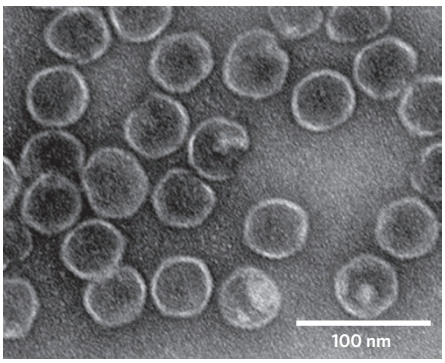
Interior design

Nature Chem. http://doi.org/jbd (2012)



The combination of controlled polymer synthesis and proteins opens up the possibility of creating composite materials with well-defined structure and function, and inherent bioactivity. One route to such materials is the use of virus-like particle (VLP) proteins as scaffolds from which to grow or encapsulate polymeric material. Trevor Douglas and colleagues have now shown that by tailoring the location of initiator sites to the inside surface of VLP proteins based on the bacteriophage P22, polymerization restricted to the particles' interiors can be achieved. Thiol functions on the inside surface of the protein shells are selectively converted to initiator sites for atom-transfer radical polymerization, and on addition of suitable monomers, crosslinked poly(2-aminoethyl methacrylate) is encapsulated within (as pictured). The polymer has a high density of reactive amine groups that are available for the attachment of small functional molecules. For example, fluorescent dye molecules or gadolinium-based contrast agents for magnetic resonance imaging can be incorporated into the hybrid nanoparticles in much higher loadings than for previous VLP-based delivery systems. *AS*

Superlenses sharpen up

Phys. Rev. Lett. **109,** 097405 (2012)

In contrast to conventional lenses, superlenses allow imaging with, in principle, unlimited resolution. Losses in the structure significantly reduce the image quality of superlenses, however, which has hampered their use for practical applications. To improve performance, Jean-Jacques Greffet and colleagues now suggest a new approach that also looks at the temporal properties of the light beam used for imaging. Superlenses are based on plasmonic surface waves that amplify not only the far-field but also the near-field evanescent waves from the object, which is crucial to achieve unlimited resolution. These plasmonic surface waves are, however, dampened by electric losses. As Greffet and colleagues have discovered, this turns out to be one of the limits to superlens performance. They studied the imaging properties of superlenses where, in contrast to the usual continuous-wave light, optical pulses are used whose duration is shorter than the surface plasmon decay time, so that associated losses are avoided. In numerical computations, such pulses are indeed predicted to lead to sharper images, promising a new approach to superlens imaging. *JH*

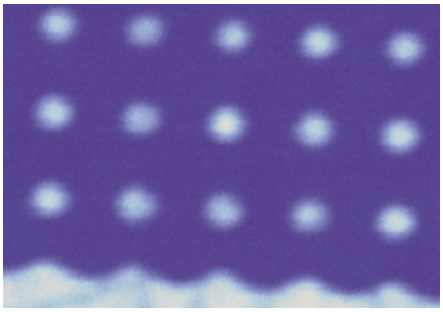
Stepping up MoS_2 integration

Nano Lett. **12,** 4674–4680 (2012)

Graphene is known for its exceptional purity and its high charge carrier mobilities. But the absence of a bandgap in monolayer graphene renders the material unsuitable for applications in electronics where low off-currents are required. Molybdenum disulphide (MoS_2), in contrast, is a two-dimensional semiconductor that could in principle allow for large on/off ratios in field-effect transistors (FETs). Large-scale growth routes and techniques for the fabrication of MoS_2-based devices are, however, only just emerging. More complex circuits require the cascading of individual logic elements with compatible input and output signal ranges. Tomas Palacios and colleagues now report the successful fabrication of integrated inverters, NAND logic gates, flip-flop gates and ring oscillators on exfoliated flakes of bilayer MoS_2. The key to their integration scheme is the use of FETs with Al and Pd gates in the inverters. The different gate metals have different work functions, leading to opposite shifts in the transistor threshold voltages and inverter operation at signal levels from 0 to 2 V that enable the direct coupling of the devices. *CM*

Rare-earth ion singled out

Nature Commun. **3,** 1029 (2012)



In addition to being the cornerstone of laser technology, the optical transitions that occur in rare-earth-doped crystals offer promise for quantum information storage and processing. But difficulties in detecting and manipulating them in individual ions — largely due to their low fluorescence yields — have so far been a stumbling block. Jörg Wrachtrup and colleagues overcome this problem and optically detect a single trivalent praseodymium ion residing in an yttrium aluminium garnet crystal host. They achieve this by taking advantage of the ultraviolet characteristics of Pr^{3+}, which allow for a so-called visible-to-ultraviolet 'upconversion'. The low fluorescence yield is a consequence of the long lifetimes of the optically visible transitions, which in turn results in a low emission rate. By promoting the ions into higher electronic states the emission rate is hugely improved, making the detection of individual ions possible. Wrachtrup and colleagues also demonstrate a method for creating Pr^{3+} ions on demand, suggesting that rare-earth ions could become an alternative to nitrogen–vacancy centres in diamond as building blocks for quantum computers. *AT*

Restrained fingering

Nature Phys. http://doi.org/jbg (2012)

A flowing, low-viscosity fluid penetrating a thicker one tends to form elongated patterns, resembling fingers, in the direction of the flow. Such 'fingering instabilities' can cause inefficiencies in oil-recovery processes and in microfluidic set-ups; for instance, when air is used to flush a liquid out of a channel, traces may be left behind. Now, Talal Al-Housseiny and colleagues show that fingering instabilities can be easily avoided by creating a depth gradient in the direction of the flow. Using a Hele-Shaw cell (a shallow rectangular channel) with varying depth, the researchers demonstrated that finger-like patterns disappear when the capillary number — the ratio of viscous to surface-tension forces — is below a critical value, which depends on the viscosity ratio of the displaced and displacing fluids, the contact angle of the fluid interface with the cell's wall, and the gradient in fluid depth. With appropriate flow rates, microfluidic channels that are tapered should then be easier to clean perfectly with a flush. *PP*

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