TIME

Peak Battery: Why Smartphone Battery Life Still Stinks, and Will for Years

By Jared NewmanApril 01, 201311

JARED NEWMAN / TIME.COM

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In the five years since Apple released its first iPhone, touch-screen smartphones have become thinner, lighter, faster and more capable. But through it all, battery life has mostly stayed the same.

You can probably make it through the day on a single charge, but not without a degree of caution. You'll want to keep Bluetooth turned off when it's not in use, and avoid long stretches of data use over 4G. High-end games and streaming video are guaranteed to melt away battery life, and if you're spending a few hours in a dead zone, you're better off powering down instead of wasting precious juice searching for a signal.

Because battery capacity hasn't improved much over the years, the batteries themselves have gotten bigger, limiting how thin and light phones can be. Meanwhile, technologies like 1080p screens and wireless screen mirroring have been hamstrung by batteries that can't keep up. Bad battery life can be an Achilles' heel for otherwise solid phones; by the time you realize your phone's battery stinks, it might be too late to send it back to the store.

The good news is that there's plenty of interest within the tech industry to make smartphone battery life better, and there's no shortage of emerging technologies to make it happen. The bad news is that any significant improvements to battery chemistry are at least a couple years away.

Pushing Lithium-Ion's Limits

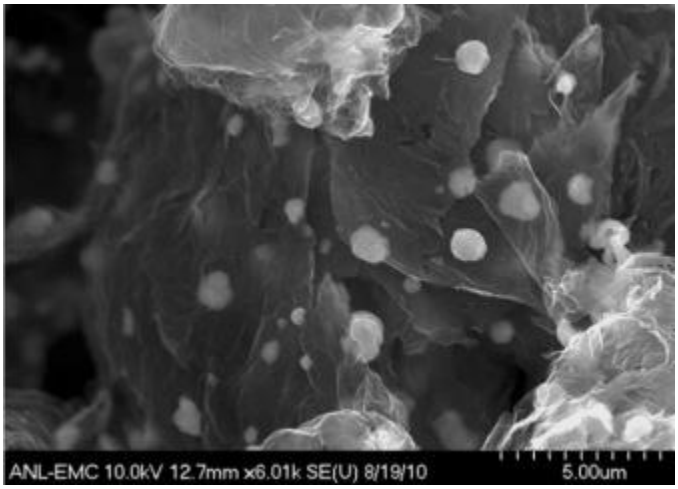
Virtually every smartphone today relies on lithium-ion batteries, which provide power by transferring electrons between the anode and cathode of a battery cell. The amount of lithium ions inside the battery directly affects how long your phone can last on a charge.

The problem lies in the graphite that stores lithium ions in the anode of a battery. Graphite has a theoretical limit to how much lithium it can hold, and today's batteries have pretty much reached it. While bigger batteries are always an option–as seen in Motorola's Droid Razr Maxx–most people don't want thicker, heavier phones, so phone makers sacrifice battery life in the name of slenderness.

With graphite-based anodes reaching peak capacity, the race is on to replace graphite with silicon, a material that can offer ten times the capacity of today's batteries–at least in theory.

“There’s a lot of research going on, because silicon is the best material for absorbing lithium, and it has the highest potential capacity of any material now,” said Phillip Roberts, CEO of California Lithium Battery.

Swapping silicon for graphite isn’t easy. Silicon swells while charging, causing electrical contacts to break during discharge, and ultimately degrading the battery. That’s a dealbreaker for smartphones, which need to survive through at least a couple of years’ worth of daily recharging.



SILICON-GRAPHENE COMPOSITE ANODE MATERIAL, COURTESY CALIFORNIA LITHIUM BATTERY

California Lithium Battery is working on a composite of silicon and graphene–a Nobel prize-winning material made from atom-thick layers of graphite–that combines the capacity of the former with the stability of the latter. And unlike some other silicon-based anode solutions, this composite, which is licensed from Argonne National Laboratory, prevents the agglomeration of silicon that leads to swelling and reduced cycle life, Roberts said.

Roberts hopes that within six months, the company can produce material by the metric ton and send it out to battery makers and phone makers for testing. In two years, the company expects its silicon-based anode to replace the graphite-based anodes in existing batteries, bringing a 30 percent improvement in capacity.

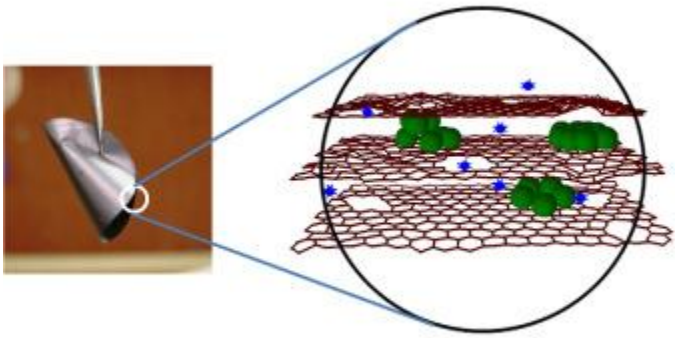
“I would say within two years, you’re going to see that technology. It’s happening relatively quickly. Behind the scenes, there’s a lot going on,” Roberts said. When paired with other advances in cathode and electrolyte materials, he expects capacity to improve by 100 percent, possibly within three years.

Many Solutions, No Quick Fixes

Three years may seem like a long time to wait for a battery bailout, but that's the reality for many companies that are pursuing new chemistry. At best, we can hope for modest gains in a couple years, followed by bigger improvements down the road.

What's the holdup? Some groups are still working out the kinks of their technology. Others are trying to secure investments to begin large-scale production. Once the technical work is done, it still takes time to test new battery technology, not only for longevity and runtime, but for safety.

"Part of the time, probably at least half of the time, is not due to the technical part, but due to what is needed to sell the product," said Harold Kung, a professor at Northwestern University.



SILICON SANDWICHED BETWEEN GRAPHENE, COURTESY HAROLD KUNG

Kung led the research on a graphene-silicon composite anode that could lead to two or three times the capacity of today's batteries. A spin-off company called SiNode is trying to commercialize the technology, but between raising funds, producing large quantities and testing a full-cell battery, Kung thinks it'll be at least five years before a product is on the market.

Other companies are more optimistic, but are facing their own challenges.

Leyden Energy, for instance, has developed an electrolyte–the part of the battery that transfers lithium between the anode and cathode–that reduces the swelling caused by silicon. This "lithium-imide" solution could bring a 25 percent to 45 percent improvement in capacity in a couple years, but only if Leyden can get the battery to last through more charges. Right now, the company's batteries only recharge about half as many times as today's lithium-ion batteries.

“We’ve got the swelling phenomenon pretty well under control, but we’re still working on optimizing cycle life,” said Rick Wilmer, Leyden’s CEO.

Meanwhile, research out of Stanford University uses silicon oxide nanotubes to contain the silicon, preventing it from swelling. A spin-off company called AmPrius is trying to commercialize the technology, and has the backing of big-name investors like Google Chairman Eric Schmidt and Kleiner Perkins Caufield & Byers.

Still, it’ll be a while before the technology achieves its full potential. Yi Cui, who led the nanotube research, said a commercial product is a couple years away, as the company figures out a low-cost way to scale up manufacturing. Even then, the technology will only bring modest improvements–around 8 percent to 10 percent–at first. The technology could reach a 40 percent capacity improvement over time, but to go any higher, new cathode materials will be necessary.

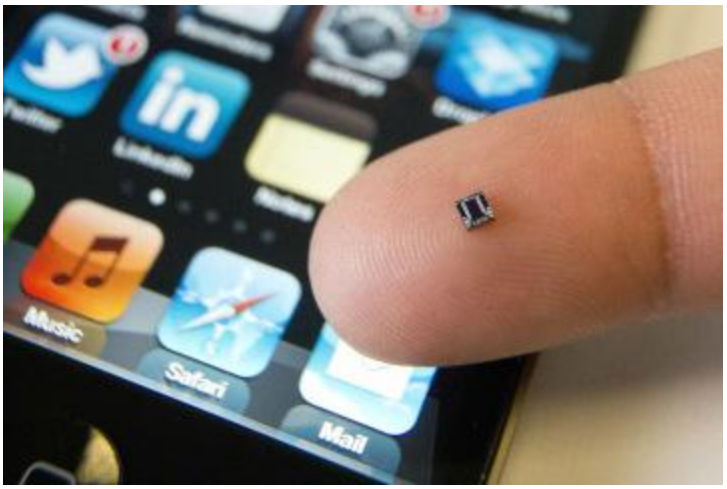
Menachem Anderman, head of Total Battery Consulting, cautioned against expecting huge gains in capacity from lithium-ion batteries, even with silicon instead of graphite. He said there tends to be a trade-off between cycle life and runtime, and while the technology will always get better, drastic improvements are unlikely to happen in the next four or five years.

“I don’t think with lithium-ion we can go 3x from where we are today; 2x would probably be a stretch,” Anderman said. “There’s always continuous improvement, but yeah, somebody looking for 5x performance? It’s hard to envision.”

Beyond the Battery

While we wait for bigger improvements to the batteries themselves, other parts of our smartphones are lending a hand by becoming more efficient.

Scotland-based Sofant, for instance, is working on a “smart antenna” that figures out where a wireless signal is coming from. Instead of wasting energy by blindly searching in all directions, Sofant’s antenna uses software to find the direction of the signal, and points itself in the right direction with a small mechanical system itself in the direction of the signal.



SMART ANTENNA COURTESY OF SOFANT

“Antenna technology has not advanced as much as other sensors and elements of a smartphone,” Sofant co-founder Ahmed El-Rayis said, “hence it has a dramatic effect on the battery life.”

A smarter antenna could provide double the battery life over conventional antennas, El-Rayis said, and would also help to prevent dropped calls. Sofant’s plan is to work with chip makers such as Qualcomm to integrate the necessary components, and with phone makers to include the antenna in their hardware designs.

Other companies, such as Eta Devices and Quantance, are working to make power amplifiers more efficient, so phones don’t have to work so hard during high-bandwidth uses like streaming video. Smartphone processors are also becoming more efficient, with low-power subsystems that burn less battery life during basic tasks. And display technologies like Sharp’s IGZO are allowing for higher screen resolutions with lower power consumption.

“There’s just a ton of innovation going on on both sides of the equation, the amount of power available and the amount of power that’s required, that continues to allow devices to run longer per charge,” Rick Wilmer of Leyden Energy said. “So I don’t know if it’ll ever end in terms of continuing to push so that devices run longer per charge.”

The Tech World Is Watching

If better batteries aren’t in our immediate future, it’s not due to lack of interest from the tech industry.

“I can tell you that some of the very large battery companies … they’ve come to us, telling us that they’re under extreme pressure to supply to the Apples of the world, and others, smaller, lighter weight batteries,” said Steven Visco, CEO of PolyPlus.

PolyPlus has developed a lithium-metal electrode that opens the door to entirely new battery chemistry, including lithium-sulfur and lithium-air. But the technology is still four or five years away from being used in rechargeable applications, and the company doesn’t plan to target consumer electronics at first.

Companies working on silicon anode technology have also felt the pressure from battery and device makers. California Lithium Battery was attracting so much attention that it changed its initial focus from electric cars to consumer electronics. CEO Phillip Roberts said “pretty much every smartphone maker” has shown interest in the company’s technology.

“We haven’t contacted one company ourselves,” CEO Phillip Roberts said. “Every group so far that we’re working with contacted us.”

You have to wonder, though, how phone makers will use new battery technology once it’s available. Will they finally deliver the rock-solid, 24-hour batteries that we need, or will they push for ever-thinner devices that are just nice to look at? It seems we have a least a couple years to agonize over the answer.