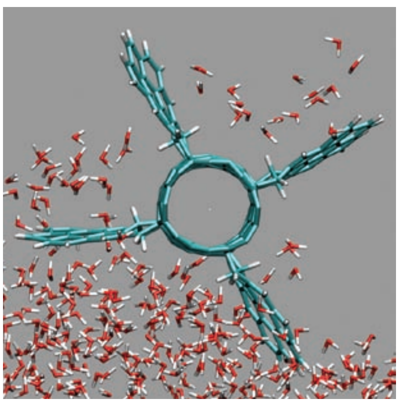
single-walled carbon nanotubes (SWNTs) can interact with microbes and kill them.

Menachem Elimelech and colleagues made highly pure SWNTs and allowed the bacteria *E. coli* to swim in a solution containing the nanotubes before measuring their survival using fluorescence-based assays. A 60-minute incubation killed a substantial portion of the bacterial cells in a dose-independent manner and those that attached onto the surface of the SWNTs almost always died. It is suggested that direct contact between the cells and nanotubes is necessary to kill the bacteria. When *E. coli* was allowed to flow through an SWNT-coated filter, 80% of the cells that accumulated on the top of the filter did not survive.

Scanning electron microscopy images revealed that the *E. coli* cells had damaged membranes, suggesting that intracellular material is discharged and results in death of the bacteria. This study shows that pristine SWNTs can kill bacteria through direct physical contact and may be useful for making antimicrobial materials in the future.

NANOSCALE PROPELLERS

Pump it up



Phys. Rev. Lett. **98,** 266102 (2007)

Molecular dynamics simulations show that it is possible to build nanoscopic propellers for pumping liquids, and to chemically tune them by altering the 'blades'. Boyang Wang and Petr Král from the University of Illinois in the USA, have proposed a propeller comprising blades — based on flat aromatic molecules (pyrene) — attached around a central carbon nanotube.

The effect of making the blades either hydrophobic or hydrophilic was investigated. It was found that the hydrophilic propeller rotated more slowly because of stronger interactions between the solvent molecules and its blades, particularly for water, which forms hydrogen bonds with them. Using hydrocarbon solvents of varying lengths, it was shown that the pumping rates speed up as the solvent molecules get longer because there are more atoms for the blades to grab onto. This effect disappears at very large lengths, however, because the pumping process is hampered by stronger interactions between the solvent molecules themselves. It was also discovered that the height at which the blades are mounted on the rotor is significant.

It is clear from these results that the rate of pumping depends greatly on the chemistry of the blade–liquid interface. These considerations, therefore, will be important in the design of such propellers for practical applications.

CARBON NANOPARTICLES

By candle light

Angew. Chem. Int. Edn
doi:10.1002/anie.200701271 (2007)

Some of the most widely studied nanomaterials are those made from carbon — namely fullerenes, graphene, nanotubes and nanofibres. A more recent addition to this particular family, however, are carbon nanoparticles (CNPs) — small-diameter clusters that have interesting photoluminescence properties.

A lack of methods to prepare and isolate CNPs has hampered their study to date, but Chengde Mao and co-workers from Purdue University in the US have now discovered that candle soot is a rich source of these materials. Soot collected on glass plates held over smouldering candles was boiled in nitric acid and the resulting black suspension centrifuged to give a light brown liquid that fluoresced yellow when exposed to ultraviolet light. Fluorescent CNPs were separated from this solution with a technique called polyacrylamide gel electrophoresis. This method — normally used to purify biomolecules — separates materials based on a combination of their size and charge as they pass through a crosslinked polymer under the influence of an electric field.

Different fractions of CNPs taken from the gel were shown to fluoresce with different peak-emission wavelengths, ranging from the red–orange region of the visible spectrum through to violet. Although much is left to be discovered regarding the exact nature of the CNPs isolated by Mao and co-workers, these materials may have a promising future in biosensing and related applications.

TOP DOWN BOTTOM UP

Strengthening old ties

As researchers move back and forth between universities and companies, they can encourage collaborations that bring together the academic and industrial worlds.

Although Yoshikazu Homma no longer works for NTT, the Japanese telephone company, he still maintains close ties with former colleagues at his old employer's basic research labs in Atsugi, near Tokyo. Now a physics professor at Tokyo University of Science, Homma has been working with Yoshihiro Kobayashi, a surface physicist at NTT, to understand the role of catalyst particles in the growth of carbon nanotubes.

Gold, silver and copper nanoparticles have all been used to grow nanotubes in recent years, so Homma and Kobayashi hypothesized that curvature on the nanoscale might be enough to act as a template for the growth of nanotubes, even in the absence of catalytic properties. Indeed, using semiconductor nanocrystals made in Kobayashi's lab at NTT, Homma and colleagues found that they could grow single- and double-walled nanotubes with diameters of 5 nm or less from silicon carbide, germanium and silicon nanoparticles. Although the yields in their experiments were relatively low, their results suggest that the essential role of the catalysts is to provide a template for the formation of the nanotube 'caps' (*Nano Lett.* **7,** 2272–2275; 2007).

"Performing experiments together is a simple and effective way for a successful collaboration to occur," says Homma, whose work on nanotubes is funded by the Japan Science and Technology Corporation as a CREST project. "I send my students to NTT to work with the physicists. They prepare the samples there and grow the nanotubes back at the university."

Homma believes that if a researcher has done good work in a specific field, there should be plenty of room to apply or extend this work into other areas. "The question is," he asks, "how do you find new fields and partners?". One answer he offers is to attend a conference in a different field.

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.