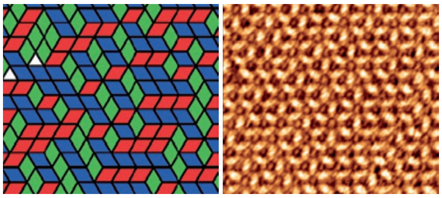
Tiling randomness

Nature Chem. http://dx.doi.org/10.1038/nchem.1199 (2011)



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Although the arrangement of tilings of surface-bound supramolecular networks has been intensely explored — mainly as a route to achieving tailored surface functionality — the degree of randomness has been difficult to measure and control in experiments. Now, by using combinations of isophthalate tetracarboxylic acids and solvents, Andrew Stannard and colleagues show that supramolecular rhombus tilings with varying randomness are possible, and that they can be characterized by an experimentally measured order parameter, which is a function of the fraction of adjacent parallel tiles and that of tiles that bind with unequal orientations. Additionally, the researchers show that the degree of order depends on the energy difference between parallel and non-parallel tiles, and that energy minimization competes with the maximization of configurational entropy (except for purely random tilings). Although a detailed microscopic description of the interactions between the molecules is still beyond reach, the authors' numerical simulations show that the order parameter can be related to an orientational dependence of the intermolecular interactions. *PP*

Thermopowerful guidelines

Phys. Rev. X **1,** 021012 (2011)

Thermoelectric materials can transform waste heat into electricity. To maximize efficiency, the ratio between the thermopower — which is proportional to the electrical conductivity — and thermal conductivity has to be as high as possible. Granular materials have potentially good thermoelectric properties, particularly if they are selected so that their grain boundaries reduce the propagation of heat and do not affect the motion of charges — electrons or holes. Stefano Curtarolo and colleagues have now used high-throughput *ab initio* calculations to estimate the thermoelectric performance of more than 2,500 granular compounds obtained by powder sintering. The basic assumption for their calculations was that the electrons move ballistically within each grain. The calculated thermoelectric properties of all these materials — available with the paper — suggest that the most efficient are those with a wide bandgap, high effective electron mass and a high number of atoms per primitive cell. The results will provide useful guidelines for thermoelectric experimentalists that are otherwise mostly limited by a time- and effort-consuming trial-and-error procedure. *FP*

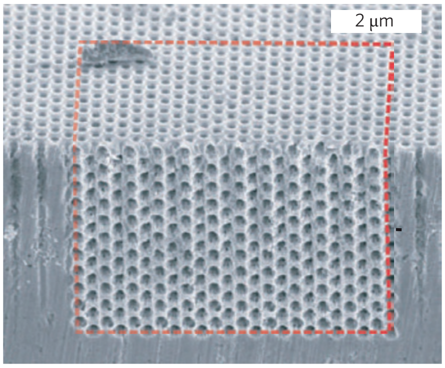
Gold nanoparticles afloat

J. Am. Chem. Soc. http://dx.doi.org/10.1021/ja208463f (2011)

Most miniaturized analytical assays carried out using surface-enhanced Raman scattering (SERS) in solution require the SERS-active gold nanoparticles (AuNPs) to first capture the analyte and then to be reconcentrated for sensitive detection. Now Keith Carron and colleagues describe how the scavenging and reconcentration steps can be combined. Functionalized AuNPs are immobilized onto the surface of a buoyant hollow silica microparticle, which functions as a floating device to direct the analyte to accumulate spontaneously and efficiently at the top of the aqueous sample. Described as a lab-on-a-bubble (LoB) assay, the method overcomes two significant limitations of low-volume SERS assays; it avoids the use of an inefficient and time-consuming reconcentration step, and eliminates the contribution of Brownian motion to the spectral noise (typically seen with traditional gold substrates) as the buoyant particles are significantly larger than the laser focus. Furthermore, because the immobilized AuNPs do not aggregate, there is no loss of SERS signal over time. Initial results from the LoB assay are promising: the limit of detection for cyanide ions is approximately 170 parts per trillion, which is on a par with other state-of-the-art detection systems. *AM*

Suppressed light

Phys. Rev. Lett. **107,** 193903 (2011)



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One of the defining features of photonic crystals is that they block the propagation of light of certain wavelengths. Within these forbidden gaps, even light emission is suppressed. This effect has now been demonstrated by Willem Vos and colleagues in a silicon photonic crystal with a full three-dimensional photonic bandgap. Etched out of silicon with nanometre precision utilizing a fully CMOS-compatible process — in itself a remarkable, pioneering achievement — the photonic crystals have their bandgap at near-infrared telecommunications wavelengths. The photonic crystals were placed in a solution containing PbS quantum dots, whose emission wavelength is matched to the photonic crystals band gap. Compared with the quantum dots outside, light emission from the quantum dots within the photonic crystal is considerably suppressed, by up to a factor of ten for wavelengths within the photonic bandgap. This light-suppression effect could be useful for situations where spontaneous light emission such as that from the quantum dots represents an undesirable noise, for example in lasers or in optical quantum computers. *JH*

Growing along

Appl. Phys. Lett. **99,** 203104 (2011)

Common growth methods for semiconductor nanowires usually yield vertical structures. To incorporate such vertical nanowires in planar electronic devices requires them to be transferred from the growth support to a flat substrate, followed by a complex alignment and lithography process. Building on previous work, Linwei Yu and colleagues have now fabricated coplanar silicon nanowire transistors in a self-aligned growth process. The researchers first pattern silicon nitride (SiN) slabs on top of a silicon substrate with a silicon dioxide layer, which later serves as a bottom gate. They then form indium droplets near the SiN slabs and coat the entire structure with a thin layer of amorphous silicon. During the temperature-driven solid–liquid–solid growth process, the indium droplets serve as mobile catalytic particles, consuming the amorphous silicon to leave behind silicon nanowires as they move along the edges of the SiN structures. Using their method, the researchers have fabricated nanowires with diameters down to 14 nm and field-effect transistors with hole mobilities of up to 228 $cm^2 V^{-1} s^{-1}$, which are comparable to devices based on polycrystalline silicon. *CM*

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