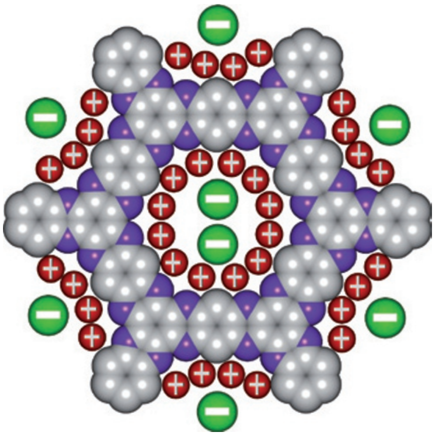
POROUS POLYMERS

Charged up

Angew. Chem. Int. Ed. http://dx.doi.org/10.1002/anie.201103493 (2011)



© 2011 WILEY

Supercapacitors store electrical charge at electrode/electrolyte interfaces and can have much larger capacitances than conventional dielectric-based capacitors. The electrodes of these devices are usually made of carbon, and various nanostructures, including carbon nanotubes and graphene, have previously been employed. Such capacitors can operate at high charge and discharge rates for over a million cycles, but the energy they can store is usually significantly lower than that of batteries. Donglin Jiang and colleagues at the Institute for Molecular Science, Okazaki have now created supercapacitors with high energy densities using electrodes made from microporous polymers.

The polymers are composed of a network of fused benzene rings in which some of the carbon atoms have been replaced with nitrogen atoms, and have an extended π-conjugated system and nanopores with diameters of less than 2 nm. This conductive structure allows electrolyte ions to move into the pores and helps the electrostatic charge-separation layers to form. As a result, the polymer-based supercapacitors have specific capacitances higher than those of carbon-based devices and exhibit excellent performance stability. Furthermore, they have energy densities as high as 53 Wh kg^{-1}, which is comparable to that of nickel-metal hydride batteries. *OV*

GRAPHENE

From waste materials

ACS Nano http://dx.doi.org/10.1021/nn202625c (2011)

Graphene — a one-atom-thick layer of carbon arranged in a honeycomb structure — can be synthesized by exfoliation or various chemical methods. However, many of these methods use purified chemicals such as methane gas or poly(methyl methacrylate) as the carbon source. James Tour and colleagues of Rice University have now synthesized pristine graphene using inexpensive carbon sources such as waste materials, insects and food.

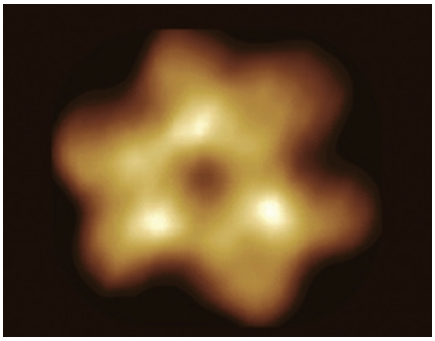
Tour and co-workers placed about 10 mg of either a piece of cookie, blades of grass, dog faeces or polystyrene plastic on top of a copper foil that was contained in a quartz boat. The sample was annealed for 15 min under hydrogen and argon gas flow using procedures that are similar to growing poly(methyl methacrylate)-derived graphene. X-ray photoelectron spectroscopy and Raman spectroscopy confirmed that the graphene, which was mostly deposited on the backside of the copper foil, was pristine and of high quality with few defects. Further analysis by selected-area diffraction pattern in a transmission electron microscope confirmed the hexagonal lattice structure of the graphene.

Although the mechanism for how the growth occurs remains to be explored, the use of waste materials to produce high-quality graphene may offer a way to recycle carbon from impure sources. *ALC*

MOLECULAR MOTORS

Watching how they work

Science **333,** 755–758 (2011)



© 2011 AAAS

F_1-ATPase is a rotary motor protein driven by adenosine triphosphate (ATP) with a central rotor that turns in a stator ring. The stator is a catalytic hexameric ring in which three of the subunits can sequentially undergo conformational changes on ATP hydrolysis to rotate the central shaft unidirectionally. The structure of the motor protein has been carefully characterized, and the rotation of the central shaft has been directly observed using fluorescent probes and video microscopy. However, the exact structural basis of the unidirectional motion remains unclear. Toshio Ando, Hiroyuki Noji and colleagues have now used high-speed atomic force microscopy to image the conformational changes in a rotorless F_1-ATPase.

The researchers — who are based at Kanazawa University, Osaka University and the University of Tokyo — covalently attached isolated stator rings to a mica surface and imaged them with a frame capture time of around 80 ms. In the three active subunits of the stator, conformational states were seen to propagate cyclically around the ring in an anticlockwise direction, which is similar to the known rotation of the rotary shaft. The rate of rotation was lower than that when the shaft is attached, but the results illustrate that cooperativity between the subunits is intrinsic to the stator ring. *OV*

POLARITONS

Lasing is easy

Phys. Rev. Lett. **107,** 066405 (2011)

Polaritons are hybrids of optical and material excited states, and can lase at very low pump energy thresholds relative to photons. Room-temperature polariton lasing has been demonstrated in semiconductors contained inside microcavities, but achieving reproducible high-quality emission spectra at low thresholds has been a challenge. Pallab Bhattacharya and colleagues at the University of Michigan have now demonstrated room-temperature polariton lasing at an energy density two orders of magnitude lower than existing polariton devices.

The low threshold was achieved by using a novel structure consisting of a single GaN nanowire placed inside a dielectric microcavity. The nanowire, which acted as the gain medium, was free of extended defects and fluctuations in alloy composition. This, and the high degree of confinement of the microcavity's optical field inside the nanowire, led to a strong interaction energy between photons and excitons, lowering the threshold for lasing.

Optical lasing in the same device structure required an energy threshold that was 2,700 times higher. This is because photon lasing requires population inversion, whereas polariton lasing does not. Polariton lasing thresholds in the nanowire device are expected to be even lower under electrical, rather than optical, pumping. *MS*

Written by Ai Lin Chun, Michael Segal and Owain Vaughan.