It's just a phase

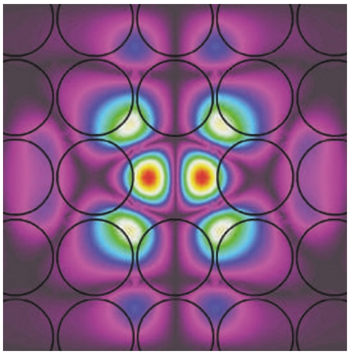
As materials freeze, solid regions begin to form at seemingly random points, called nucleation sites, within the liquid state. These initial 'grains' grow rapidly in size until they coalesce to form a single solid body. Computer simulations lend themselves well to the study of this stochastic process, but questions remain regarding the dependence of the dynamics on the size of the model. Frederick Streitz and colleagues (*Physical Review Letters* **96,** 225701; 2006) examine how the size of growing solid grains depends upon the total number of atoms contained within a simulation. As the authors increase the number of atoms modelled, the average grain size at a critical point in the freezing process is found to grow proportionally according to finite-size scaling theory (FSST). FSST is the mathematical method used to translate macroscopic results from limited scale models. In larger simulations, Frederick Streitz and co-workers found that the maximum grain size remained almost constant, deviating from FSST expectations. These results indicate that realistic simulations of the solidification process must contain more than eight million atoms in order to avoid model-dependent results.

To recycle or not to recycle

End-of-life electronics have become one of the fastest growing environmental concerns. Today, when an electronic item breaks, it seems more cost-effective to discard it and buy a new one than to have it repaired. But these items often contain significant amounts of materials that may pollute the environment. On the other hand, if recycled, these materials retain considerable value. Even if on the financial side recycling makes sense, decisions on which recycling operations are more effective cannot be based simply on economic considerations. In a topical case study on electronic waste recycling, Atlee and Kirchan demonstrate a pragmatic approach to measure the overall sustainability of recycling systems (*Environmental Science & Technology* doi:10.1021/es050935l; 2006). The problem is that it is easy to apply poor operational metrics and lose sight of the underlying goal of sustainability because the analysis of effectiveness is rather complex. In fact, the purpose of recycling is not just to reduce landfills, but also to reduce emissions and make the most of available resources, Atlee and Kirchain show how to select indicators according to their relevance, and weight their specific contribution to the overall performance of recycling facilities. As industrial data collection is standardized, it should be possible to implement these weighting schemes and gain insights into best practices.

Light and sound special effects

Photonic and phononic crystals are periodic structures, which, for certain wavelengths, exhibit a bandgap that does not allow the propagation of either light (photons) or sound (phonons). Both these structures have been realized individually, although surprisingly as yet there has been no report on a combined structure that is a photonic as well as a phononic crystal. Martin Maldovan and Edwin Thomas have now investigated theoretically the structural requirements for such a two-dimensional structure (*Applied Physics Letters* **88,** 251907; 2006). Their design uses easy-to-fabricate silicon pillars surrounded by air, and numerical simulations predict the existence of a joint bandgap. Furthermore, the authors calculate that removing a single pillar in the structure acts like a defect that, at the appropriate frequencies, can lead to strongly localized photon and phonon wavefunctions. This simultaneous localization of phonons and photons around the defects could result in intriguing effects based on a strong photon–phonon interaction. The hope is that this will enable functionalization of such structures for integrated acoustic–optical devices.



RIPPLED GRAPHENE

Since they were first isolated a few years ago, single sheets of graphite, known as graphene, have exhibited a series of unusual electronic properties. Sergey Morozov and his colleagues at Manchester University have now shown that in graphene, weak localization, a phenomenon deriving from the quantum nature of the electron transport, is unconventional (*Physical Review Letters* **97,** 016801; 2006). Weak localization is the reduction of the electron conductance at low temperature, as a consequence of symmetry of the electronic environment. Usually, an applied magnetic field destroys this symmetry, resulting in a gradual increase of the conductance. This does not happen in graphene — or at least in the several flakes examined in this experiment — for which the conductance stays low even in a magnetic field. The origin of this behaviour has not been unequivocally established, but Morozov and colleagues propose that ripples exhibited by the graphene flakes cause the orientation of the field with respect to the surface to vary from point to point, so that the translational symmetry cannot be broken. If this explanation turns out to be true, it would have significant consequences for the design of electronic devices based on graphene, that, being a self-standing sheet, is easily prone to ripples.

Nanonose

An electronic nose can be regarded as a modular system comprising a set of active materials that detect a specific odour. Associated sensors transduce the chemical quantity into electrical signals, followed by appropriate signal conditioning and processing to mimic the mammalian olfactory system. The response of such devices towards complex gas mixtures relies on well-developed pattern-recognition techniques. Andrei Kolmakov and colleagues now report on the gas-sensing properties of individual TiO_2, SnO_2 and In_2O_3 nano- and mesowires fabricated on a silicon wafer and connected as an array of chemiresistors (*Nano Letters* doi:10.1021/nl060185t; 2006). The nanostructures exhibited highly sensitive and selective responses to small concentrations of hydrogen and carbon monoxide in oxygen. The discrimination between the gases was achieved using an electronic nose approach involving correlation analysis of the different responses from the three-nanowire array. This methodology should be broadly applicable to existing sensor devices based on one-dimensional metal oxide nanostructures.