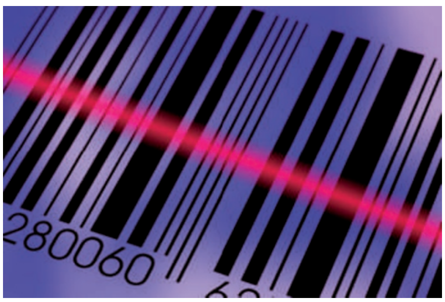
Silicon lives

Nature **462,** 491–494 (2009)

The search for alternatives to silicon for future applications is a topic that attracts a lot of interest in the research community. Yet, the 'grand old man' of electronic devices still has much to offer. For example, Saroj Dash and colleagues have now demonstrated the electrical injection of spin-polarized electrons and holes into silicon at room temperature. The charges were injected by tunnelling through a barrier from a ferromagnetic electrode, and an unbalance in the spin polarization was detected both in the case of electrons and holes. The polarization could also be manipulated — and more precisely reduced — by the application of a magnetic field perpendicular to the spin polarization. With this technique the researchers extracted spin lifetimes of the order of hundreds of picoseconds and spin-diffusion lengths of a few hundred nanometres. The results could lead to the integration of spintronic applications in electronic devices based on this already widely used semiconductor.

Luminescent barcodes

J. Am. Chem. Soc. 10.1021/ja907885m (2009)



Barcoded materials are interesting as encryption tags and labels in multiplexed bioanalytical assays, and can provide an unambiguous way to identify an object or a biological entity. Stephane Petoud and colleagues now propose a way to create luminescent barcoded systems based on the use of metal–organic frameworks (MOFs) that contain several near-infrared (NIR)-emitting lanthanides that show well-controlled compositions and photophysical properties. This barcoded system simultaneously emits several independent NIR signals arising from different lanthanide cations reproducibly. By controlling the reactant stoichiometry, the lanthanide composition of the MOF can be tuned and the resulting individual emission intensities can be controlled. Moreover, excitation at a single wavelength produces controlled ytterbium and erbium emission bands that are linearly correlated to the lanthanide ratio. The possible ytterbium-to-erbium energy transfer for these systems should make them attractive for practical incorporation into objects (such as money or clothing) in ways that do not detrimentally affect their signals.

Assembling colloids

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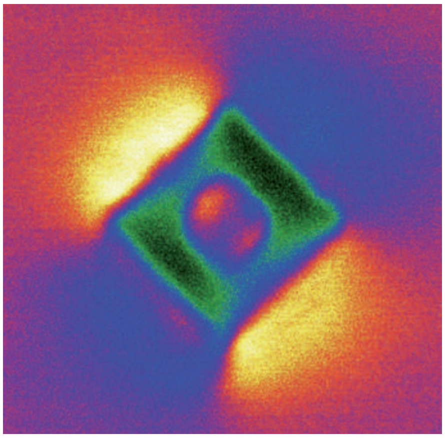

The electrostatic and entropic forces that guide the self-assembly of colloidal particles in isotropic liquids (for example, water) tend to be isotropic, limiting the number of possible structures that can be achieved. This limitation could be overcome if the assembly took place in an anisotropic liquid crystal (LC). To this end, Clayton Lapointe and colleagues use polarizing microscopy to look at the effects of the interactions that arise when colloidal equilateral polygonal platelets of different shapes are dispersed in the nematic LC pentylcyanobiphenyl. The team find that the platelets change the alignment of the LCs in a distinct manner so that the platelets experience a director field with dipolar symmetry if there is an odd number of sides, or quadrupolar symmetry if there is an even number of sides. This gives rise to highly directional interactions between the colloidal platelets that drive their assembly. The work suggests that systems could be designed in which the interactions between colloids are predetermined, leading to ordered structures that produce new types of colloidal crystal or metamaterial.

Nanocomposite sensors

Angew. Chem. Int. Ed. doi:10.1002/anie.200904936 (2009)

Detection of gamma radiation is made easy by the approach reported by Lobez and Swager, which avoids problems such as expense and the lack of real-time signals that are associated with some traditional radiation detectors. The researchers use composites of carbon nanotubes dispersed in a polymer matrix. The nanotubes form a percolating network within the matrix, but are initially partially insulated from one another by thin layers of insulating polymer. When gamma rays hit the composite the material between the tubes is depolymerized, thereby reducing its insulating capability. By monitoring the current through the composite at a constant voltage, the researchers can see the conductivity rise as the gamma radiation breaks down the polymer. Quantitatively different detection results were achieved under different radiation fluences. Lobez and Swager found that functionalizing the polymer to improve nanotube dispersion partially improved the detection response of the composite, but the best results were achieved by adding a bismuth-containing moiety to the polymer. Bismuth is highly opaque to gamma rays, making the polymer much more sensitive to radiation.

Competing neighbours

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At the boundary of thin-film superlattices, unusual physical phenomena can emerge as a result of the interaction between the superlattice components. For example, multiferroic coupling may result from the interaction of ferroelectric and magnetic layers. Masao Nakamura and colleagues have now studied superlattices made from the ferromagnetic conductor $La_{0.5}Sr_{0.5}MnO_3$ (LSMO) and the antiferromagnetic insulator $Pr_{0.5}Ca_{0.5}MnO_3$. The properties of the superlattices depend strongly on the relative thickness of the films. If LSMO is thicker, the superlattice shows ferromagnetic behaviour in its ground state, whereas if LSMO is the thinner layer, the antiferromagnetic behaviour dominates. If the respective layers are of equal thickness, however, both phases compete with each other. In this case, the ferromagnetic and the antiferromagnetic order are simultaneously present. Intriguingly, the relative distribution of these two phases is not defined by the confinement of the respective layers, but extends across the film boundaries. For example, in the presence of a magnetic field the ferromagnetic phase increases in size relative to the antiferromagnetic one, suggesting that this movable-boundary effect could be used for bistable switching devices.