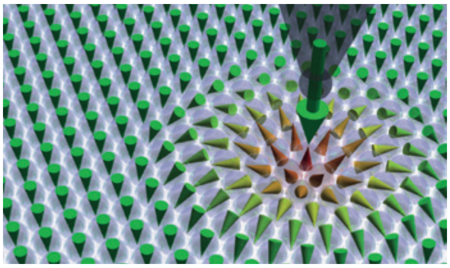
MAGNETIC NANOSTRUCTURES

Skyrmions on demand

Science **341,** 636–639 (2013)



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Magnetic skyrmions are spin nanostructures with a whirling magnetization configuration. This configuration is topologically protected and, as a result, skyrmions are stable structures that are difficult to generate. These nanostructures have been proposed as information carriers in future spintronic devices, but such applications will require the controlled nucleation and annihilation of individual skyrmions in nanostructured magnetic thin films. Kirsten von Bergmann, André Kubetzka and colleagues at the University of Hamburg have now shown that single skyrmions can be created and destroyed using a scanning tunnelling microscope.

The researchers manipulated single skyrmions in ultrathin PdFe bilayers on an Ir substrate. Starting from a ferromagnetic state at a temperature of 4.2 K, and under an applied magnetic field, spin-polarized current from the tip of a scanning tunnelling microscope was used to locally write and delete individual skyrmion structures with diameters of a few nanometres. The skyrmions were nucleated in the vicinity of the tip and preferably at defect sites. The mechanism for switching between the skyrmion and ferromagnetic state was attributed to the injection of high-energy tunnelling electrons, with the switching rate determined by the electron energy. The researchers also found that spin-transfer torque influences the switching parameters. *ED*

ELECTRON MICROSCOPY

At the limit

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The first aberration-corrected transmission electron microscope was built in 1998 and offered a resolution of around 0.13 nm. Since then, improvements in electron optics have led to the development of instruments capable of resolutions of around 0.05 nm. Stephan Uhlemann and colleagues at Corrected Electron Optical Systems GmbH in Germany have now shown that the resolution of such microscopes is limited by magnetic field noise from thermally driven currents in the metallic components of the instrument.

The researchers removed the aberration corrector from an electron microscope and replaced it with a cylinder that could be cooled with liquid nitrogen and house metallic (stainless steel and permalloy) tubes. They then studied how the resolution of the instrument varied with temperature and the material of the tube by comparing diffactograms of images of amorphous tungsten thin films on carbon supports. The resolution was found to improve at lower temperatures and to depend on the material of the tube, which is consistent with the presence of thermal magnetic field noise.

This noise causes stochastic deflections of the electron beam in the instruments and the team suggest that this limits the resolution of modern instruments to around 0.05 nm. *OV*

SUPRAMOLECULAR CHEMISTRY

Multimetal rings take shape

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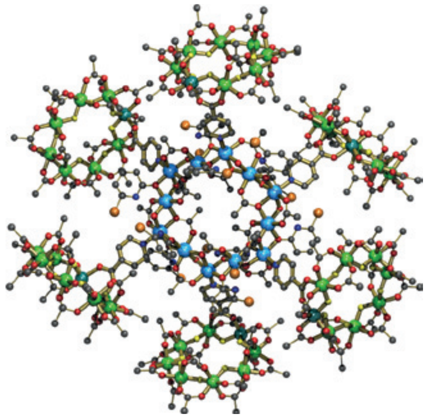

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To make large molecules that can perform specific tasks, it is necessary to direct the assembly of simpler molecular blocks in a spatially controlled fashion. In particular, if multiple metallic centres can be incorporated into supramolecular aggregates, macromolecules can be created with magnetic, redox and catalytic properties. Richard Winpenny and colleagues at the University of Manchester, l'Institut Néel and the Lawrence Berkeley National Laboratory have now developed a conceptually simple, yet powerful, strategy for making multimetallic assemblies.

The researchers start with a ring-shaped compound that contains seven chromium atoms and one nickel atom arranged in an octagon. The nickel atom is attached to a Lewis base, which can be used to link the 8-centre ring to various other compounds using common acid–base coordination chemistry. For the Lewis acid, the team choose compounds containing a labile group (typically water or tetrahydrofuran) that can be easily displaced by the Lewis base to form a new covalent bond.

Three examples are used to highlight the generality of the approach. In the first, a 3-centre ring comprising three manganese atoms attached to a labile group is reacted with three equivalents of the 8-centre ring to create a multimetallic 27-centre compound. In the second, a bitetrahedral, 6-centre ring is reacted with four equivalents of the 8-centre ring to give a 38-metal centre aggregate containing 4 different metals. Finally, a compound with 60 metal centres is synthesized from a 12-centre hexagonal ring and six equivalents of the 8-centre ring. *AM*

NANODIAMONDS

Taking the temperature of a cell

Nature **500,** 54–58 (2013)

The ability to monitor the tiny temperature fluctuations within a cell requires a very tiny thermometer and current methods of local temperature sensing struggle to achieve the required sensitivity. Hongkun Park, Mikhail Lukin and colleagues at Harvard University and the City University of Hong Kong have now used nanodiamonds containing nitrogen impurities to create nanoscale thermometers that can detect changes in temperature as small as 1.8 mK, over distances as small as 200 nm.

By replacing a carbon atom in a nanodiamond with a nitrogen atom, a vacancy is created. The transition frequency of electrons between the ground and excited states of this vacancy is temperature dependent. By detecting the transition frequency optically, using fluorescence microscopy, the researchers could correlate this signal to a quantitative change in temperature. As nanodiamonds are excellent thermal conductors, the temperature recorded should be the same as their immediate surroundings.

To demonstrate the potential of the approach to monitor and control temperature, the nanodiamonds were inserted along with gold nanoparticles into a human embryonic fibroblast cell. Laser light was used to excite the gold nanoparticles enabling them to act as localized heat sources, changing the temperature within the cell, which could be measured using the nanodiamonds. Taking this further, the researchers went on to determine the temperature increase required to destroy a cell. *SB*

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