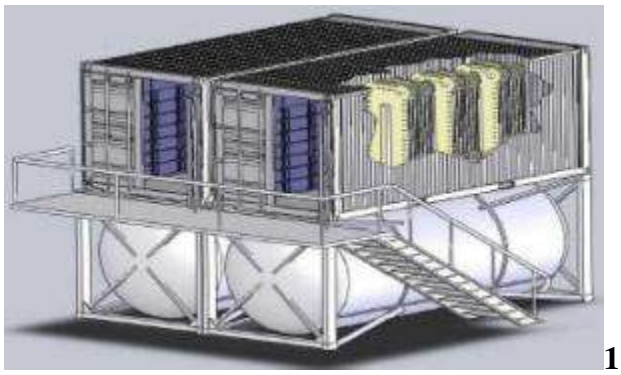
8). ActaCell: ActaCell is a four-year-old company, which is working to commercialize low-cost, high-power, lithium-ion cell materials, and is based on research out of the Material Science and Engineering labs of professor Arumugam Manthiram at the University of Texas at Austin. The company is working on materials for battery anodes (which draws in lithium ions when a battery recharges) and cathodes (which draws out current), and is also conducting research on battery cell and pack designs, and has built a module for demonstration in hybrid and plug-in hybrid vehicle applications.

Last month ActaCell said it started the process of scaling up its nanocomposite alloy anode material. ActaCell is backed by Google.org, DFJ Mercury, Applied Ventures (Applied Materials' venture arm), and a grant from the National Institute of Standards and Technology (NIST).

9). Boston-Power: Boston-Power once dreamed of building a lithium-ion cell battery factory in the U.S., but recently announced that it's lined up $125 million in funding and will shift a big part of its business to China, thinning its operation in the U.S. by about 35 percent. The factory near Shanghai will be able to produce 400 megawatt hours of battery cells, or 18 million battery cells, per year.

Boston-Power was founded in 2005 and sells both laptop batteries and batteries for electric cars. It's electric car battery is supposed to be able to provide 50 percent more usable energy density by volume compared to competitors, have a 10-year lifespan and can operate at a wide-ranging temperature, down to -40˚C.

10). Atieva: Atieva was co-founded in 2007 by former Tesla Motors VP Bernard Tse and the company is working on software for monitoring individual battery cells, mechanical packaging and controls for vehicle battery packs. Using commodity cells, Atieva aims to produce customized packs primarily for smaller, independent car companies and recently won support from Chinese bus companies. The startup is backed by Beijing's China Environment Fund III, Venrock, Mitsui & Co, and JAFCO Asia.



11). EnerVault: While most of these battery companies make lithium ion batteries or mobile batteries for gadgets and cars, EnerVault makes flow batteries, which are large tanks of liquid batteries that are used to provide energy storage for the grid. EnerVault has completed the design of its prototype battery and is counting on a demonstration project next year to help the company launch its technology into the market in 2013.

Flow batteries separate the energy storage materials and electrolyte from the cells in which the electrochemical reaction occurs. The design involves two big tanks, each of which contains a different mix of energy storage material and electrolyte. EnerVault's design fills one tank of electrolyte with iron (the energy storing material) and another electrolyte tank with chromium. Pumps send the solutions from the tanks into separate chambers of a cell to generate electricity.

12). Envia: Envia develops low-cost cathode materials for vehicle lithium ion batteries and other energy storage applications, and the company is also expanding its focus to include anode technology. A battery is made up of an anode on one side and a cathode on the other, with electrolyte in between. Lithium ions travel from the anode to the cathode through the electrolyte, creating a chemical reaction that allows electrons to be harvested along the way.

Envia is backed by GM Ventures, Asahi Kasei, Asahi Glass, Bay Partners, Redpoint and Panagea Ventures. The company also raised $4 million grant under the Department of Energy's high-risk energy tech fund, ARPA-E (Advanced Research Projects Agency-Energy).

13). Better Place: Better Place hasn't developed a new battery chemistry technology, but it's been working on a breakthrough business model around electric car batteries. The company is launching its first networks in Israel and Denmark and is selling electric charging and miles as a service with a highly-subsidized electric car. Better Place has launched battery swapping stations and electric car charging stations all over the these two countries and is essentially adopting the cell phone and minutes business model for EVs.

Coda sedan

14). Coda Automotive: Electric car maker Coda Automotive has long emphasized how important batter management systems are, from air and liquid cooling systems to software to manage the charge. A couple months ago it bought battery management startup EnergyCS for its electronics and software that manage the charge and discharge of the energy from the battery pack. Coda told us last year that its battery management system was more sophisticated than

Nissan's for its electric LEAF. Along with EVs Coda plans to sell energy storage systems for uses such as supplying backup power and banking renewable energy and has a partnership with Chinese battery maker, Lishen.

15). Amprius: Amprius makes lithium-ion batteries with four times more energy density (the amount of energy that can be stored in a battery of a given size) compared to today's state of the art technology. The key, according to Amprius, is a silicon nanostructured anode, or a material that draws in the lithium ions when a battery recharges. Amprius is backed by Google's former CEO Eric Schmidt, VantagePoint Venture Partners, and Stanford University.

16). AES: Power company AES doesn't make batteries, but it has been pushing the edge of using lithium ion batteries for grid storage and recently scaled up a 32 MW lithium-ion battery project in conjunction with grid operator PJM in West Virginia.

17). Next-Gen Sodium Grid Battery: Sodium sulfur batteries (NAS) are pretty much the cheapest form of battery for energy storage on the power grid, and power companies in Japan have been using hundreds of them for years. But a project from the Pacific Northwest National Laboratory and battery and electrochemical company Eagle Picher Technologies plan to use an ARPA-E grant to develop a next-generation sodium battery here in the U.S. for the power grid. The battery will be a planar-shaped sodium beta-battery that is supposed

to be less expensive and with a 30 percent higher energy density than standard NAS batteries. Eventually the battery could cost $200 per kWh compared to the current costs of NAS batteries that are closer in the range of $500-$600 per kWh.

18). Contour Energy Systems: Contour Energy Systems, which was spun out Caltech and formerly known as CFX Battery, sells disposable coin cell batteries, with one of its first products being batteries that are specifically engineered to make 3-D TV glasses last longer than competitors. The company says its batteries will outlast standard coin cell competitors, such as Energizer, by about 60 percent, and its technology uses the volatile element fluorine that could deliver longer lasting, higher power batteries for devices spanning from smart meters to pacemakers, and — potentially years down the road — electric vehicles and laptops.

19). PolyPlus: An 11-year-old company named PolyPlus, which hails out of Lawrence Berkeley Labs and has a grant from the Department of Energy's high risk early-stage ARPA-E program, has been working on batteries made of lithium and seawater (or just plain tap water for that matter) as well as batteries made from lithium and air. The water battery can achieve awe-inspiring energy densities (the amount of energy that can be stored in a battery of a given size) of 1,300 wh/kg (for small batches), and potentially 1,500 wh/kg at larger scale production. For comparison, standard lithium-ion batteries have closer to 200 wh/kg to 400 wh/kg. PolyPlus says one day its air battery could make electric vehicles with ranges from 300 to 500 miles.

20). Incremental development, not huge leap: Last year Paul Beach, president of battery company Quallion, gave a fascinating talk about the differences in progress between batteries and IT: "Moore's Law has delivered a 10,000 times improvement over the years for chips, while historically batteries have shown a 3 to 4 times improvement," said Beach.

Customer rides of the Model S Beta

Quallion works on these tiny improvements, including creating "ultrasafe" batteries, developing battery management systems for high voltage and high density batteries, and creating batteries with a wide operating temperature range.

21). Quantance: Quantance isn't a battery maker, but it's a chip company that makes an analog radio chip that helps boost the signal that a cell phone delivers to the base station and thus enables the battery in cell phones to last longer. Really? Cell phone companies care that much about extending mobile life, and not using new battery chemistry? Yes, yes they do.

22). Tesla Motors: Electric car maker Tesla also doesn't make batteries, but it's innovation is that it packages together small format batteries — the kind found in laptops and gadgets — into a battery pack that it can use for its EVs. Tesla commonly buys bulk batteries from Asian battery makers like Panasonic, and has been able to benefit from the economies of scale of these players. Next year it will launch an EV with a range of 300-miles.

23). 24M: 24M, which stands for the material concentration 24 molar, was spun out of lithium-ion battery company A123 Systems in mid-2010, and has plans to work on advanced non-traditional, lithium-ion based storage technology that uses a semisolid energy storage material,

compared to the traditional use of solid materials. 24M raised $10 million in Series A funding from Charles River Ventures and North Bridge Venture Partners, and won a $6 million grant from ARPA-E. The company has plans to work on a system for vehicles and grid storage that combine aspects of lithium-ion batteries and flow battery technology.

24). Leyden Energy: Leyden Energy has developed a lithium-ion battery containing salt in the liquid electrolyte in order to build more high temperature-tolerant and longer-lasting batteries. It cells for laptops can run over 1,000 cycles and three years, and a supplier called Dr. Battery is currently offering Leyden-embedded laptop batteries with a 2-year warranty.

Leyden is also interested in developing cells for the transportation market. Leyden has raised $38 million in venture capital since its inception in 2007 from New Enterprise Associates, Lightspeed Ventures and Sigma Partners.

25). A123 Systems: While public A123 Systems has been struggling in recent months, it's managed to win over some electric car and grid players with its lithium ion battery tech, including Fisker, GM for its Chevrolet Spark, and China's top wind maker Dongfang Electric Corporation.

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