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Surrey University designs new long-life battery

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A new battery design that could significantly extend the range of electric vehicles and the lifespan of portable electronics has been developed by researchers at the University of Surrey's Advanced Technology Institute (ATI).

In a study published in ACS Applied Energy Materials, researchers introduce a novel lithium-ion battery anode that delivers some of the highest energy storage capacities reported for silicon–carbon nanotube systems, while maintaining stability over hundreds of charge cycles.

Lithium-ion batteries power much of modern technology – from smartphones and wearables to electric vehicles. Graphite, the most commonly used anode material, is stable but limited in the amount of energy it can store. Silicon, on the other hand, offers far greater capacity, but it expands during charging, causing it to crack and degrade over time.

To overcome this, the research team developed a new "Vertically Integrated Silicon–Carbon Nanotube" (VISiCNT) structure. The design grows dense forests of carbon nanotubes directly onto copper foil and coats them with a thin layer of silicon, creating a flexible, conductive scaffold that can absorb expansion while maintaining performance.

The resulting anode can store a very large amount of energy for its weight. In laboratory tests, it stored more than 3500 milliampere-hours per gram – close to the maximum possible for silicon and far higher than the graphite (370 mAh/g) used in today's batteries. It also demonstrated improved stability and performance over repeated charge cycles.

Dr Muhammad Ahmad, Research Fellow at the University of Surrey's ATI and lead author of the study, said:

"There's been a growing push for battery innovation, as many of today's technologies are limited by how much energy batteries can store. Our VISiCNT design offers a practical route to harness silicon's huge storage capability without sacrificing cycle life.

"This is a much-needed breakthrough, delivering very high capacity, fast charging and long-term durability, while bringing us closer to batteries that can power electric vehicles and everyday devices for much longer on a single charge."

A key advantage of the new approach is that the carbon nanotubes are grown directly onto copper – the material already used in commercial batteries – using a scalable manufacturing process. This could make it easier to integrate the technology into existing industrial production lines.

Professor Ravi Silva, Principal Investigator and Director of the ATI, said:

"This work is an important step towards bringing CNT-silicon anodes out of the lab and into real-world manufacturing. We can grow carbon nanotube structures directly onto copper foil at speed and tailor the silicon layer for stability, meaning this approach could be integrated into existing battery production lines with minimal disruption. The technology has clear potential not just for electric vehicles, but also for grid storage and smaller batteries used in microelectronics.

"We are very proud to present yet another CNT technology following our initial research in delivering the world's darkest material, VANTA-Black via the university spin-out Surrey NanoSystems Ltd., which is showing real-world impact of fundamental research funded by UKRI."

As demand for energy storage grows, batteries will need to store more energy, charge faster and last longer to support the UK's transition to Net Zero. The VISiCNT design offers a promising route to meeting these challenges and could be key to powering next-generation electric vehicles and phones.

Surrey University

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