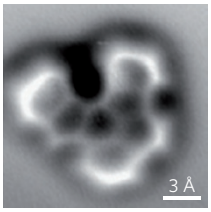
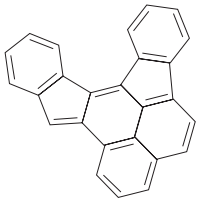
Snapped in the act

Science http://doi.org/mq6 (2013)





Chemists have long relied on spectroscopic methods to identify the composition and structure of chemical species as they react, and the products they generate. Furthermore, developments in microscopy techniques have, over the past years, made real-space imaging of molecules and surfaces with atomic resolution possible. It has therefore been a long-standing objective to combine the two approaches and directly image complex molecules as they undergo a chemical reaction. Now, a collaboration led by Michael Crommie and Felix Fischer has accomplished this feat, by using atomic force microscopy to image individual aromatic molecules placed on a silver surface as they undergo several cyclization processes on heating. By using the technique in a so-called non-contact mode it is sensitive to tiny changes of electronic charge, which allows the scientists to visualize both the carbon atoms, as well as the nature of the chemical bonds joining them together. The detailed mechanistic understanding offered by this approach holds promise for the rational design of other molecular architectures on surfaces. *AT*

Diamond photonics

Nano Lett. **13,** 1898–1902 (2013)

Diamond has a number of desirable materials properties that make it a promising candidate for on-chip high-performance photonic devices. In particular, its large Raman-gain, relatively large Kerr nonlinearity, wide bandgap (~5.5 eV), negligible multiphoton loss mechanisms as well as its excellent thermal properties are of interest for the fabrication of active and passive optical devices that are capable of handling high optical powers. Marko Loncar and colleagues now report the realization of an integrated diamond photonic platform based on a thin single-crystal diamond film on top of a silicon dioxide/silicon substrate. Using this approach, the researchers demonstrated high-quality-factor single-crystal diamond racetrack resonators that operate at near-infrared wavelengths (1,550 nm). Optical characterization of these resonators revealed quality factors as high as ~250,000 and overall insertion losses as low as 1 dB per facet. Furthermore, in these waveguides scattering-induced mode splitting, as well as signatures of nonlinear effects, such as optical bistability, were observed at an input pump power of ~100 mW. *KT*

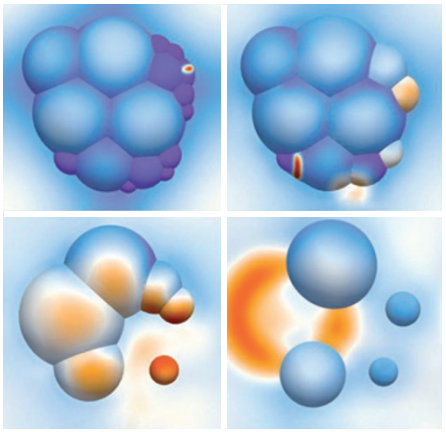
Fuel for delivery

Nature Chem. http://doi.org/mq7 (2013)

Synthetic biomolecular agents that can respond to biological signals and selectively release drug molecules are an example of how biological processes can be exploited for therapeutic gain. With this in mind, Takuzo Aida and colleagues have made protein-based assemblies and demonstrated their ability to release guest molecules in the presence of intracellular adenosine-5'-triphosphate (ATP). The ATP-fuelled delivery system comprises of nanotubes formed from the coordination of chaperonin GroEL mutants with Mg^{2+} and, when surface-functionalized with boronic acid derivatives, the nanotubes are seen to be taken up by human cancer cells. In the presence of ATP, conformational changes occur in the protein units resulting in mechanical forces that cause the nanotubes to break up into short-chain oligomers, releasing the guest molecules. When denatured proteins with pendant drug molecules were introduced into the cavities of the nanotubes, this ATP-responsive dissociation enabled the intracellular delivery of the drugs. In preliminary *in vivo* investigations, the boronic acid-coated nanotubes show preferential accumulation in tumour tissue compared with other tissues. *AS*

All-in-one model for foams

Science **340,** 720–724 (2013)



Looking at an evolving beer head can be fascinating. Indeed, foam dynamics involves cycles of slow draining of the thin-film network of fluid surrounding the gas bubbles, followed by the fast burst of a small section of the network and the subsequent rearrangement of the topology of the bubbles. As these physical processes involve many scales in both space and time, predicting the evolution of foam-like materials accurately is challenging. Now, Robert Saye and James Sethian show that modelling foam dynamics is possible if both space- and timescales are appropriately separated through a multiscale model that combines the Navier–Stokes equations for fluid dynamics, both continuum and mesh-like models of the network, Voronoid tessellation for tracking its structural evolution and numerical schemes for solving the resulting set of coupled partial differential equations. The researchers show that the predictions of their multiscale model (which can be expanded to include other phenomena such as evaporation dynamics or diffusive coarsening) agree with experimental data from the merging of two soap bubbles. *PP*

Straight backbone

Adv. Mater. http://doi.org/f2c6ch (2013)

The morphological organization and crystallinity of conjugated polymers can be engineered to modify their electronic properties: this has been widely applied in organic electronics, with the aim of improving the charge-transport performance of transistors and, more recently, the power-conversion efficiency of organic solar cells. Yue Wu and colleagues now apply molecular design to improve the structural regularity of a highly efficient organic semiconductor polymer known as PBDTTT, which usually adopts an amorphous configuration. The authors modify the molecular structure of the monomers composing this organic material, and achieve new polymer chains with a linear backbone conformation. Absorption spectra and X-ray diffraction patterns collected from deposited thin films made of this reshaped conjugated polymer show enhanced interchain packing and π–π stacking, which lead to a more crystalline morphology. Such improved regularity is reflected in the performance of bulk heterojunction solar cells: the authors obtain devices with a 30% increased efficiency when they replace PBDTTT with the linear polymer as the electron-donor material in polymer–fullerene blends. *LM*

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