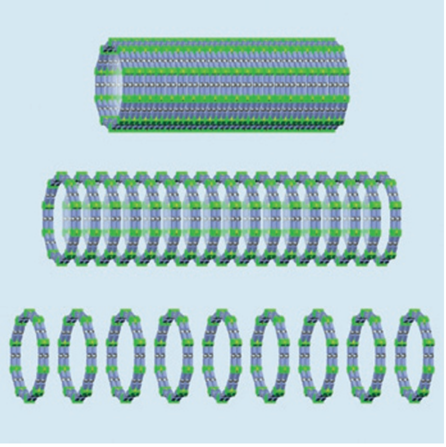
NANOTUBES

Make up to break up

Science **344,** 499–504 (2014)



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Non-covalent interactions such as hydrogen bonds and π–π interactions can be used to build intricate self-assembled nanostructures. These interactions are typically weaker than covalent bonds and the steps of the assembly process can be reversible, allowing 'errors' to be corrected and for highly ordered structures to be created. Manipulating the nanostructures once they are assembled is, however, a significant challenge. Takuzo Aida and colleagues in Japan have now shown that ferrocene-based building blocks can be self-assembled into nanotubes and then disassembled into individual nanorings by altering the non-covalent interactions between the components.

Ferrocene is a sandwich compound in which two cyclopentadienyl (C_5H_5) rings are bonded to opposite sides of an iron atom. Two aromatic arms, with metal-coordinating pyridyl groups (RC_5H_4N) at their ends, are attached to each of the cyclopentadienyl rings, and in the presence of silver ions, the building blocks can self-assemble into metal–organic nanotubes with diameters of around 7 nm and 13 nm, depending on the size of the pyridyl arms. The nanotubes can then be sliced into their constituent nanorings through oxidation of the ferrocene groups, which reduces the attractive interaction between the rings. The researchers also show that the nanorings can be transferred onto substrates electrostatically or reassembled into nanotubes through reduction of the ferrocene groups. *OV*

NANOPARTICLES

Clinical glue-stick

Angew. Chem. Int. Ed. http://doi.org/f2rd7t (2014)

Sutures and staples are common tools that are used to stop bleeding, close wounds and repair organs in the surgical theatre. However, they are not so practical for inaccessible regions of the body and can be traumatic to tissues and organs. Polymer adhesives have been used as alternatives but are limited by poor strength, excessive swelling, and stringent storage and preparation steps. Now, Didier Letourneur, Ludwik Leibler and colleagues in France show that an aqueous solution of nanoparticles can rapidly close and heal deep wounds in the skin and liver without causing any inflammation.

The researchers applied, using a micropipette or brush, an aqueous solution of silica nanoparticles to a 1.5-cm-long and 3-mm-deep wound on the back of rats. The wound began to close after manually pressing the two edges of the wound together for one minute, and histological analysis after three days showed no infection or inflammatory reactions. The nanoparticle solution could also stop bleeding and seal deep incisions in the rat liver. Furthermore, when brushed onto the surface of the rat's heart, the nanoparticles were able to keep a three-dimensional biodegradable hydrogel scaffold firmly attached on the beating heart without any signs of inflammation even after three days. *ALC*

SPIN CURRENTS

a.c./d.c.

Nature Commun. **5,** 3768 (2014)

The generation of pure spin currents is achieved when electrons carrying opposite spins are driven in opposite directions. As a result, there is a net flow of spins, but not of charge, which is desirable in low-power applications. Pure spin currents can be detected by the inverse spin Hall effect, which converts them into a voltage. However, the conversion efficiency is quite low in material systems of technological relevance, and only small voltages can be measured. Furthermore, steady-state spin Hall voltages have been detected, but theory predicts the concurrent existence of a.c. components. Georg Woltersdorf and colleagues in Germany have now measured a.c.-spin Hall voltages in junctions made of a ferromagnet and a non-magnetic metal ten times larger than the d.c. component in the same sample.

The researchers use spin pumping — spin excitation by the application of a resonant magnetic field — to inject a spin current from ferromagnetic NiFe to non-magnetic Pt. The spin polarization of this current has a time-dependent and a constant component, both generating a spin Hall voltage across mutually orthogonal directions. The researchers probe both these voltages, and find that the amplitude of the a.c. component at 6 GHz is 120 μV, which is 12 times larger than the constant spin Hall voltage. By taking into account losses in the high-frequency set-up used in these experiments, the a.c. voltage is estimated to be even larger, up to 400 μV. This makes the NiFe/Pt junctions promising as sources of pure spin currents with gigahertz frequency. *ED*

SINGLE-MOLECULE JUNCTIONS

Azulene challenges the rules

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The conduction of electrons through π-conjugated molecules can, in some cases, be suppressed due to destructive quantum interference effects, and graphical rules based on an atom-counting model can predict the existence of these effects in single-molecule junctions. Luis Campos, Latha Venkataraman and colleagues now show that atom-counting rules may not apply to non-alternant hydrocarbons — conjugated systems with at least one odd-numbered ring.

The researchers — who are based in the US, Denmark and Israel — used azulene, a hydrocarbon made from fused 5- and 7-member rings, as a prototypical non-alternant molecule and placed it between two gold electrodes using gold-binding substituents. The conductance of four azulene molecules substituted in different positions was then measured against a small applied voltage. Azulenes substituted at opposite ends of the molecule and at opposite ends of the 7-member ring did not show quantum interference, as predicted by the atom-counting model. However, those substituted at alternate carbons on the 5- and 7-member rings (positions 1,3 and 5,7, respectively) were found to conduct even though these molecules should show destructive interference according to the model.

Campos and colleagues explain this breakdown of the quantum interference rules in azulene — which could be common to other non-alternant molecules — by comparing their experiments with calculations. The calculated transmission curve for 1,3 and 5,7-substituted azulenes indeed show destructive interference features. However, charge-transfer suppression occurs at higher bias than expected from simple atom-counting rules. The researchers attribute this effect to the asymmetric energy-level alignment of the frontier orbitals of azulene. *AM*

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