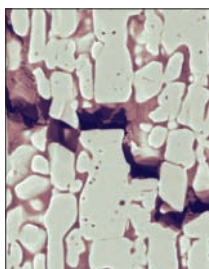


Compiled by John Swain, Northeastern University

Nature inspires tough ceramic

Substances such as bone and shell are strong hybrid materials with many lessons to offer. Taking hints from mother-of-pearl (also known as nacre) Robert Ritchie and colleagues at the Lawrence Berkeley National Laboratory (LBNL) and the University of California, Berkeley, have been making their own versions with dramatic results. This shows, once again, how thousands of millions of years of trial and error on planet Earth gave rise to some good ideas.

Nacre is made of layers of calcium carbonate glued together with a biopolymer such as chitin. The Berkeley team worked with aluminium oxide instead of calcium carbonate, carefully using ice templates to control how the layers grew. They then pressed and sintered what they made and filled in the gaps with polymethyl methacrylate (PMMA) instead of a biopolymer. The result is a highly crack-resistant material that is 300 times as strong (in terms of the energy required to break it) than either of its components. The



Left: in the "brick and mortar" phase of the alumina/PMMA hybrid ceramic, "bricks" of aragonite (calcium carbonate) slide past each other to dissipate strain energy, while the polymer "mortar" acts as a lubricant. Right: the roughness of the new ceramic controls the strength of the interfaces, which is critical in determining the material's overall toughness as it affects sliding in the "mortar" layers. (Courtesy R Ritchie, LBNL.)

hybrid is as strong as aluminium, but stiffer, harder and more resistant to abrasion.

Further reading

E Munch *et al.* 2008 *Science* **322** 1516.

Falling objects create water jets

While high-energy physicists will soon be able to study jets at the LHC, Stephan Gekle and colleagues at the universities of Twente and Seville are making headway in understanding a different kind of jet – the kind that jumps up from water when an object is dropped into it. The basic mechanism involved is the collapse of an air cavity carved out in the water by the object as it falls, pushing the water out and up as the cavity itself fills.

The collapse is driven by "inertial focusing" – the concentration of energy as the cavity collapses under pressure from the sides – and surface tension, which also tends to collapse the cavity. By combining theory, experiment and simulation the team developed a near complete description of the process. As the cavity fills with water and also collapses, the water is squirted out of the top – like toothpaste from a tube when squeezed; the effect of surface tension is negligible.

Further reading

S Gekle *et al.* 2009 *Phys. Rev. Lett.* **102** 034502.

Electronic circuit reveals Lamb shift

Quantum fluctuations lead to shifts in energy levels that go under the general name of "Lamb shifts". While these are usually seen in atomic systems, Andreas Wallraff and colleagues at ETH Zurich and Sherbrooke University in Quebec have made an electronic

circuit in which the effect can be seen.

A superconducting circuit acting as a qubit (a two-state "artificial atom"), coupled to the vacuum in a transmission-line resonator, undergoes a shift of as much as 1.4% in its transition frequency owing to fluctuations in the quantum vacuum. Engineers may soon have to learn quantum field theory.

Further reading

A Fagnier *et al.* 2008 *Science* **322** 1357.

Giant amoebae suggest new origins

Trace fossils – those of tracks left by creatures long ago – are important in calculating when animals first appeared. Mikhail Matz of the University of Texas at Austin and colleagues argue that *Myxomitodes*, a trace fossil nearly two thousand million years old that has been attributed to some sort of early multicellular animal, could actually be from a giant amoeba. As evidence for their case, Matz and co-workers have observed giant, single-celled shelled amoebae of the species *Gromia sphaerica* moving round the ocean floor. The amoebae, which can be up to 3 cm across, leave grooves that bear an uncanny resemblance to the trace fossils and so may force a reinterpretation of their origin.

Further reading

MV Matz *et al.* 2008 *Current Biology* **18** 1849.

Zero-point vibrations are important in liquids

Zero-point oscillations are well known to every physicist, but there are relatively few places where they have significant effects. Larry Ford of Tufts University in Massachusetts and Nami Svaiter of the Centro Brasileiro de Pesquisas Fisicas in Rio de Janeiro have found that the scattering cross-section from zero-point fluctuations in classical liquids rises as the fifth power of frequency, and for some cold liquids it can be a significant part of the scattering in the optical region. For liquid neon the zero-point scattering would be about 13% and would be a significant part of the optical blurring from density fluctuations that would be seen on looking through the liquid. The work is particularly interesting as it probes similar physics to that in the Casimir effect, but deals with a local quantity rather than a global one.

Further reading

L Ford and NF Svaiter 2009 *Phys. Rev. Lett.* **102** 030602.