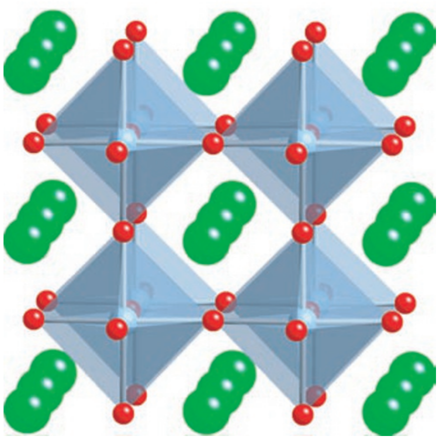
components into such structures enables them to interact with specific biological targets, which could prove useful for therapeutic and diagnostic medical applications. Peptides — small chains of amino acids — are promising candidates to impart bioactivity as they are known to mediate a range of biological events.

Now, Myongsoo Lee and co-workers from Yonsei University in Seoul, Korea report a general approach for the self-assembly of bioactive nanostructures with good control over their shape and size. A range of molecular building blocks, with a hydrophobic lipid chain grafted to the end of a peptide known to penetrate cells, were made. Depending on the size and degree of branching of the lipid, these compounds assembled into either spherical structures (11 nm in diameter) or short cylinders (12 nm in diameter and 100 nm long) with a hydrophobic lipid core and a hydrophilic peptide shell. Longer cyclindrical nanostructures could be made using branched lipids with modified chain ends.

When cells were incubated with short nanocylinders loaded with red-dye molecules, it was found that the dye was transferred to the cytoplasm and the nucleus, suggesting that these self-assembled materials are promising candidates for drug-delivery applications.

MICROSCOPY

Better and better



Nature **450,** 85–88 (2007)
Nature doi:10.1038/nature06352 (2007)

Electron microscopes have supplied data for countless papers. However, researchers are always looking for ways to improve the performance of these scientific workhorses, as demonstrated by two recent papers in *Nature* from independent groups in Japan and the US.

Koji Kimoto and co-workers at the National Institute for Materials Science in Tsukuba, Japan report how scanning transmission electron microscopy can be combined with electron energy-loss spectroscopy to perform element-selective imaging of atomic columns in a layered manganite crystal. Although these two techniques have been combined before, various technical difficulties have made it impossible to perform two-dimensional imaging of atomic columns. Using advances in both equipment (such as improved electron sources) and software enabled Kimoto and co-workers to image the columns of lanthanum, manganese and oxygen atoms in their sample.

Meanwhile Kamil Ekinci and colleagues at Boston and Cornell Universities in the US have developed a souped-up scanning tunnelling microscope (STM) with a frequency response (bandwidth) that extends up to 10 MHz — 100 times better than the previous state of the art. Although the basic idea behind the STM is quite simple — a sharp tip is scanned over a conducting surface, moving up or down to keep the tunnelling current constant — complex read-out electronics are needed to achieve atomic resolution. By improving the impedance matching in the read-out circuitry, the group was able to increase the bandwidth, and hence the temporal resolution, of the STM.

ENZYMES

All wired up

Nano Lett. doi:10.1021/nl072319o (2007)

Hydrogenase enzymes, which are found in various microbes, can catalyse the reversible oxidation of molecular hydrogen, providing a biological alternative to expensive precious-metal catalysts. There has, therefore, been great interest in their potential for use in biofuel cells and hydrogen production. However, it is difficult to incorporate them into electrical devices without compromising their catalytic activity.

Now, a group from the National Renewable Energy Laboratory in Colorado in the US have made biohybrids from hydrogenases and single-walled carbon nanotubes (SWNTs) in which the nanotube acts as a molecular wire and forms an electrical connection to the catalytic region of the hydrogenase. Michael Heben and colleagues used an iron-based hydrogenase from the bacterium *Clostridium acetobutylicum* and simply mixed it with a suspension of SWNTs in a surfactant. The enzyme spontaneously displaced the surfactant and adsorbed onto the SWNT surfaces.

Photoluminescence excitation and Raman spectroscopy studies were used to evaluate electron transfer in the hybrid material. Under anaerobic conditions and with an appropriate H_2 partial pressure, the hydrogenase remained catalytically active and could mediate the injection of electrons into the nanotube.

TOP DOWN BOTTOM UP

Collective memory

Researchers on opposite sides of the Atlantic are working together on a new approach to making silicon-based memory devices.

Michael Kozicki and Rainer Waser had known about each other's work for a number of years before they met for the first time at the Euromat conference in Prague in 2005. Kozicki, who is director of the Center for Applied Nanoionics at Arizona State University (ASU), agreed to write a chapter for a book that Waser, a physicist at the Jülich Research Centre in Germany, was editing, and they also started a collaboration to make better non-volatile memory devices with copper-doped silicon oxide.

Work started in earnest in 2006 when Maria Mitkova of ASU visited Jülich. One of Waser's students, Christina Schindler, then went to ASU to work on the fabrication and characterization of the devices, which can be switched between a high-resistance OFF state and a low-resistance ON state with relatively low voltages and currents (*IEEE Trans. Elect. Dev.* **54**, 2762–2768).

The low voltages and currents required for switching should translate into devices that are smaller and consume less power than other memory technologies. And being based on silicon, the new approach should be compatible with existing approaches to device fabrication.

Kozicki admits that it is never easy to collaborate between facilities separated by thousands of miles. "But having a physical presence, in the form of Ms Schindler certainly helped overcome this", he says. "Once there is an ongoing relationship, it is easier to maintain the collaboration by exchanging data and samples even when people are back in their home institutions."

The project was originally funded by Axon Technologies Corporation, a spin-out company co-founded by Kozicki, and the exchange of personnel between ASU and Jülich was supported by a grant from the US National Science Foundation held by Himanshu Jain, a materials scientist at Lehigh University.

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.