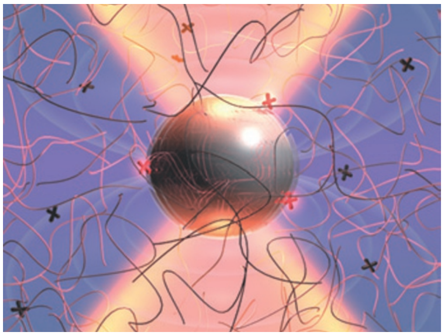
Particles with memory

Nature **478,** 85–88 (2011)



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The position and energy of particles experiencing Brownian motion fluctuate randomly over time, a phenomenon also known as thermal noise. However, as a Brownian particle is kicked along, some solvent molecules are displaced and others will occupy the space left behind by the moving particle. This hydrodynamic backflow adds an autocorrelation term (memory effect) to the thermal, or white, noise. Experimental observation of this term has now been achieved by Sylvia Jeney and co-workers. The authors trapped a particle in the focal spot of a laser and imaged its motion over time. Adjusting the viscosity of the solution, the size and surface chemistry of the particle and the tightness of the focused area, the authors observed non-random fluctuations in the mean squared displacement of the trapped particle. Deviation from the white-noise spectrum is detected at the blue end, at frequencies much lower than the solvent collision rate. Exploiting the hydrodynamic memory effect through the judicious design of the particle-fluid-trap system could be useful for studying the dynamics of soft-matter systems and developing label-free particle sensing applications, the authors say. *AM*

Electrons in-between

Phys. Rev. Lett. **107,** 150503 (2011)

Nitrogen-vacancy centres in diamond have many of the requirements for quantum-information protocols. Their spin can be addressed optically and they have long coherence times. What is still missing, however, is the possibility of controlling the interaction between two or more spins. Alejandro Bermudez and colleagues have proposed a scheme that could solve the problem and allow control of the interaction between nuclear spins in distant nitrogen-vacancy centres. Unfortunately the dipole–dipole interaction between distant nuclear spins is too weak to warrant communication between the two. However, the electron spins can function as intermediaries. Their dipole–dipole interaction is long range and each of them can interact with the respective nuclear spin through hyperfine interaction. According to the model, the realization of quantum gates should be possible, especially if the spins are driven by microwave fields, which have the additional advantage of reducing the negative decoherence effects of the environment. The scheme should work with systems other than nitrogen-vacancy centres, making an interesting approach to realize solid-state quantum-information processors. *FP*

Not-so-rare LEDs

Opt. Lett. **36,** 2868–2870 (2011)

White-light-emitting diodes (white LEDs) are increasingly used for applications such as lighting. However, the phosphorescent materials used to convert the blue light of the LED into red light to achieve the LED's overall white-light emission contain rare-earth elements that are increasingly difficult to obtain on the world market. Hirokazu Masai and colleagues from Kyoto University have now developed a new material for use in white LEDs that contains no rare-earth elements. Instead of using energetic states in rare-earth elements, manganese offers an alternative for light conversion at similar wavelengths. And instead of using a crystalline phosphor as a matrix for the manganese cations, here the light conversion works best if a glass is used. This has the additional benefit that the emission of the red light occurs across a broader range of wavelengths, which enhances the overall light emission. Furthermore, with conversion efficiencies that match those of the rare-earth dopants presently in use, rare-earth-free white LEDs might soon be a reality. *JH*

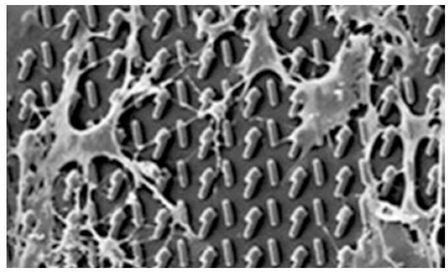
Three for one

Nano Lett. http://dx.doi.org/10.1021/nl202915p (2011)

Colloidal semiconductor quantum dots can be synthesized and solution-processed in large quantities, and their optical properties have motivated applications ranging from photodetectors to solar cells. In particular, multiple exciton generation has been suggested as a route towards enhanced photovoltaic efficiencies, as photocurrents could increase if photons from the high-energy part of the solar spectrum could be harvested to produce multiple electron-hole pairs in low-energy-gap compounds. Although this process has been reported for some systems in solution, its efficiency remains under debate. Using time-resolved microwave conductivity measurements, Laurens Siebbeles and colleagues have now found evidence for the generation of multiple mobile charge carriers from single incident photons in PbSe quantum dot films. The films were fabricated in a layer-by-layer deposition and ligand-exchange process to increase the electronic coupling between the quantum dots. The researchers found quantum yields of up to 300%, which they attribute to inelastic scattering in strongly delocalized conduction states in the films, and they suggest that the effect could enhance solar-power conversion efficiencies by up to 24%. *CM*

Screening for topographies

Proc. Natl Acad. Sci. USA **108,** 16565–16570 (2011)



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Cells in contact with surfaces typically respond to their micro- and nanostructure, for example by spreading, changing the degree of adhesion, or differentiating. However, the mechanisms by which surface topography elicits specific cellular responses are not well understood, and therefore it is generally not possible to predict which feature sizes and shapes would be optimal to evoke a specific cell action. A team of researchers in the Netherlands have applied a brute-force, combinatorial approach to screen for unique surface topologies that induce desired cellular responses. By using a mathematical algorithm that combines a few primitive shapes, the researchers generated an enormously large library of topographic features and randomly selected 2,176 of them, which were photolithographically moulded in silicon and then imprinted in poly(DL-lactic acid) films. After seeding human mesenchymal stromal cells on the films, the team found that the cells' proliferation correlated with the Fourier parameters of certain surface features. High-throughput technologies that screen for surface topography and material composition should speed up the decoding of cell–topography and cell–material interactions. *PP*

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