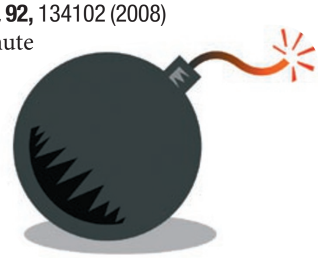
Bent on explosives

Appl. Phys. Lett. **92,** 134102 (2008)



To detect minute quantities of explosive materials, small, cheap and rugged detectors are used. Ideally, they should be able to detect explosives from a safe distance. Apart from relatively expensive spectroscopy techniques, cheap and practical devices based on microcantilevers have been successfully applied to detect even small quantities of explosives. Previously, their function was based on explosive molecules being adsorbed on the surface of the cantilevers. On irradiation with suitable infrared light the molecules absorb radiation, and as a consequence the cantilevers heat up and bend. This bending can be detected through the deflection of a laser beam. Now Van Neste and colleagues use a modified approach that also works from a distance. Tunable infrared radiation is directed at a surface that contains traces of explosives, where the light is absorbed by the molecules depending on its wavelength. This absorption is detected in the reflected light beam that is focused onto the microcantilever, where its absorption by the cantilever leads to a proportionate bending. On measuring complete absorption spectra, molecule-specific sensitivities of 100 ng cm^{-2} have been achieved.

Bioluminescent switch

Angew. Chem. Int. Ed.
doi:10.1002/anie.200704440 (2008)

Molecular switches are of increasing interest for use in, for example, nanosensors and memory devices. Now, Krystal Hamorsky and colleagues present a switch that uses bioluminescence as the on/off signal, providing better detection capabilities than the usual fluorescent counterparts. The researchers modified the bioluminescent protein aequorin (AEQ) by inserting the glucose binding protein (GBP) into the structure, separating the two AEQ fragments. In the presence of glucose, GBP undergoes a conformational change that brings together the fragments of AEQ, which then bioluminesces at 469 nm — the ON state. Without glucose, the AEQ fragments are held too far apart to assemble and emit light — the OFF state. The bioluminescent intensity was found to increase in proportion to the concentration of glucose, with the ON and OFF states being in the range of blood glucose levels, which implies that this method could be used for clinical detection of this important molecule.

How cities are built

Phys. Rev. Lett. **100,** 138702 (2008)

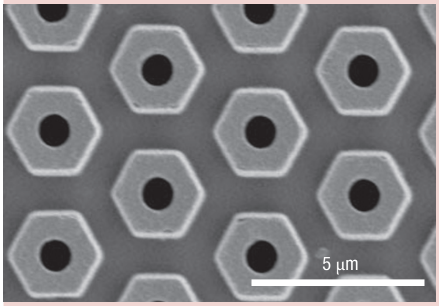
Urban planning often seems a contradiction in terms. Indeed, networks of city streets have a striking resemblance to natural transportation structures such as rivers, plant leaves or blood vessels. However, how a road network develops in the absence of a global design strategy has remained unclear. Marc Barthélemy and Alessandro Flammini have now developed a parameter-free model that is based on a local optimality principle. Their model assumes the formation of local city centres over time. Consequently, these centres are connected to the existing road structure in the most efficient way. The developing road network matches the statistics of many large cities very well, for example in the ratio of roads to intersections. Further improvement is achieved if the spatial distribution of the centres in the model follows the known exponential decrease of population density from the main city centre. The model shows a remarkable universality in the formation of road networks, although it may not seem entirely surprising that short-term planning and local optimization are the driving factors in the development of urban transportation networks.

Climbing secrets

Nano Lett. doi: 10.1021/nl0725704 (2008)

It climbs up walls but has no legs, what is it? If 'ivy' is the obvious solution to this children's riddle, the answer to the more scientific question 'how does it do it?' is far less clear. Darwin had observed that the adhering disks of this wall climber secreted a yellowish substance; Mingjun Zhang and colleagues have now examined these secretions more closely. They grew ivy for a week onto both silicon and mica substrates, and then examined the released substance with an atomic force microsope (AFM). The AFM revealed a rather uniform distribution of nanoparticles, of a few tens of nanometres in size. Using chromatography and mass spectrometry the researchers found 19 organic compounds in these particles, all with the tendency to create hydrogen bonding. It is reasonable that millions of adhering disks, each secreting nanoparticles that can create hydrogen bonds with rocks and bricks, can generate enough adhesion for ivy to affix to a surface. Apart from exploring the secrets of ivy, the results may inspire the synthesis of new materials for engineering applications.

Protein moulding



J. Am. Chem. Soc. doi: 10.1021/ja8014428 (2008)

Established syntheses of protein particles have been unable to control particle size and shape, while maintaining the functionality of the biomolecules. Now, Jennifer Kelly and Joseph DeSimone have overcome these problems by using lithographic and templating techniques to make insulin and albumin particles of specific size and shape. The mild fabrication method works by making a polymeric mould with cavities that are filled with protein solution and, after the majority of water is removed, the protein particles can be transferred onto a thin film of medical adhesive. This forms an array from which individual particles are collected when the adhesive film is dissolved. Monodisperse cubes and more complex structures (pictured), in the size range of hundreds of nanometres to a few micrometres can be made using this route. In addition, the researchers incorporate therapeutic agents, for example, paclitaxel, into the albumin-based materials — a combination known to be effective in cancer therapy — making these particles attractive vehicles for drug-delivery applications.

© 2008 Nature Publishing Group