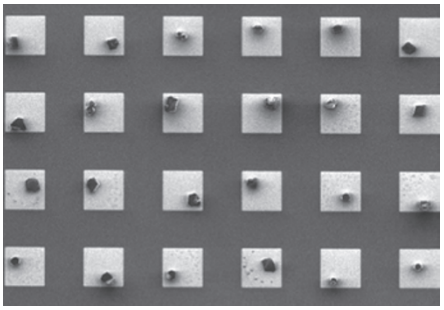
Printed MOFs

Adv. Mater. http://doi.org/fxhzh9 (2012)



The large porosity and chemical versatility of metal–organic frameworks (MOFs) make them attractive for their potential use in catalysis, sensing, gas storage and drug delivery. Although most efforts have concentrated on controlling the preparation of novel framework topologies and their internal functionalities, immobilization and integration of these materials in functional devices has remained elusive. Jeroen Lammertyn and colleagues now use a microfluidic approach to accurately deposit monodisperse individual MOF crystals, which leads to high-throughput yet flexible single-crystal patterning. The proposed methodology relies on a digital microfluidic platform, which is designed for the controlled delivery of femtolitre droplets of MOF building-block solutions. The hydrophobic surface of the device is patterned to obtain hydrophilic-in-hydrophobic micropatches onto which droplets of MOF precursor solution are printed per second in a chosen pattern. On controlled evaporation of these droplets, large arrays of single MOF crystals can be fabricated. Compared with other methodologies, this approach does not rely on expensive equipment and results in the flexible production of large arrays of monodisperse MOF crystals with high parallelism. *VD*

Water from other worlds

Phys. Rev. Lett. **108,** 091102 (2012)

Ice giants is the term commonly used to describe planets like Neptune, Uranus and several extrasolar planets discovered in the last few years. Water is abundant in the cores of these celestial bodies, but at those extreme pressures and temperatures it little resembles its liquid and solid forms we see on Earth. Its equation of state has been modelled in different ways, which naturally lead to conflicting estimates of the properties of the planets. Marcus Knudson and colleagues have now used a high-precision shock-wave experiment to study the compressibility of water at several hundred gigapascals of pressure, which resembles the conditions expected in the ice giants. Their results are in agreement with the equation of state predicted by a recent first-principle model, and suggest that the temperature in the core of Neptune and Uranus can be up to 20% lower than previously estimated. Validation of this equation of state will be instrumental in understanding the internal composition of planets of this type. *FP*

Zoom-in on organic memory

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In memory capacitors, a floating charge-storage layer is sandwiched between two insulator layers. The memory state of these cells can be modified by applying a high voltage across the stack, which induces a tunnelling current that changes the stored charge. The miniaturization of such devices relies on the identification of storage materials that can maintain high charge densities over long times. Sarah Paydavosi and colleagues now use Kelvin force microscopy to investigate the microscopic charge-storage properties of the organic semiconductor tris(8-hydroxyquinoline) aluminium (Alq_3). The researchers modify the technique, in which a microscope tip is scanned over a surface to measure variations in the local potential, by injecting charges in Alq_3 films, which they then monitor over time. They find that both electrons and holes in these films remain highly localized with decay times on the order of several hours. Building on this result, the researchers successfully apply 3-nm-thick Alq_3 storage layers in prototype memory capacitors, leading to charge densities of up to 5×10^{13} cm^{-2} and reversible programmability over more than 100,000 cycles. *CM*

Live bacteria resist attraction

Proc. Natl Acad. Sci. USA **109,** 4052–4057 (2012)

Add sufficient non-adsorbing polymers to a colloidal suspension, and the colloids will precipitate. This is caused by the attractive (depletion) forces that arise between colloids when they are too close for the polymers to fit in the space between. Such an entropic-driven phase separation has also been observed in suspensions of non-motile bacteria. Now, Jana Schwarz-Linek and colleagues find that a suspension of self-propelled *Escherichia coli* needs roughly three times more polymer to precipitate. The researchers explain that bacterial self-propulsion competes with depletion forces, and that therefore live *E. coli* experience an attraction that is weaker than that between passive colloids. They also observed that when the strength of the attraction is too feeble to cause phase separation (but not aggregation), the competition between self-propulsion and entropic attraction also makes clusters of bacteria rotate unidirectionally, and that the net torque results from the random forces exerted by a cluster's outermost bacteria. The researchers' computer simulations of self-propelled spheres with a short-range intersphere attraction show that the observed phenomena should be generic to active matter. *PP*

Solar fibre lasers

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To operate a laser, its light-emitting gain medium needs to be excited by electrical or optical pulses designed to match the medium's excited energy states. For some applications it would be desirable if a laser could simply be powered by sunlight. However, the realization of solar-powered lasers is challenging as it requires the efficient conversion of the Sun's broad spectrum to light emission in the gain medium. Indeed, although solar-pumped crystal lasers were realized almost 50 years ago, extending this concept to more practical devices has proved difficult. However, Shintaro Mizuno and colleagues have now demonstrated the first solar-powered fibre laser. The laser is enabled by a Nd^{3+}-doped glass that combines efficient light absorption in the visible region with strong light emission at the near-infrared laser wavelength of 1,053.7 nm. Lasing was demonstrated by focusing sunlight onto the fibre with a parabolic mirror, showing an overall laser energy-conversion efficiency of 1.76%. Such solar-powered lasers could be used for free-space communication tools, or to convert solar energy into other forms of energy. *JH*

Written by Vincent Dusastre, Joerg Heber, Christian Martin, Pep Pàmies and Fabio Pulizzi.