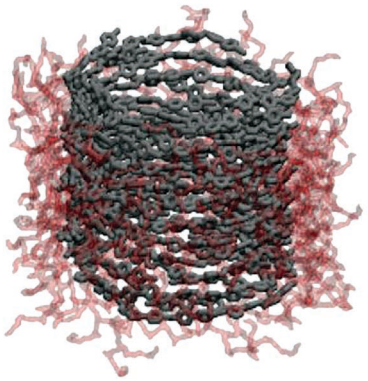
CHEMICAL SELF-ASSEMBLY

A nonlinear breaking strain

Proc. Natl Acad. Sci. USA http://doi.org/cfdq (2017)



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Self-assembled chemical structures produce molecular aggregates with complex molecular functionalities often inspired by biological systems. But while self-assembly has been the focus of intense investigation, the disassembly of these molecular aggregates is much less explored, even though it can lead to temporal control over the aggregate functionality. Fredy *et al.* now describe artificial supramolecular tubules that disassemble in a nonlinear fashion, mimicking the disassembly dynamics of natural tubules.

The system is composed of V-shaped molecules with two aromatic arms. Embedded in the chemical structure are also photoresponsive azobenzene groups. The molecules are made water-soluble by hydrophilic substituents. In water, the molecules self-assemble into tubules about 11 nm in diameter and more than 200 nm in length. Upon irradiation with UV light, the azobenzene groups switch to a nonplanar, *cis* configuration that induces mechanical strain to the tubules. With time, the aggregates first reorganize forming J-aggregates, in which the building blocks slide relative to each other, then break up into smaller tubules and finally disappear. The same experiment in a mixture of water and acetonitrile leads to simple, linear disassembly because the building blocks are more soluble in the organic solvent.

The behaviour of these artificial tubules in water is not dissimilar to that of natural microtubules in which the disassembly is driven by an initial accumulation of strain energy. *AM*

SOLAR-FUEL PHOTOCATALYSIS

Carbon nitrides get close

Angew. Chem. Int. Ed. **56,** 13445–13449 (2017)

2D polymers represent a new frontier for functional materials. Such materials offer robust mechanical properties yet high reactivities for important chemical transformations. Carbon nitride, a nitrogen-containing cousin to graphene, is a promising metal-free catalyst that harvests sunlight and produces hydrogen from water. However, carbon nitride exhibits a poor exciton-separation ability and therefore underperforms in comparison to inorganic solar-to-fuel materials.

Now, Wang and Antonietti report a synthetic means to improve the solar-to-hydrogen conversion abilities of carbon nitride. The researchers employed molten salt mixtures to condense urea, with or without oxamide, and produced crystalline carbon nitride. The molten salt mixture forced the carbon nitride sheets to crystallize more closely, reducing the typical 0.326 nm intersheet spacing to 0.292 nm.

The closely packed carbon nitrides absorbed UV–visible light more strongly and displayed enhanced exciton-splitting behaviours. These advanced carbon nitrides displayed a 30-fold hydrogen production enhancement under white light illumination and nearly 40-fold with green light. The carbon nitrides presented ultrahigh activities in 3% NaCl without any activity losses across four removal–reuse cycles. *AW*

SCANNING TUNNELLING MICROSCOPY

Orbital ordering mapped

Sci. Adv. **3,** eaao0362 (2017)

Broken-symmetry states involving electronic degrees of freedom are extensively investigated in condensed-matter physics. In particular, long-range ordered phases involving spin or charge are routinely detected directly and can be visualized in real space. However, the orbital degree of freedom is more elusive and the experimental detection of orbital ordering generally relies on its indirect signatures.

Now, Kim *et al.* report on the direct visualization of Co orbitals in $CeCoIn_5$ — a prototypal heavy fermion material — by means of scanning tunnelling microscopy. The researchers map the topography of cleaved CeIn- and Co-terminated (001) surfaces with atomic resolution, highlighting different properties of these two configurations. In particular, the shape of atoms is gradually modified from circular to dumbbell-like upon decreasing the tip–sample distance (or, equivalently, increasing the tunnelling current value) only for the Co-terminated surface.

Phenomenologically, the observed dumbbell orientation is only along [100] or [010] directions — a fact interpreted by the researchers as evidence for the electronic occupancy of Co d_{xz} or d_{yz} orbitals. Remarkably, occupied Co d_{xz} and d_{yz} orbitals alternate for nearest-neighbour lattice points, resulting in an antiferro-orbital ordered pattern along both the [100] and [010] directions. The researchers associate the origin of this state to surface-specific properties and, in particular, to the increased Coulomb repulsion energy due to the reduced amount of electrostatic screening. *GP*

DRUG DELIVERY

Lean by design

ACS Nano **11,** 9223–9230 (2017)

Brown adipose tissue (BAT) is a heat-generating organ abundant in hibernating animals and newborn babies. While white adipose tissue (WAT) stores excessive energy in the form of fatty molecules, BAT consumes energy through non-shivering thermogenesis. Conversion of WAT into BAT, defined as a 'browning' process, could offer treatment options for obesity and its associated pathologies, such as type-2 diabetes. However, the use of browning agents in the clinic is stymied by the existence of side effects affecting unrelated organs.

Now Zhang *et al.* engineer a biocompatible microneedle patch for local delivery of browning molecules encapsulated in dextran nanoparticles. The nanoparticles also contain glucose oxidase (GOx) and catalase, which allow controlled release of the browning drugs. In the presence of a physiological concentration of glucose, GOx produces gluconic acid, while catalase neutralizes the hydrogen peroxide produced by the reaction. The resulting decrease of the local pH triggers degradation of the nanoparticles and subsequent drug release.

After confirming that the nanoparticles induce *invitro* reprogramming of white adipocytes into brown adipocytes, the researchers apply the nanoparticle-loaded microneedle patch to the inguinal region of lean and obese mouse models. Six days post-treatment, lean mice show local browning of visceral white fat pads and improved systemic metabolism, an indication of the sustained effect of the browning agents. After four weeks, diet-induced obese mice lose 30% of their visceral WAT and display increased energy consumption, higher fatty acid oxidation, improved body weight control and higher insulin sensitivity. These observations support the anti-obesity and anti-diabetic potential of the designed microneedle patch. *CP*

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