Peroxide detector

Hydrogen peroxide (H_2O_2) is a tiny molecule, but its presence has a unique significance in environmental and biochemical settings. H_2O_2 concentrations are a key parameter for monitoring atmospheric and hydrological conditions. It is widely used in industry for bleaching and disinfection. Moreover, because it is a product of oxidase enzymes, biological assays for H_2O_2 can indirectly quantify enzymatic activity, or the concentration of inhibitors or substrates. Recently, this molecule has even raised medical concerns over its ability to damage DNA. So far, fluorescence-based methods for H_2O_2 detection have required complex reaction mixtures and lasers using two-photon excitation or second-harmonic generation. A group of researchers led by Otto Wolfbeis at the University of Regensburg report a new fluorescent probe to detect H_2O_2 concentrations as low as 1.8 mM l^{-1} (*Angewandte Chemie–International Edition* **41**, 4495–4498; 2002). They used a much simpler system, based on a europium-ion and tetracycline complex that can be directly excited with a violet diode laser. This method also allows for gated measurements that reduce the background signal and thus improve sensitivity. The authors demonstrate the effectiveness of their approach with a series of direct and indirect assays, and are now focusing their attention on the creation of a europium-based optical sensor, which is able to continuously monitor H_2O_2 through fluorescence imaging.

Polystyrene doughnuts

Converting a monomer, such as styrene, into a stable emulsion of polymer colloids, such as polystyrene latex, is a delicate process. Precipitation of water-insoluble complexes makes existing batch procedures cumbersome and inefficient. Helmut Ritter and colleagues, writing in *Macromolecules* (http://dx.doi.org/10.1021/ma020229u), have now developed a convenient semi-continuous procedure — in which styrene is gradually added to the reaction vessel — for obtaining stable polystyrene latex, free of precipitates and ready to be used without further purification steps. The crucial ingredient that made the reaction mixture work, even without surfactants or solvents, was a sugar molecule — cyclodextrin. Thanks to its doughnut shape, with a hydrophobic hole and a hydrophilic rim, cyclodextrin is able to host small hydrophobic molecules such as styrene, thereby increasing their solubility in water. The formation of styrene– cyclodextrin complexes improved the polymerization process in several ways. The reaction became faster, and it yielded polymer colloids of identical size. The latter is a long-sought after characteristic because it affects the performance of these latexes in applications such as coatings, inks and photonic crystals.

Granular games

In most cases, when a system of discrete particles — such as a bag of marbles — is mechanically agitated, diffusion naturally increases the degree of homogeneous mixing of the system. But in many instances, the exact opposite can also occur, with agitation causing a mixture of granular particles of different types to become segregated. The conditions under which this occurs are poorly understood and difficult to predict. Pedro Reis and Tom Mullin (*Physical Review Letters* **89, 244301; 2002) have now conducted an experimental study on a binary mixture of particles, in which they observe a phase transition associated with the onset of segregation. The data in the image shows the evolution over time (vertical axis) of a mixture of poppy seeds (black) and phosphor-bronze spheres (white) as they are mechanically agitated. Variations in the filling factor, *C*, of the initial mixture (horizontal axis), result in different degrees of segregation. The authors suggest that a process known as entropic ordering drives the observed phase transition by increasing the total entropy of the system through the clustering of larger particles, which increases the free space available to the smaller particles. The authors hope that theoretical approaches to critical behaviour in granular materials will soon provide a general picture of the underlying mechanisms of mixing and segregation in these systems.**

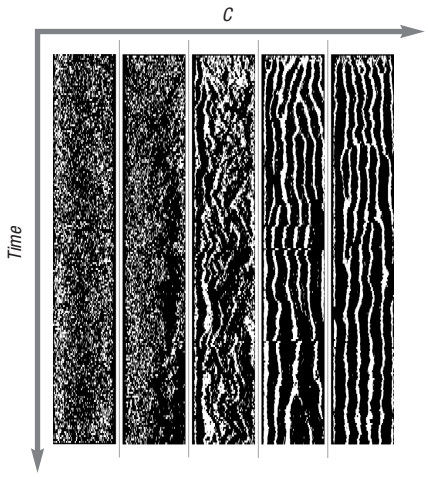

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Image: Pedro Reis and Tom Mullin

IMPURITY-INDUCED NANOPIPES

Gallium nitride and its aluminium alloys are wide-bandgap materials with many potential applications in light-emitting devices. One of the long-standing mysteries of these materials is how they manage to emit light so efficiently when the dislocation densities are so high. Dislocations are defects that generally destroy optical activity by acting as non-radiative recombination centres that compete with the desired radiative recombination pathways. Understanding how these dislocations form, and how they might be reduced, is therefore of great importance in understanding and optimizing the performance of GaN devices. Cherns and colleagues at the University of Bristol and Arizona State University have studied the structure of threading dislocations in AlGaN films heavily doped with Mg, which is used as a p-type dopant (*Applied Physics Letters* **81, 4541–4543; 2002). In GaN films, screw dislocations have an open-core 'nanopipe' structure, whereas edge and mixed dislocations have closed cores. This difference in dislocation structure has an important effect on the electronic properties of the material. In their transmission electron microscopy study of dislocations in AlGaN films, Cherns and co-workers found that edge and mixed dislocations in this material have open rather than closed cores. In addition, they observed some segregation of Mg impurities to the cores of these dislocations, but not to the cores of screw dislocations. The researchers propose that the precipitation of Mg at edge and mixed dislocation cores is accompanied by the formation of voids, which coalesce into continuous hollow pipes as AlGaN growth progresses. It is suggested that impurity segregation may also be responsible for the hollow core screw dislocations observed in undoped and n-type GaN films. This mechanism may also explain the formation of nanopipes in nominally undoped and n-doped GaN.**