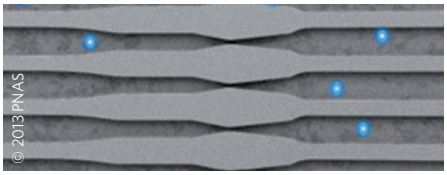
Squeeze to deliver

Proc. Natl Acad. Sci. USA **110,** 2082–2087 (2013)



When it comes to intracellular delivery, there are essentially two strategies: to take advantage of endocytosis — a naturally occurring engulfing process — or to stimulate the formation of transient pores in the cell's membrane. Endocytotic delivery vehicles usually have to be designed according to cargo and cell type. On the other hand, techniques that rely on temporal membrane disruption — such as electroporation or microinjection — allow any material to passively diffuse into the cell, yet they suffer from low delivery efficiency and limited throughput, and can damage the cargo or cause cell death. Now, Armon Sharei and colleagues show that poration can also be triggered mechanically. By squeezing cells through constrictions in series made in microfluidic channels, the authors were able to deliver proteins, nucleic acids, carbon nanotubes and other materials to various cell types at high throughput and with minimal effect on their viability. This strategy may be advantageous for high-throughput screening of drug libraries and in drug-delivery applications involving cell types that are difficult to transfect. *PP*

The virus catcher

Nature Nanotech. **8,** 130–136 (2013)

Amyloid fibrils composed of human-derived peptides are known to enhance retroviral gene delivery. Now, Jan Münch *et al.* report the improved efficiency of fibril-induced retroviral gene transfer using a 12-amino-acid peptide, termed EF-C. It was identified during a study of the viral infection ability of peptide fragments isolated from the human immunodeficiency virus type 1 glycoprotein gp120. The EF-C peptide spontaneously self-assembles into fibrils in solution and these peptide fibrils interact with virions in seconds. Using low-speed centrifugation, Münch *et al.* show that the fibrils can bind, precipitate and concentrate virions. Microscopic analysis of fibril–virion complexes in the presence of cells, suggests that a stable interaction is formed between the positively charged fibrils and the negatively charged surfaces of viral and cell membranes. This electrostatic interaction probably improves the fusion of the fibrils and the biological species, resulting in the observed enhancement in virus infection. Compared with RetroNectin, a commonly used retroviral agent, EF-C is found to be as effective, but is simpler and quicker to use. *AS*

Optical nanocircuits

Nano Lett. **13,** 142–147 (2013)

Similar to their classical counterparts, nanoantennas are optical components that can bring light signals from the (nanoscale) near-field to the far-field. In analogy to radiofrequency antennas, optimal operation is achieved if these nano-components are impedance-matched to free space and can be tuned at will. At radio wavelengths this is usually achieved by using lumped circuit elements, which, however, do not exist at optical frequencies. Andrea Alù, Naomi Halas and colleagues have now experimentally demonstrated optical nanoscale circuits with three-dimensional lumped elements, whose operation is based on photons rather than electrons. The researchers used the optical lumped elements to tune and impedance-match a single optical dimer nanoantenna. They managed to control the antenna's resonance and impedance bandwidth using suitably designed lumped-element loads made from combinations of basic circuit elements, namely nanoscale capacitors, inductors and resistors. These results may open a route to extending standard circuit concepts into the visible domain for applications that include data storage and wireless optical links. *KT*

High-performance nanotubes

Science **339,** 182–186 (2013)

Single carbon nanotubes (CNTs) have shown outstanding mechanical, thermal and electrical properties that are difficult to reproduce on the macroscopic level. Because of severe limitations in large-scale manufacturing protocols, CNT fibres fail to fulfil the expected strength of carbon fibres as well as the thermal and electrical conductivities of metals. Natnael Behabtu and colleagues now demonstrate that, by using highly purified CNTs that are ten times longer than those currently used, fibres with unprecedented multifunctional performance can be produced using the well-known wet-spinning technology. A highly ordered texture reaching a packing fraction of 90% improves their tensile strength compared with wet-spun fibres made using other approaches. This morphology, combined with iodine doping and annealing steps, also favours inter- and intra-CNT electrical transport as well as thermal conductivity. The researchers also foresee that the properties of the fibres will get closer to those of single CNTs when even longer and defect-free CNTs will be available for industrially scalable wet-spinning processes. *LM*

A moment of change

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Molybdenum disulphide (MoS_2) has a layered structure reminiscent of graphite that makes it an ideal dry lubricant. Latterly there has also been increasing interest in its electronic properties, as these share large similarities with, and may even offer some tantalizing advantages over, those of graphene. The key difference between the two is that MoS_2 is characterized by a honeycomb structure in which there are two atoms with different symmetry. This offers an additional degree of freedom in the form of quantized momentum valleys in the electronic structure, which can be selectively excited by circularly polarized light. Xiaodong Xu and colleagues now show this difference in symmetry can also be harnessed in bilayer MoS_2, by demonstrating that the circularly polarized photoluminescence can be continuously tuned using an electric field. A direct consequence of this is that the magnetic moment associated with the valley also changes sign from a positive to a negative value. *AT*

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