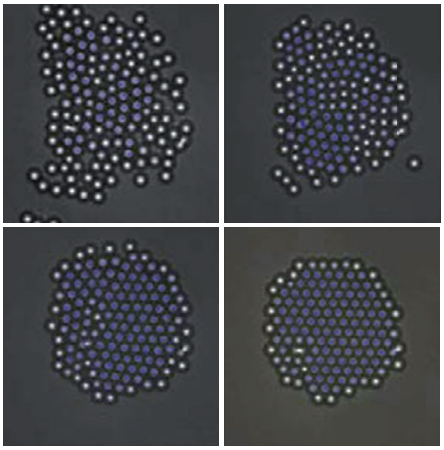
Guiding self-assembly

Adv. Funct. Mater. http://doi.org/fz46bp (2012)



The stable state and self-assembly kinetics of an ensemble of colloidal particles depends on the interaction potential between the particles and on any competing external potential. Because the latter can be easily tuned, it is, in principle, possible to actively guide the self-assembly process towards the desired state. This is what Jaime Juárez and Michael Bevan have achieved. The researchers show that the assembly and disassembly of a charged colloidal monolayer in an electric field can be controlled by manipulating the electric potential (which competes with the colloids' chemical potential) so as to correct for the difference between actual and desired values of a crystallization order parameter (such as that for bond orientation). This is realized through a feedback control loop that involves measuring in real time the order parameter (by tracking particle positions with an optical microscope) and setting its desired value according to an *a priori* computed free-energy landscape model (constructed from measured histograms of the order parameter). This feedback-control approach should also be applicable to more complex colloidal systems. *PP*

Ion transistor logic

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Most organic electronic circuits designed to interface with biological systems have to balance electrical connectivity with stability because the ion-rich electrolyte that such systems contain generally degrades device performance. Ionic bipolar transistors, which are based on ion-conducting polymers, could in principle circumvent these challenges. Because conduction in these devices is intrinsically ionic, they can be operated in electrolytes, and can even modify the composition of their environment, albeit rather slowly. Ionic bipolar transistors are based on two cation- or anion-selective electrodes, a channel from a neutral polymer electrolyte, and a base electrode with complementary ion selectivity that controls the salt concentration in the channel and thus the conductivity. Magnus Berggren and colleagues have now integrated such devices in unipolar and complementary inverters and NAND gates. The circuits have a signal range of 10 V and low energy consumption. Such gates form the basis for more complex logic circuits and could be used to gate and distribute chemical signals in biological and medical applications, the researchers suggest. *CM*

Oxidized spintronics

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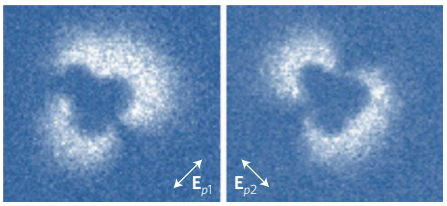
Oxides play an important role in spintronics, as they are used for the barriers in magnetic tunnelling junctions. However, as this class of materials includes ferroelectrics, ferromagnets and multiferroics, we could in principle envisage all-oxide-based spintronics devices. Before such a goal can be achieved it is essential to achieve injection of spin-polarized electrons directly into an oxide layer. $LaAlO_3$–$SrTiO_3$ structures are ideal systems for studying spin transport, as the electron gas formed at the interface between the two materials has been shown to have large electron mobility. Nicholas Reyren and colleagues have now observed spin injection from a ferromagnetic contact into a $LaAlO_3$/$SrTiO_3$ interface. They deposited the ferromagnetic electrode on top of the $LaAlO_3$, which served as a tunnel barrier. The details of the experiments suggest a sequential tunnelling, from the electrode into localized states in the barrier, and subsequently from these states into the interface. The next step will be to improve the device design and the materials to finally obtain direct injection into the interface. *FP*

Visualizing plasmons

Nano Lett. http://doi.org/hxg (2012)



Surface plasmons are optical resonances that are of broad interest for sensing and photonic applications. However, the localized nature of these resonances on the nanoscale has made their characterization difficult. Aycan Yurtsever and Ahmed Zewail have now demonstrated a powerful new analytical technique that enables the measurement of local optical fields around nanoparticles with high spatial resolution. In their photon-induced near-field electron microscopy technique, nanostructures are illuminated by laser light to excite the strong localized electromagnetic fields around the object. An ultrashort electron pulse at high energy from an electron microscope is simultaneously directed at these nanoparticles, and the electrons are scattered by the intense fields around them. Analysis of the scattering then enables the retrieval of entire two-dimensional maps of the optical field with ultrahigh spatial resolution. This enables efficient study of the optical properties of plasmonic nanoparticles. Further extensions of this technique could promise not only the three-dimensional mapping of optical fields, but also measurements mapping such fields with ultrafast temporal resolution. *JH*

Resist and sense

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Nanoparticle films have been used for the resistance-based sensing of small organic molecules. These sensors rely on the change of resistance that occurs when the distance between nanoparticles alters in the presence of analyte molecules. Biological species, such as proteins, are too large to penetrate the interparticle regions of the films, however, and biosensors that exploit resistance-based sensing have not been realized so far. Now, Justin Gooding and colleagues have made a biosensor in which the displacement of antibodies from the surface of nanoparticles changes the interparticle distance and hence the resistance of the film. First, gold-coated magnetic nanoparticles are functionalized with a self-assembled monolayer containing amine functions, followed by covalent attachment of the antibiotic, enrofloxacin. Anti-enrofloxacin IgM antibodies bind to enrofloxacin, yielding antibody-modified magnetic nanoparticles that assemble between two interdigitated electrodes. In the presence of enrofloxacin, some antibodies dissociate from the nanoparticles and the resistance of the films decreases. The biosensor has a response time of only 40 minutes and is able to detect enrofloxacin in a spiked solution of milk. *AS*

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