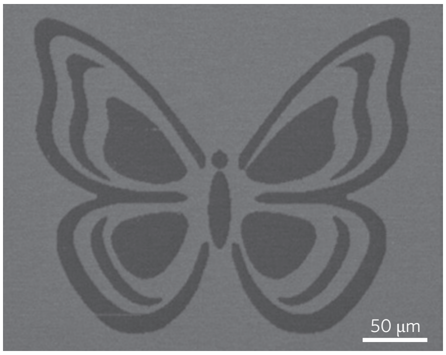
Changing domains

Nature Nanotech. **8,** 667–675 (2013)



Block copolymers — which can self-assemble into nanoscale domains — may hold the key to high throughput, solution-processable routes to simplifying lithographic methods and the fabrication of nanoscale devices. Now, Heejoon Ahn, John Rogers and colleagues report an electrohydrodynamic jet printing technique for the deposition of complex geometrical patterns of block-copolymer films, with a high degree of spatial control over the structures, periodicities and morphologies of the nanodomains within the patterns. The printing inks are solutions of the block copolymer, polystyrene–polymethylmethacrylate (PS–PMMA) and, on application of an electrical field, are fed from nozzles to a grounded, polymer-functionalized silicon substrate. The substrate can be moved relative to the nozzles to achieve a desired pattern. Thermal annealing causes phase separation of the block copolymers into various nanodomains depending on the PS–PMMA composition. This method allows PS–PMMA of differing molecular weights and film thicknesses to be sequentially deposited at a specific location on the substrate and, as a result, any periodicity of nanodomain spacing that falls in between that of the initially deposited block copolymers can be obtained. *AS*

Plasmonic darkness

Nano Lett. **13,** 3722–3728 (2013)

Plasmonic nanostructures and metamaterials suffer from considerable optical losses that may compromise some of their envisaged applications. Special kinds of modes that are supported by these nanosystems have a useful property of not coupling to the continuum, contrary to their bright counterparts. These so-called dark modes suffer only from dissipative losses. Furthermore, in complex nanostructures the dark modes can hybridize, giving rise to collective supermodes that can be either bright or dark. Now, Ann Roberts and colleagues show how the dark plasmonic supermodes from three Au plasmonic nanorods arranged in a triangular configuration can be excited and optically detected. Because of the characteristic symmetry, the lowest-energy dark mode can be excited by radially polarized light. The researchers present experimental results that confirm the excitation of this mode, which has a longer lifetime compared with the bright supermodes. Indeed, the relatively long plasmonic lifetimes of these modes may enable them to be coupled strongly to nanoscale emitters. *KT*

Hyperelastic nanowires

Nature Commun. http://doi.org/nrq (2013)

Atomic crystals are far from elastic. Typically, crystals yield inelastically at strains of about 1% because of the activation of dislocations, deformation twinning, cracking, or the appearance of stress-induced phase transformations. However, confinement of the deformation to scales smaller than a few micrometres supresses the basic processes of plastic deformation, which leads to larger elastic strains. In fact, continuous and reversible lattice strains of up to approximately 8% have been probed in defect-free uniaxially loaded micropillars and nanowires, and values exceeding 30% have been predicted for metals. Yet strains above 8% have not been observed in experiments. Now, Evan Ma, Xiadong Han and colleagues report lattice shear strains up to 34.6% (corresponding to a stored elastic energy that is more than 100 times that of bulk metals) in bent Ni nanowires inside a transmission electron microscope. Along the path of applied strain, they observed continuous and reversible phase transformations between various cubic phases, which had been predicted theoretically. The continuous lattice sharing can however be terminated by dislocations at lower strains. *PP*

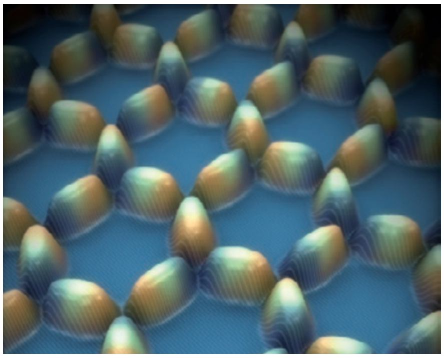
The logic of graphene

Preprint at http://arxiv.org/abs/1308.2931 (2013)

In digital electronics applications, the use of graphene-based transistors is hampered by the difficulty of defining clearly separated on and off states for the current. This difficulty is due to the absence of an intrinsic energy bandgap, which at present cannot be introduced artificially without affecting the excellent transport properties of graphene. Now, Guanxiong Liu and collaborators overcome this limitation by taking advantage of the nonlinear output characteristics of graphene-based transistors. Using a diode-like biasing configuration they demonstrate that the current flowing in the device decreases when the applied voltage increases, unlike the behaviour observed in linear resistors. This negative resistance is the key to realizing high-speed electronic circuits, which can be used as building blocks both for Boolean and non-Boolean logic operations. Importantly, this nonlinearity is also theoretically demonstrated for nanosized transistors operating in the ballistic transport regime, paving the way for the realization of high-density electronic circuits based on graphene. *LM*

Artificially cool

Nature **500,** 553–557 (2013)



The concept of frustration is often invoked when describing systems that cannot reach a global energy minimum because of the presence of many energetically similar ground states. In magnetism, the topic has been the subject of intense investigation over the past decades, most notably when the origin of the frustration can be traced down to geometric constraints. Recently, these ideas have been revisited in lithographically fabricated arrays of interacting nanoscale magnets that, owing to their conceptual similarity with a celebrated frustrated magnetic system known as spin ice, are referred to as artificial spin ices. In principle, they represent an ideal platform for investigating magnetic frustration, but in practice they are often found to occur in frozen 'athermal' states, making the study of their equilibrium properties problematic. Peter Schiffer and colleagues now demonstrate a way to overcome this issue and bring artificial spin ices of different geometries into thermal equilibrium. Their annealing approach closely resembles a strategy for investigating the properties of these systems by numerical simulation, therefore making artificial spin ice even more attractive for studying frustrated magnetic materials. *AT*

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