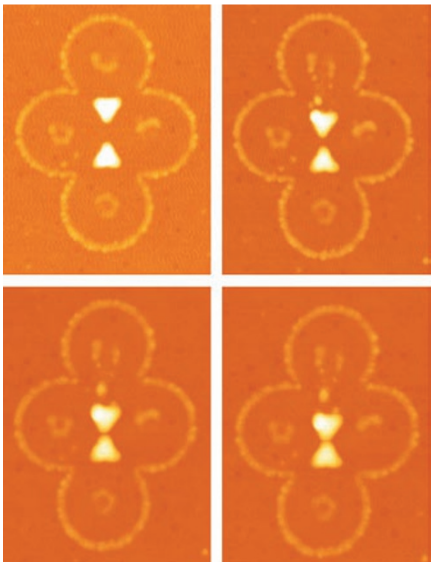
mirrors to be rigid and massive, whereas quantum behaviour is much more likely to be seen in structures that are small and flexible. Now Jack Harris and co-workers at Yale University and Ludwig-Maximilians University have developed an approach that allows mechanical structures and high-quality cavities to be combined without compromising the mechanical or optical properties of either.

Harris and co-workers use commercial mirrors to define their cavity, which is 6.7 cm long, and place a 50-nm-thick commercial silicon nitride membrane inside it. The cavity is then excited by a laser, and the membrane experiences radiation pressure in two directions. The team is able to cool the membrane from room temperature to 6.82 mK. The 'membrane-in-the-middle' geometry also allows the square of the membrane's displacement to be read out directly, which should make it possible to read out its energy eigenstate — something that has not been possible with existing optomechanical experiments. Harris and co-workers conclude that "it should be practical to use this scheme to observe quantum jumps of a mechanical system".

NANOPHOTONICS

Get in tune



Nature Photon. **2,** 230–233 (2008)

Antennae and aerials are used in most homes to capture electromagnetic radiation and convert it into electrical pulses that are processed into pictures and sounds. However, the physical size of the antenna has to be an appreciable fraction of the wavelength of the radiation, which can be several metres for radio and television signals. The ability to make much smaller antennae that absorb radiation at much shorter optical wavelengths would have many advantages, and could open up new possibilities for applications in areas such as medicine and photovoltaics.

Antennae that operate in the near-infrared region of the spectrum have been made by fabricating devices in which metal stripes are separated by a nanoscale 'feedgaps'. However, little is known about the properties of such nanoantennae at optical wavelengths. Now, Rudolf Bratschitsch and co-workers at the University of Konstanz have fabricated a tunable 'bow-tie' optical nanoantenna where the feedgap between two nanoscale gold triangular structures on a glass substrate can be changed with the tip of an atomic force microscope (AFM).

Bratschitsch and co-workers were able to arbitrarily change the gap between the triangles by exploiting the poor adhesion of the gold layers to the glass and using the AFM tip to move one of the triangles closer to the other. The response of the nanoantenna showed two strong peaks for gaps of less than 45 nm, but only one peak for gaps between 45 nm and 85 nm.

DRUG DELIVERY

Like a virus

Angew. Chem. Int. Ed. **47,** 2418–2421 (2008)

The development of nanocarriers to deliver drugs — in particular, for treating cancer — to specific cells in the body is the subject of intense research. The ability of viruses to target and kill cells has inspired the design of many drug-delivery systems, but none of these have been able to match the targeting capabilities of viruses, or their ability to move on to a new cell once the previous cell has been destroyed.

Now, You Han Bae and co-workers at the University of Utah and the Catholic University of Korea have developed a nanogel that is able to mimic viral properties much better than previous systems. The nanogel consists of a hydrophobic polymer core that contains histidine units, and two layers of hydrophilic shell — polyethylene glycol (PEG) and bovine serum albumin (BSA). The BSA shell is functionalized with folate ligands, which can bind to the folate receptors that are present on many tumours. The core is loaded with a model anticancer drug.

The nanogel is pH sensitive, swelling when the pH reaches about 6.4 (owing to protonation of the histidine units) and then shrinking again at higher pH. When the nanogel enters a cancer cell it swells because the pH value inside the cell is slightly lower than that outside, and this swelling causes some of the drugs inside the nanogel to be released. Moreover, the nanogels can move on to other cells where the process can be repeated to release more drugs.

TOP DOWN BOTTOM UP

Golden share

University physicists in Germany are working with a healthcare company to speed up the analysis of DNA

When Jochen Feldmann, a physicist at Ludwig-Maximilians-Universität (LMU) in Munich, began studying the optical properties of gold nanoparticles, he soon realized that they could provide information about their environment. He thought the nanoparticles might be useful for sensing, so he contacted Roche Diagnostics and the result was a long-running collaboration between the Photonics and Optoelectronics Group at LMU and the healthcare company to detect and manipulate biological molecules such as DNA.

The collaboration's latest research project, funded by the Bavarian Science Foundation and the German Science Foundation, involves the use of gold nanoparticles as 'nanostoves' to speed up the melting of double strands of DNA into single strands for analysis (*Nano Lett.* **8,** 619; 2008). To do this, the researchers fire a laser at large aggregates of gold nanoparticles bound together by strands of DNA. The nanoparticles directly transfer energy from the laser to the DNA, causing the strands to split. As an added bonus, the nanoparticles can 'report' that the DNA has melted because their optical properties change when they break free of the aggregate. Moreover, the whole process takes just a few microseconds, compared with minutes for previous techniques.

In addition to a string of papers, two of the postdocs who worked on the collaboration — Carsten Sönnichsen and Thomas Klar — are now professors with their own groups. So what is the secret of a successful collaboration? "The most important thing is to find the right partners from other fields and work together as open-minded specialists," says Feldmann. "Indeed, I cannot think of a current project in our group that is not multidisciplinary. Synthetic chemistry and biochemistry now play a central role in our work, with physicists and experienced chemists using the same coffee machine."

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.