each silicon atom incorporates up to 4.4 lithium ions. However, the silicon tends to expand during use, meaning that the battery can only be recharged a few times before it becomes unusable.

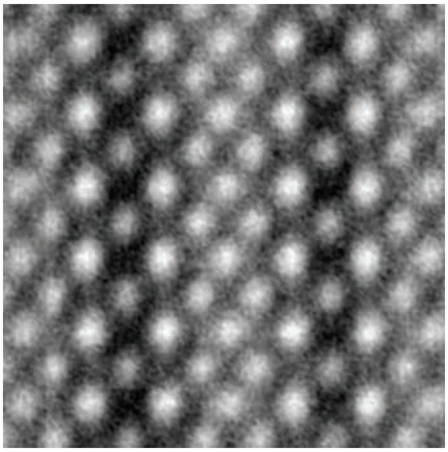
To overcome this problem, Cho, Cui and co-workers made parallel bundles of silicon nanotubes coated in carbon. Each nanotube presents a large functional surface area for the battery, because lithium ions in the electrolyte can accumulate both inside and outside the nanotubes.

The researchers built a lithium-ion cell including the silicon nanotubes and found it had a ten times higher capacity than commercial cells with graphite anodes. More importantly, the new cell retained its high performance even after 200 cycles of charging and discharging.

ELECTRON MICROSCOPY

Renewed focus

Nature Mater. **8,** 808–812 (2009)



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For decades the performance of electron microscopes was limited by spherical aberration in the optics that handled the electron beams, rather than the de Broglie wavelength of the electrons. However, the introduction of aberration-corrected electron microscopes led to significant improvements in resolution. For instance, scanning transmission electron microscopes (STEMs) can now routinely achieve resolutions of better than 0.1 nm, but the performance of scanning electron microscopes (SEMs) — which image secondary and backscattered electrons, rather than electrons that have passed through the sample — is no better than 0.4 nm. Now Yimei Zhu and co-workers at the Brookhaven National Laboratory and Hitachi have shown that it is possible to routinely achieve resolutions of 0.1–0.15 nm with an aberration-corrected SEM.

The aberration correction reduces the size of the beam and increases the beam current. An improved detector design and an increase in the operating voltage also boost the performance. Zhu and co-workers demonstrate the ability of their new microscope to image single atoms by studying a variety of samples, including a cuprate superconductor.

By using a combined SEM/STEM instrument, the Brookhaven–Hitachi team was able to probe both the surface and the bulk structure of their samples. Moreover, it should be possible to combine this new approach with various diffraction and spectroscopy techniques to learn even more about the properties and behaviour of materials on the nanoscale.

CARBON NANOTUBES

Taking root

ACS Nano doi:10.1021/nn900887m (2009)

Some nanomaterials are known to penetrate the cell walls of plants and there is interest in using nanoparticles as delivery agents in agriculture and horticulture. However, it is more difficult for nanomaterials to get into plant seeds because they have thicker walls than plant cells, so the effects of nanomaterials on the germination of plant seeds remain unknown. Now researchers at the University of Arkansas have shown that multiwalled carbon nanotubes can penetrate tomato seeds and accelerate the sprouting process.

Mariya Khodakovskaya, Alexandru Biris and colleagues immersed tomato seeds in standard agar medium supplemented with different concentrations of carbon nanotubes and examined their germination patterns. Seeds supplemented with nanotubes had similar root lengths to untreated seeds but grew faster, had greater biomasses and longer stems. Furthermore, seeds exposed to nanotubes were moister than the unexposed ones, suggesting that the carbon nanotubes had enhanced the uptake of water. Raman spectroscopy revealed that the nanotubes penetrated the seeds and roots of developed plants.

Although the mechanisms for increased water uptake by the nanotube-treated seeds remain unclear, and possible side effects still have to be investigated, the use of nanotubes for accelerating plant growth could open up new avenues in biofuel research.

The definitive versions of these Research Highlights first appeared on the *Nature Nanotechnology* website, along with other articles that will not appear in print. If citing these articles, please refer to the web version.

Top down
Bottom up

Ring cycle

The cooling rates of fullerene ions have been measured at a storage ring in Japan.

The story behind a recent paper on fullerene ions began over a decade ago when a facility called ELISA — which stands for electrostatic ion storage ring, Aarhus — was built in Denmark. At the time Klavs Hansen was a postdoc working with Jens Ulrik Andersen, a physics professor at Aarhus University, on the cooling of hot clusters and molecules in the storage ring. In 2001 they published a paper showing that negative fullerene ions and metal clusters cool as $1/t$, where t is time, but they were not able to determine a lifetime or absolute cooling rate, and they moved on to work on other problems.

The work picked up again years later when Sophie Canton, a postdoc at Lund University in Sweden, discussed the storage ring data with Hansen, who is now at the University of Gothenburg, also in Sweden. These discussions led to a new method for measuring absolute cooling rates in storage rings, so Hansen took his student, Erika Sundén, to the newly commissioned electrostatic storage ring at Tokyo Metropolitan University (TMU) to make the measurement.

Together with a team of chemists and physicists from TMU, Sundén and her Scandinavian colleagues were able to measure the absolute cooling rate of negative fullerene ions, and also track the relative importance of radiative and non-radiative contributions to cooling (*Phys. Rev. Lett.* **103,** 143001; 2009). The new approach could prove to be an important tool for studying the thermodynamics and optical absorption of large molecules or clusters, including several of astrophysical interest.

Hansen and co-workers did a lot of background work before they headed east. "We knew exactly what we were going for when we went to Tokyo," he says. Although the visiting team found themselves in a unique part of the world, work was the focus: "Cultural exchange is a plus, but you spend most of your waking time in a confined space in a lab," says Hansen. And what is his advice for anyone thinking about starting a collaboration? "Just do it".