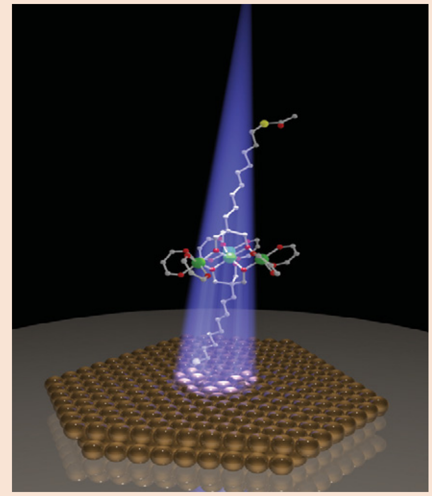
Molecular magnets wired on gold

MAGNETIC MATERIALS

Memory storage miniaturization is progressing steadily on to smaller and smaller devices. As structures go, one cannot miniaturize further than to the size of individual molecules. Precisely this has been achieved by a group of scientists from the INSTM units of the Universities of Florence and Modena, Italy, the ISTM-CNR, Florence, Italy, the Université Pierre et Marie Curie, Paris, France, and the Synchrotron Soleil, Gif sur Yvette, France [Mannini, *et al.*, *Nat. Mater.* (2009), doi:10.1038/NMAT2374]. Although single-molecule magnets (SMMs) have been reported before (utilizing Manganese as magnetic material), the retention of magnetic hysteresis has been a problem as the Manganese ions gradually underwent reduction. The SMMs reported now consist of robust, propeller shaped organic molecules, comprising four high-spin Fe(III) ions, which display the redox stability missed in the Manganese compounds. The molecules have been mounted on a gold surface, in order to make them individually accessible by scanning probes. "What we have shown is that the magnetic hysteresis of molecular origin is observable when the molecule is attached to a conductive surface," says Roberta Sessoli, corresponding author. "We have selected gold as a surface material because our approach was a 'wet' one, i.e., using self assembly from a solution of magnetic molecules." The result represents a breakthrough in nanomagnetism, since this compound excels in stability, magnetically as well as chemically, both in solution and crystalline form. However, the question of writing and reading information from the individual molecules remains. "Scanning probe techniques are very promising, but also very expensive," admits Sessoli. "Other methods might be employed, although very little is known at the moment about the transport properties of isolated molecules and their interplay with their magnetization state." However, the scientists hope to learn more about the interactions of conducting electrons and magnetism at a fundamental level from these systems in the closer future. Consequently, Sessoli and her group plan to move on from the chemically stable, non magnetic gold to magnetic surfaces, now that they have evaporable SMMs ready for use. "The field of hybrid nanostructures comprising single molecules and traditional magnets is also fully unexplored and could reveal new interesting proximity effects," says Sessoli, on the way to challenge Moore's law down to the nanometer scale.



Fe_4 complex anchored on a gold surface.

Michel Fleck

Nanostructured origami

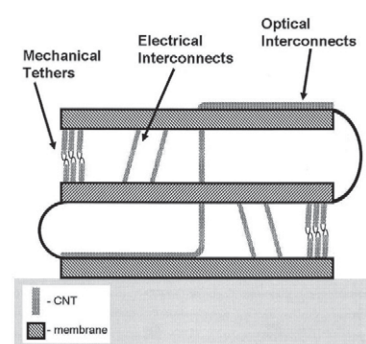
NANOTECHNOLOGY

Using the art of origami a group of scientists [*MIT tech talk* (2009) **53**, 4] and [Arora, *et al.*, *J. Microelec. Syst.* (2009) **18,** 98] have successfully fabricated a functional microscale super capacitor, which is essentially a nanostructured 3D device. It consists of one electrode placed on a fixed substrate and the other on a folding membrane. Folding over the single membrane flap brings the two electrodes together to form one super capacitor cell. The microscale super capacitor could potentially be used as an effective, integrated power source for stand alone microsystems. "Origami" is the japanese art of paper folding; nanostructured origami is the manufacturing process that folds nanopatterned thin films into a desired 3D shape. In the first step of the process, standard planar fabrication tools and techniques are used to create a micro and nanopatterned 2D membrane. The membrane can be thought of as the analog of "paper" used in conventional origami and, in addition to being patterned directly, can provide a base on which to grow or deposit nanostructured materials.

The nanostructured origami process provides several advantages over current fabrication methods. First, a multilayer device can be made by patterning and repeatedly folding a single layer, thus avoiding fabrication difficulties associated with multilayer devices. Improved alignment and spacing among the folded layers can be achieved through the use of pyramid-shaped alignment features. In addition, whereas current nanofabrication methods are largely limited to building nanostructures on the top surface of a horizontally oriented substrate, the origami method allows the patterned surfaces to be oriented arbitrarily within the final 3D system.

Because the origami method of fabrication is based on standard 2D fabrication tools and techniques, a wide range of origami devices, including the origami super capacitor, can be integrated with pre-existing micro and nanosystems.

In addition, the origami super capacitor benefits greatly from the use of nanostructured surfaces and 3D geometry, two main features of origami fabrication.



Schematic of nanostructured origami

The use of high surface area carbon electrode with nanoscale pores and particles resulted in a 50 x increase in capacitance, whereas the ability to vertically stack the layers resulted in devices with a real footprint of less than 1 mm. Future devices will incorporate more complex nano architecture to further increase performance

Jonathan Agbenyega