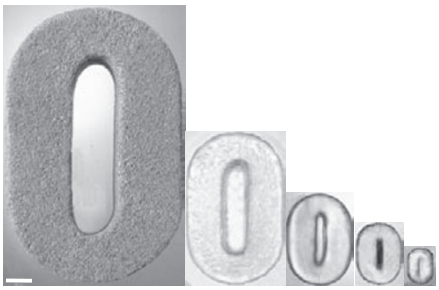
Minipatterns



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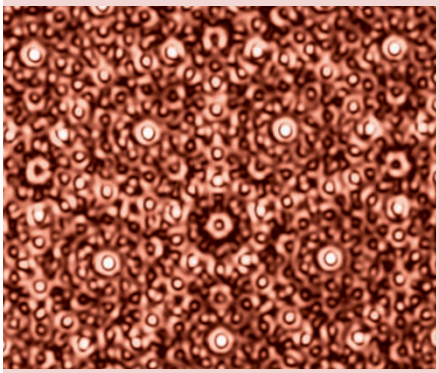
Adv. Mater. doi:10.1002/adma.200602681 (2007)
A group of researchers in India have developed a method of preparing nanoscale patterns by a miniaturization technique using the natural ability of hydrogels to shrink in response to changes in the environment. Current methods of preparing topographically patterned surfaces need a mould or a mask of the same size as the required pattern, which in turn requires special techniques such as electron-beam lithography. In contrast, Apurba Lal Das and colleagues mould a large pattern (more than a micrometre) from a polydimethylsiloxane block onto a hydrogel, which is then dried under controlled conditions. The hydrogel shrinks isotropically, resulting in a smaller version of the original pattern. This process can be repeated until the required pattern size is reached (pictured, scale bar is 1 mm). The researchers have shown that this process also works for miniaturization of three-dimensional objects. They note that so far the method is only suitable for patterns with curved edges, because the possibility of nanoscale air bubbles nucleating around a sharp corner may result in loss of information.

Graphene spintronics

Nature doi:1038/nature06037 (2007)
Given the high quality of charge transport in graphene — single-layer graphite — news of the demonstration that spin transport is also very efficient was expected. Indeed, the details of the interaction between the electron spin and the crystal lattice suggests the possibility of spin transport over reasonably long distances, even at room temperature. The news has finally arrived. Nikolaos Tombros and colleagues have demonstrated spin injection and detection in single-layer graphite, using a four-terminal device with ferromagnetic contacts. The resistance measured across two of the ferromagnetic electrodes was shown to depend strongly on the magnetization configuration of the contacts. Correlation between the resistance measurements and the sample geometry allowed determining that spin transport occurs for distances close to 2 μm at room temperature. Interestingly, the absence of temperature dependence in the magnetic field data suggest that the spin transport is limited by extrinsic factors, such as impurity centres, and not by intrinsic properties of the crystal. This raises the hope that improving the material quality may lead to spin-transport lengths orders of magnitude higher even than these first observations.

Photonic carpets



NIKOLAY ZHELUDEV

Appl. Phys. Lett. **90,** 091119 (2007)
Subwavelength imaging, where the structures in question are much smaller than the theoretical limit of classical optics, is important for a number of applications, for example high-resolution lithography. Complementing competing approaches such as superlensing using metamaterials, Fu Min Huang and colleagues now demonstrate that something as basic as a quasicrystal array of nanoholes in a metal screen can focus light into tiny spots. The shape of the image behind the hole array depends strongly on the distance from the metal screen. Generally, the images mirror the features of the quasicrystal arrays and therefore are visually attractive — resembling patterns found in Islamic architecture or Persian carpets. Importantly, Huang and colleagues find that at certain distances and illumination wavelengths the focus spots are much smaller than the imaging wavelength. Although the nature of the effect means that the properties of the focus spots are solely determined by the hole array, these structures might nevertheless be used to focus light for high-resolution lithography or for data-storage applications.

Sensitive whispers

Small doi:10.1002/smll.200600676 (2007)
Sequence-specific detection of nucleic acids is needed for a variety of applications such as disease diagnosis and forensic analysis. Most of the methods currently used involve multiple steps, including the labelling of the analyte to enable detection, which can increase analysis time and costs. Edin Nuhiji and Paul Mulvaney present an analysis method using inexpensive, commercially available silica microspheres, and demonstrate sensitive detection of unlabelled oligonucleotides. They use the whispering gallery modes (WGMs) of the spheres for detection — standing waves that result in a scattering spectrum of numerous sharp peaks when light is shone on the structures, and which are highly sensitive to surface changes. Doping the microsphere with a fluorescent dye simplifies WGM detection — a UV lamp is used to excite the dye and the fluorescence is emitted as easily measured WGMs. By tethering an oligonucleotide onto the sphere surface that is complementary to the target molecule, the analyte oligonucleotide is immobilized, causing changes in the WGM spectrum. The authors show that the process is reversible, and a complete assay takes only a few minutes.

Mixed nanotubes

Nano Lett. doi:10.1021/nl070327z (2007)
Nanotubes have unique structural and physical properties, but controlling the geometrical structure of carbon nanotubes with the aim of tuning their electronic properties has proved difficult. Preparing nanotubes made of carbon and other chemical elements, such as boron and nitrogen, that have different electronegativities should prove useful for tailoring the electronic characteristics of the nanotubes as a function of chemical composition. Now, Annick Loiseau and colleagues report on the synthesis of single-walled nanotubes made of boron nitride nanodomains embedded into a graphene layer. Boron and nitrogen co-segregate and form nanodomains within the hexagonal lattice of graphene in a sequential manner along the tube axis. The growth is believed to be mediated by a liquid-like phase, and the sequence of boron nitride domains alternating with long carbon segments result from phase separation at the solidification front. Such synthetic and growth characteristics should ultimately help to produce single-layer BN-C heterojunctions for electronic devices.

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