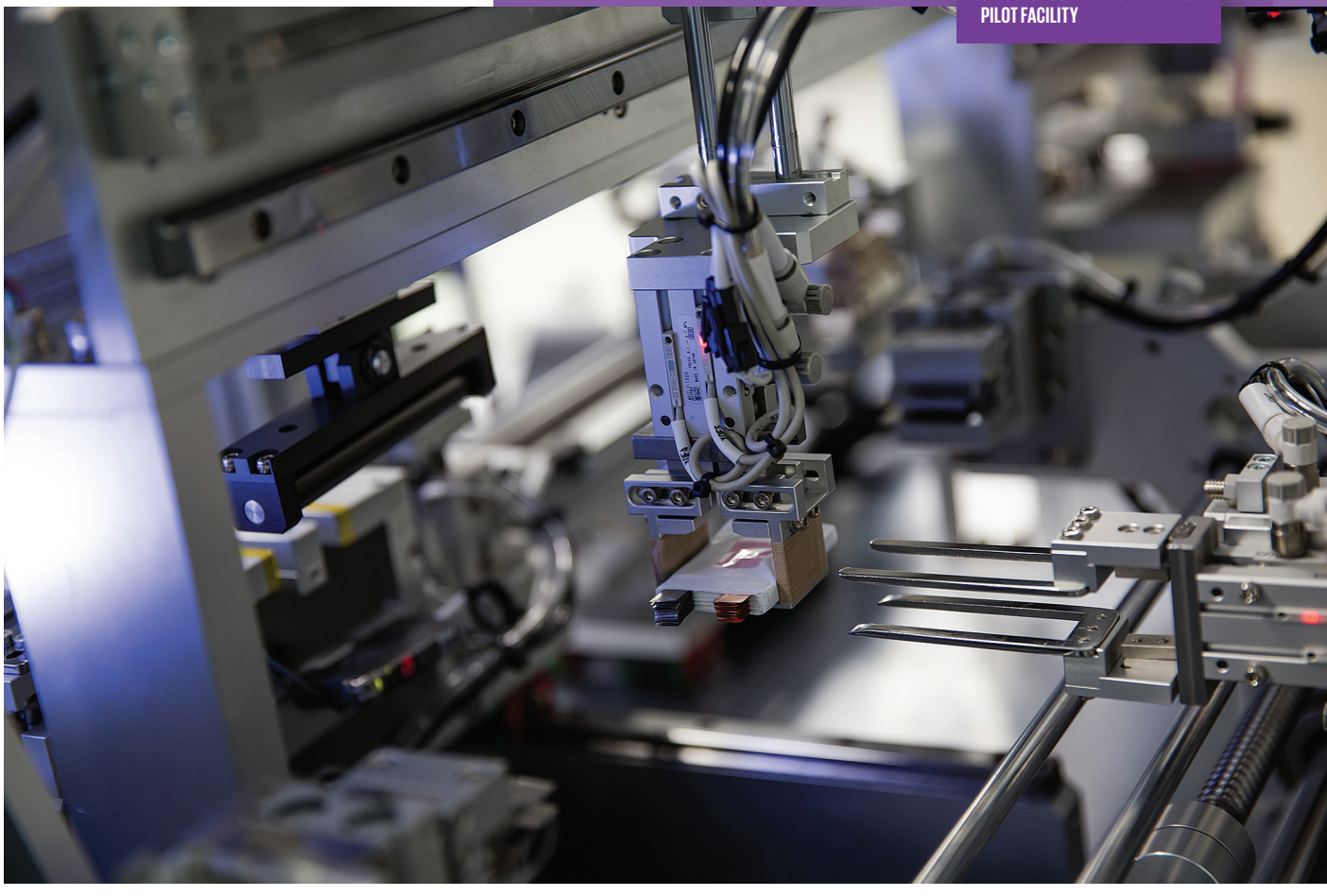


5,000: NUMBER OF SEMISOLID BATTERY CELLS SOLIDENERGY CAN PRODUCE PER MONTH AT ITS PILOT FACILITY

NEW BATTERY TECH LAUNCHES IN DRONES

SolidEnergy Systems will put safer lithium batteries in drones this year, in cars after 2021

Lithium-ion batteries boast a powerful blend of energy capacity and long cycle life. But they have a dangerous tendency to burst into flames, leading to injuries, product recalls, and flight bans.

READY-MADE: SolidEnergy says its new batteries can be manufactured with existing equipment.

Researchers have touted solid-state lithium batteries as a safer alternative. These devices swap out flammable liquid electrolytes for an inert solid such as plastic or ceramic. But researchers have pursued solid-state battery technology for decades without coming up with any products.

Now, SolidEnergy Systems, in Massachusetts, plans to become the first company to sell such batteries. The startup says it can pack twice as much energy into its battery as a conventional lithium-ion battery of the same weight can store.

That means devices could work twice as long. For example, right now "advanced drones have sensors, cameras, and processors on board, so the battery lasts only 20 minutes,»

SOLIDENERGY SYSTEMS

and it's heavy," says founder Qichao Hu. With SolidEnergy's new battery, those drones could fly for 40 minutes or more.

The company is currently testing its batteries for drones and expects to begin selling them later this year, followed by batteries for wearables in 2019 and for electric vehicles after 2021.

In today's batteries, a dilute solution of lithium salts serves as the electrolyte. Its job is to shuttle ions between the carbon anode and the lithium transition metal oxide cathode. Some ceramics, polymers, and glassy materials can also do that well. In addition to being safer than their liquid counterparts, these alternatives could also support a pure lithium anode, which would boost energy density.

Lithium-ion battery pioneers originally chose lithium metal for the anode in the 1980s. But lithium metal anodes quickly grow mossy whiskers called dendrites, which can reach the cathode and short the battery. So battery researchers switched to carbon for the anode.

SolidEnergy's workaround is to coat its ultrathin anode, made of a pure lithium foil, with a mixed polymer-ceramic electrolyte, which smothers dendrite growth. Another electrolyte, a paste of lithium salts, goes on the cathode.

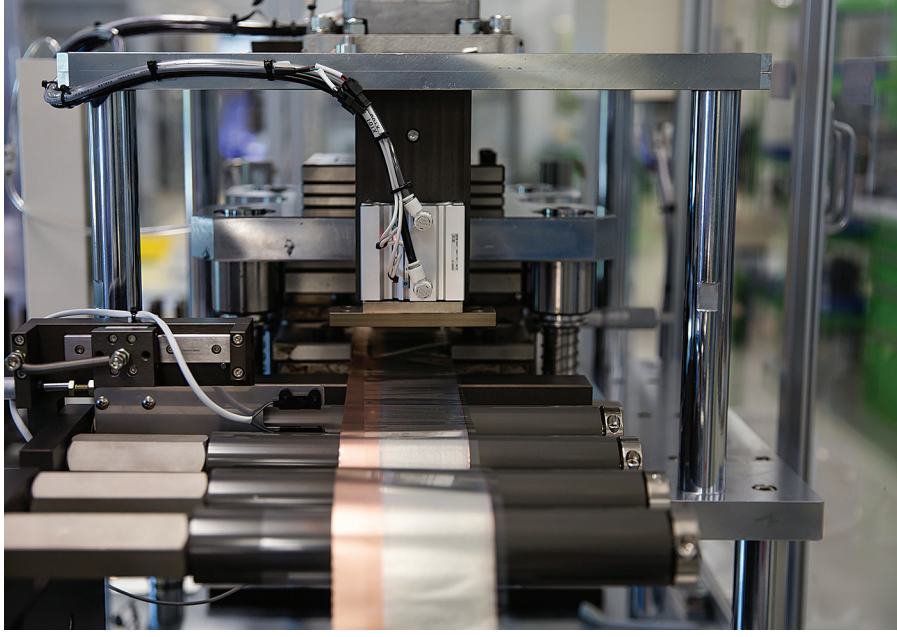
The electrolyte on the cathode contains just enough solvent to make the lithium salts conduct ions at room temperature. The device is technically a semisolid battery but safer than conventional lithium-ion cells, Hu says. The battery's energy density is about 500 watt-hours per kilogram, twice that of a conventional lithium-ion battery's 250 Wh/kg. The downside is that it can be recharged only about 200 times, as opposed to more than 1,000 times for conventional batteries.

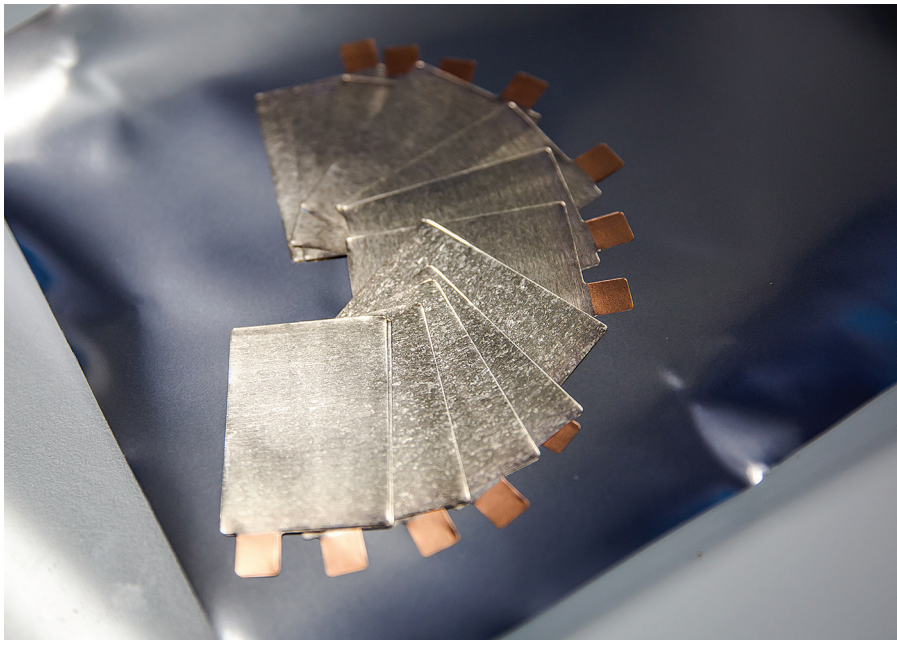
"There are lots of people trying to find the 100 percent perfect solid-state approach," Hu says. "But we think our semisolid approach is good enough."

Other labs remain focused on that vision of the ultimate solid-state battery. Last year, John Goodenough at the University of Texas at Austin unveiled a solid glass battery. He and colleague Maria Helena Braga use a lithium-doped glassy material as the electrolyte. In their latest design, which they reported in April in the *Journal of the American Chemical Society*, they coat the flexible cathode with a special plasticizer solution.

One problem with solid-state batteries is that as various materials expand and contract at different rates, the batteries' interfaces crack. The plasticizer acts as a cushion to prevent cracking, Braga says. The new battery design has twice the energy density of conventional lithium-ion batteries and can be recharged 23,000 times.

Recently, industry giants have also begun to invest in solid-state batteries. Honda, Nissan, and Toyota have teamed up with Panasonic Corp. to develop them for electric vehicles. But some high-profile buyouts of solid-state technology startups have sputtered.





WEED CONTROL: These ultrathin anodes, made of pure lithium foil, are covered in a polymer-ceramic coating to prevent harmful dendrites from sprouting.

SOLIDENERGY SYSTEMS (2)

In 2015, Dyson bought University of Michigan spin-off Sakti3 with plans to develop an EV battery, while German giant Bosch bought Seeo, a solid-state polymer battery startup from Lawrence Berkeley National Laboratory (LBNL). Both companies have since deserted those technologies.

Lithium metal batteries are not easy to work with, says LBNL scientist and chemical engineer Nitash Balsara, who cofounded Seeo with other LBNL alumni in 2007. "By and large, the battery industry is really interested in safety, as long as it's free," he says. "I think [that's] a mistake. There is room to develop intrinsically safe lithium batteries and give [them] to consumers."

Balsara now has a new startup, Blue Current, which is perfecting a hybrid polymer-ceramic electrolyte. Polymers don't conduct ions as well as ceramics, but ceramics are brittle. The hybrid "mixes the best of both worlds to stuff more energy into a battery, and it doesn't crack when a car hits a bump," Balsara says.

Solid-state batteries might work eventually, but they still face engineering challenges, says lithium-ion pioneer M. Stanley Whittingham, a professor of chemistry at Binghamton University, in New York. "Nothing's going to replace lithium-ion batteries in the near future," he says, predicting that solid and semisolid batteries will be relegated to niche markets for the next 5 to 10 years. "In the end, the challenge is how expensive they'll be," he says.

At $500 per kilowatt-hour, SolidEnergy's battery is currently much pricier than conventional lithium-ion batteries, which now sell for about $200. But Hu expects costs to go down with large-scale manufacturing and is talking with major battery makers.

"We're not ready for the ultimate goal of EVs yet," Hu admits. "But we've met the key performance requirements for drones and are making great progress toward EV batteries." —PRACHI PATEL

↗ **POST YOUR COMMENTS** at https://spectrum.ieee.org/semisolidbattery0718

SILKLAB/TUFTS UNIVERSITY

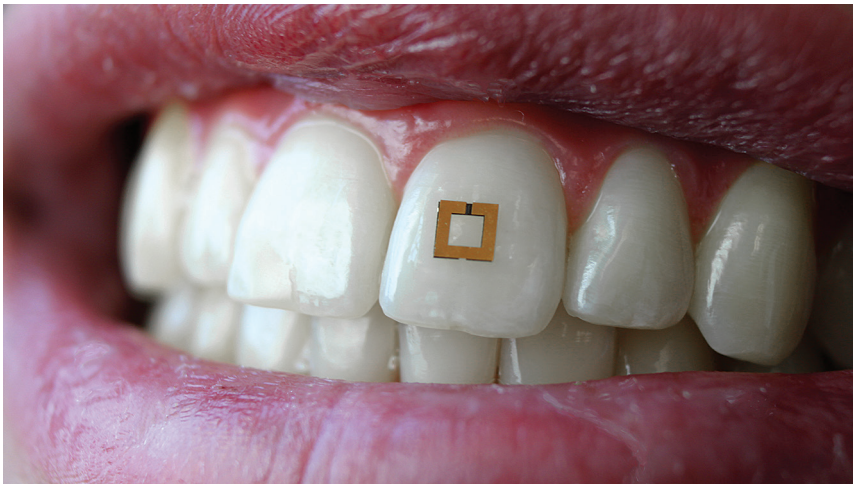
3 SENSORS TO TRACK EVERY BITE AND GULP

These technologies could make it easier to watch what you eat

People looking to track their diets and count their calories can choose from dozens of apps designed to help them do just that. But using the apps properly requires a lot of effort.

"There's a huge problem with self-reporting," says Edward Sazonov, a professor of electrical and computer engineering at the University of Alabama, who has worked on a number of food tracking systems. "Imagine that you're passing by the kitchen at work and there's a bowl of strawberries, and you grab a couple. Are you going to pull out your smartphone and take a picture, then enter the information that you just ate three strawberries?" And if the bowl is full of candy bars instead, he adds, most app users are even less likely to record it.

That's why researchers are developing passive devices that monitor eating behavior. As long as people wear the device, the tech takes care of the rest. Researchers are experimenting with sensors that directly record food going into the mouth and down the gullet, and they hope to eventually turn their lab gizmos into commercial products.



SAY CHEESE: This sensor sticks to the uneven surface of a tooth to monitor the wearer's glucose, salt, and alcohol intake.

THE AUTOMATED INGESTION MONITOR

Sazonov's latest invention, which he's describing at the meeting of the IEEE Engineering in Medicine and Biology Society this month, detects the muscle motions involved in every chew. The gadget clips onto a pair of eyeglasses, and it contains two sensors: a strain sensor that presses lightly against the temple to monitor the contractions of the temporal muscle, and an accelerometer that picks up the subtle movements of the jaw. When the system detects food intake, it triggers a tiny camera (also tucked into the gadget) to take a photo every few seconds, thus creating a time-stamped visual record of the food consumed.

Sazonov says the ingestion monitor captures detailed information