

X-RAY AND MRI IMAGING SHOW THE DEADLY DANGER'S OF TESLA MOTORS PANASONIC BATTERIES

A team of chemists has developed a method to yield highly detailed, three-dimensional images of the insides of batteries. The technique, based on magnetic resonance imaging (MRI), offers an enhanced approach to monitor the condition of these power sources in real time. "One particular challenge we wanted to solve was to make the measurements 3D and sufficiently fast, so that they could be done during the battery-charging cycle," explains NYU Chemistry Professor Alexej Jerschow, the paper's senior author. "This was made possible by using intrinsic amplification processes, which allow one to measure small features within the cell to diagnose common battery failure mechanisms. We believe these methods could become important techniques for the development of better batteries."

The work, described in *Proceedings of the National Academy of Sciences*, focuses on rechargeable Lithium-ion (Li-ion) batteries, which are used in cell phones, electric cars, laptops, and many other electronics. Many see lithium metal as a promising, highly efficient electrode material, which could boost performance and reduce battery weight. However, during battery recharging it builds up deposits--or "dendrites"-- that can cause performance loss and safety concerns, including fires and explosions. Therefore, monitoring the growth of dendrites is crucial to producing high-performance batteries with this material.

Current methods for doing so, developed previously by the same team, have used MRI technology to look at lithium dendrites

directly. However, such procedures have resulted in lower sensitivity and limited resolution, making it difficult to see dendrites in 3D and to precisely understand the conditions under which they accumulate.

With this in mind, the researchers sought to enhance this process by focusing on the lithium's surrounding electrolytes-- substances used to move charges between the electrodes. Specifically, they found that MRI images of the electrolyte became strongly distorted in the vicinity of dendrites, providing a highly sensitive measure of when and where they grow.

Moreover, by visually capturing these distortions, the scientists were able to construct a 3D image of the dendrites from fast MRI experiments. Alternative methods usually do not work on charging cells and require the batteries to be opened up, thus destroying the dendrite structure and altering the chemistry of the cell.


"The method examines the space and materials around dendrites, rather than the dendrites themselves," explains Andrew Ilott, an NYU postdoctoral fellow and the paper's lead author. "As a result, the method is more universal. Moreover, we can examine structures formed by other metals, such as, for example, sodium or magnesium--materials that are currently considered as alternatives to lithium. The 3D images give us particular insights into the morphology and extent of the dendrites that can grow under different battery operating conditions."

In May 2018, Wake D'Elia was at home using an electronic cigarette when the device's battery malfunctioned and exploded, killing him instantly. He was 38.

An investigation revealed that the battery was what's called an 18650.

The explosion caused the device to shoot "like a rocket into the cranial cavity and then [fall] to the ground, igniting a fire at the same time," said Lt. Steven Lawrence, deputy fire marshal for St. Petersburg Fire Rescue.

"It appears the battery failed, and when it failed, it was quick," Lawrence told NBC News.

 Wake D'Elia was killed instantly when his e-cigarette malfunctioned and exploded.

Wake D'Elia was killed instantly when his e-cigarette malfunctioned and exploded. Courtesy Chris D'Elia

This was not the first time that an 18650 battery has been implicated in an [e-cigarette explosion](#). Concern over these accidents prompted the Food and Drug Administration recently to take the first steps toward monitoring the devices.

"The incidents that we've seen generally involve ... vaping devices that use the drop-in 18650s," said George Kerchner, executive director of The Rechargeable Battery Association, known as PRBA. "That's where we have our biggest concern."

An 18650 is slightly larger than a AA battery. They are lithium-ion products that, according to Kerchner, are "robust cells that have a stainless steel can so they can withstand the rigors of outdoor power equipment." Indeed, the batteries' intended use is in electric vehicles and power tools - not devices that consumers can modify and put into their mouths.

The 18650 batteries are often used in certain types of electronic cigarettes called mechanical mods, which are specialized vaping devices that do not have an internal safety circuitry.

"The hallmark of the devices is that the batteries need to be taken out and charged," said Gregory Conley, president of the American Vaping Association.

Automakers Head To Silicon Valley For Apps, Startup Mentality

The 18650 cylindrical cell is sometimes used to power electronic cigarettes, and has been implicated in explosions. Tony Avelar / Bloomberg via Getty Images

But simply doing so can put users at risk. That's because the act of taking 18650s in and out of vaping devices or chargers can damage the cell's insulating wrapper, compromising the safety of the battery, Kerchner said.

Mechanical mods give consumers control over the intensity of their vaping experience.

But, Conley said, "if you attempt to draw too much power off those batteries, or if you use a damaged battery, and you have metal-on-metal contact, that's when these incidents occur."

"If you are going to use a mechanical mod ... you need to learn battery safety," Conley added.

Those in the battery industry take the advice a step further.

"We strongly recommend consumers stay away from vaping devices that are powered by 18650s," Kerchner said.

JUUL devices, which resemble small computer flash drives, do not appear to carry this risk. They do have lithium-ion batteries, but they are not 18650s, and they are designed to remain permanently in place.

"The manufacturer of JUUL specifically worked with the battery manufacturer to design a battery. They have overcharge protection," Kerchner said.

"Flaming rockets"

A recent [study](#) from George Mason University estimated there were more than 2,000 visits to U.S. emergency rooms from 2015 to 2017 for e-cigarette burns and explosion-related injuries.

The vast majority of those injured were men who had put e-cigarette batteries in their pants or shorts pockets when they said the batteries exploded.

Many experienced severe burns to their legs, arms and hands. Some also had keys in their pocket - a dangerous mix of metal and lithium-ion batteries.

A [2017 report](#) from the U.S. Fire Administration, in charge of fire data collection, education, research and training, stated, "The shape and construction of electronic cigarettes can make them [more likely than other products with lithium-ion batteries] to behave like 'flaming rockets' when a battery fails."

The author of that report, Larry McKenna, said lithium-ion batteries contain two thin plates separated by a sponge saturated with a combustible liquid similar to kerosene in terms of flammability.

"If those two thin plates touch, that liquid then heats up and bursts into flame," said McKenna.

Still, the failure rate is low. "Not many of these [explosions] happen, but because we are holding these things in our pockets or in our mouths or in our hands," said McKenna, "we're much more intimate with the hazard when it does happen."

Deadly explosions


Two e-cigarette explosions have proven fatal. In addition to D'Elia, a 24-year-old Texas man was killed in January when his [e-cigarette exploded](#), sending a metal part of the device into his neck, severing an artery.

Chris D'Elia, Wake's father, said that when his son's e-cigarette exploded, "the metal part of the pipe was actually embedded in his skull."

"He died instantly. He was dead before he hit the ground," D'Elia told NBC News.

D'Elia remembers his son as a "beloved character" who was a world traveler, an accomplished videographer and a music aficionado.

"People were drawn to him; he was a magnet to others," he said.

 "We never got to see our son to say goodbye," said Chris D'Elia of his only child, Wake, who was killed when his vaping device exploded.

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Wake D'Elia also worked for CNBC for nine years, until 2015.

"It was horrible," D'Elia said of the accident that killed his son. "Everything was horrible about this."

D'Elia said he made the decision to speak publicly about his son's death to make others aware of the potential for disaster when using vape mods.

"He's gone. I can never get him back. But maybe I can help somebody else so they don't have to go through this agony."

[Vaping is hurting teenage athletes, dashing their future in sports](#)

Those who advocate for the use of electronic cigarettes to help people quit smoking point out that injuries related to e-cigarette explosions are rare.

"There are hundreds of thousands of people who build their own coils and vape every day and do it without issue," Conley said.

"The public health benefit far outweighs any risk to the public. This technology, in my mind, is going to reduce death and disease in the long run," he told NBC News.

However, Conley stressed that using advanced mechanical mod systems requires consumers to learn battery safety. He said there are ways consumers can reduce their risk of e-cigarette-related battery failure:

- Never use a battery that has been damaged, or exposed to extreme temperatures
- Do not store 18650 batteries in pockets or bags. Always use a protective case, sold in most vape shops, for storage.
- Do not leave batteries on a charger longer than necessary
- Do not get batteries wet

- Move away from the device quickly if you feel it getting abnormally warm
- Do not block ventilation holes on the device

The Consumer Advocates for Smoke Free Alternatives Association also suggests only purchasing high-quality batteries from a known source. Its [website states](#), "Beware of re-branded batteries claiming to have 'high output' - many of these are counterfeit and will fail."

Beyond those safety measures, Conley said anyone using a mechanical mod to vape must be educated about voltage, current and resistance.

"If you are not willing to put in the time to learn how to use that product," advised Conley, "don't use it."