Single-use e-cigarettes contain batteries that last hundreds of cycles despite being discarded

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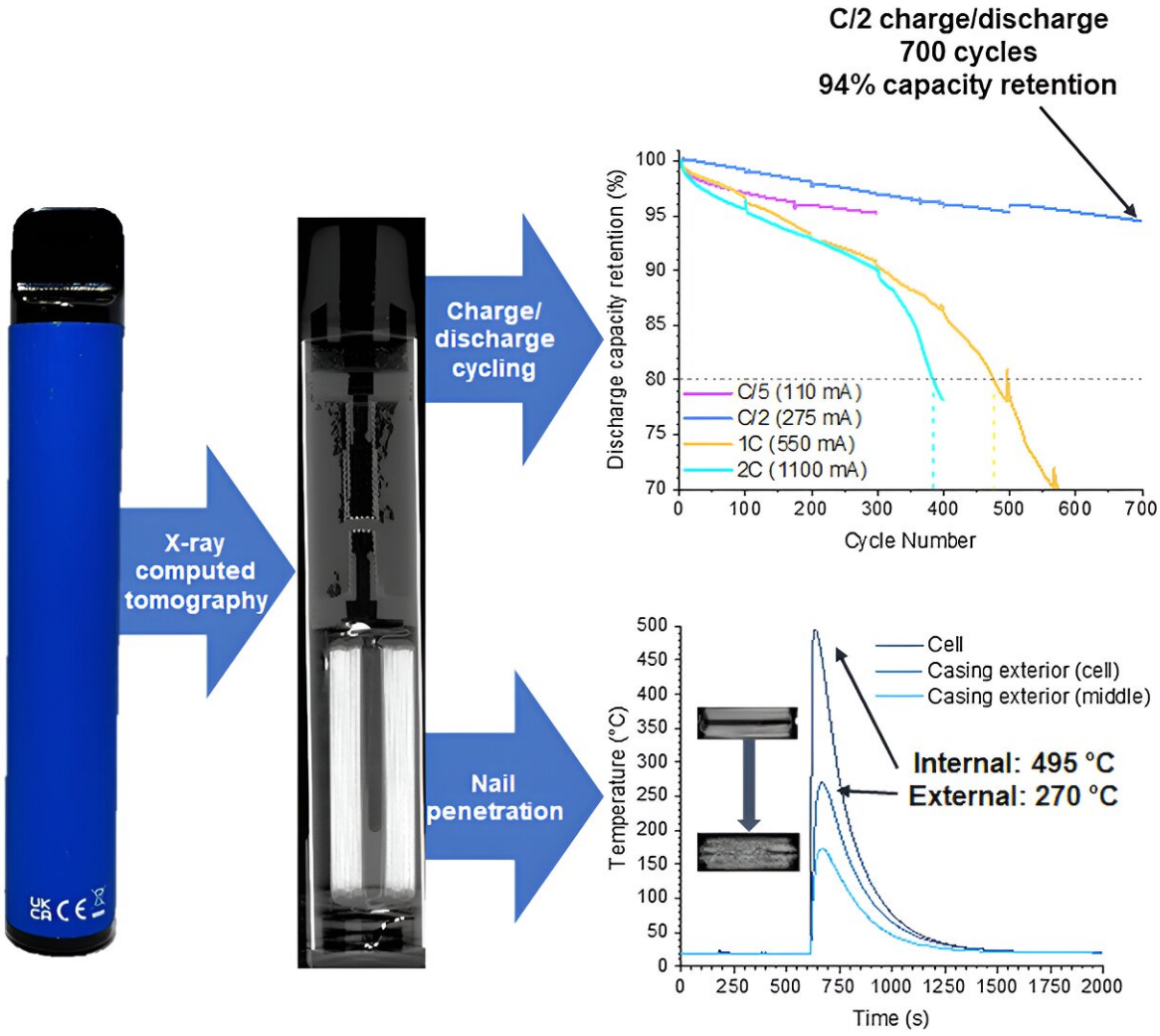

Disposable e-cigarette cells are potentially capable of over 700 cycles. Credit: *Joule*/Shearing et al.

While the lithium-ion batteries in disposable electronic cigarettes are discarded after a single use, they can continue to perform at high capacity for hundreds of cycles, according to a study published December 12 in the journal *Joule*.

The analysis, conducted by scientists from University College London (UCL) and the University of Oxford and supported by The Faraday Institution, highlights a growing environmental threat from these increasingly popular vape pens, which are not designed to be recharged.

"The surprise for us were the results that pointed toward just how long these batteries could potentially cycle," says Paul Shearing, Professor of Sustainable Energy Engineering at the Department of Engineering Science at the University of Oxford and UCL.

"If you use a low charge and discharge rate, you can see that for over 700 cycles, you still have more than 90% capacity retention. That's a pretty good battery, actually. And these are just being discarded. They're being chucked on the side of the road."

Disposable e-cigarettes have skyrocketed in popularity in the UK since 2021, with a survey finding an 18-fold increase recorded between January 2021 and April 2022. Within 15 months, their popularity among 18-year-olds rose from 0.4% to 54.8%. The speedy rise of single-use e-cigarettes has led to pressing new waste problems, with about 1.3 million of the devices thrown away in the nation each week.

As a result, about 10,000 kilograms (over 22,000 lbs) of lithium from e-cigarette batteries wind up in UK landfills each year, threatening nearby waterways with toxic nickel, cobalt, and organic solvents.

"Early on, we got the notion that the batteries going into these e-cigs were likely to be rechargeable batteries," says Shearing, noting that, to his team's knowledge, previous studies had not assessed how long the lithium-ion batteries in these products are capable of lasting.

To test their hunch, Shearing and colleagues harvested batteries from disposable e-cigarettes under controlled conditions and assessed them using the same tools and techniques that they use to study batteries in electric vehicles and other devices.

They examined the batteries under microscopes and used X-ray tomography to map their internal structure and understand the constituent materials. By repeatedly charging and discharging the batteries, they determined how well the batteries maintained their electrochemical performance over time, finding that they could be recharged "sometimes many hundreds of times," says Shearing.

"As a bare minimum, the general public needs to be aware of the types of batteries going into these devices and the need to properly dispose of them," he said. "Manufacturers should provide the ecosystem for reuse and recycling of e-cigarette batteries, and also should be moving towards rechargeable devices as the default."

Shearing and his team are also researching new, more selective ways to recycle batteries that allow individual components to be recovered without cross-contamination, as well as more sustainable battery chemistries, including post-lithium ion, lithium sulfur, and sodium ion batteries.

In order to address challenges across the entire battery supply chain, scientists should consider batteries' life cycles when thinking about any of their applications, he said.

"That permeates all the work we do, really, whether it's a vape battery or whether it's a battery going into an electric helicopter," says Shearing. "It's the same kind of thought process where we need to fully understand the life cycle of a battery device."

More information: Up in smoke: considerations for lithium-ion batteries in disposable e-cigarettes, *Joule* (2023). DOI: 10.1016/j.joule.2023.11.008. www.cell.com/joule/fulltext/S2542-4351(23)00482-8

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