the powdered form of the solid limits the possibilities of structure determination to within a certain cell volume range. It has been shown theoretically[9] that, using synchrotron radiation with the highest resolution, it is not feasible to solve a structure from powders for a cubic F lattice if the cell volume is larger than ~300,000 Å^3.

The microdiffraction set-up developed by Loiseau and co-workers enables, for the first time, single-crystal diffraction with a spot of about 1 × 1 μm^2, representing an important advance in X-ray diffraction. The researchers show the importance of the technique by solving the crystal structure of MIL-110, for which powder X-ray structure determination has proved to be insufficient. The single-crystal data collected on a micrometre-sized crystal, together with supporting data from computational simulations and solid-state NMR spectroscopy, enabled an accurate structure determination of the previously unknown phase.

The researchers constructed hexagonal, rod-like crystals of MIL-110 using a hydrothermal route. Single crystals of approximately 3 × 3 × 10 μm were analysed by synchrotron radiation and their 3D structure subsequently determined. The nanoporous framework of MIL-110 is based on the decoration and expansion of a (9, 3)-connected network. The assembly can be depicted as a combination of dual trigonal prismatic (green) and triangular (yellow) building blocks (Fig. 1). The dual trigonal prismatic building blocks are octanuclear aluminium-carboxylate-based clusters, and the triangular building blocks are derived from the planar and trifunctional organic ligand, 1,3,5-benzene tricarboxylate. The aluminium-carboxylate clusters are linked by nine of the tritopic organic ligands, to construct a 3D structure with 1D hexagonal channels of the order of 1.6 nm.

The results prove that single crystals, with dimensions of ~1 μm, are now sufficiently large for their structures to be solved accurately, which will surely have a profound impact on the discovery of new materials. In particular, this breakthrough opens up avenues in other disciplines, including the structural elucidation of proteins. There are several broad advantages. The existence of this microdiffraction set-up, implemented in a large instrument facility (here, the European Synchrotron Radiation Facility in Grenoble, France), makes it accessible for scientists who may have previously disregarded microcrystalline products. A floodgate has therefore been opened, which enables many researchers to expand the limits of structural knowledge of solids.

Most importantly, this technological improvement is still in its infancy. In the future, will it be possible to collect data on even smaller crystals? With correct data, what will be the limit for cell volumes suitable for correct structure determination?

Finally, how many new or forgotten structures are waiting in the wings to be revealed as a result of this technical innovation? It is now only a matter of time before we know the answers.

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MATERIAL WITNESS

Natural order

Biomimetic materials are often so-called because they mimic the forms and functions of natural materials. Lay down crystalline sheets separated by thin organic films, and you have something that looks and acts like hard, tough nacre. Or you can use existing biomaterials as templates, casting replicas of bone or marine exoskeletons by filling up the empty spaces with inorganic materials and then dissolving the mould.

Such structures can be valuable, but they are rather literal mimics — to put it harshly, they simply plagiarize nature. It is as though you have claimed to write a new play by setting *Hamlet* in Milan and translating it into Italian.

How much more creative and satisfying to analyse the literary, psychological and theatrical devices Shakespeare used, and then use that understanding to write something truly original. This (if you do not push the analogy too hard) is the guiding philosophy behind a study of 'bioorganization' published recently by Marshall Stoneham of University College in London (*Rep. Prog. Phys.* **70**, 1055–1097; 2007). Stoneham ostensibly asks a specific question: how do soft materials control harder ones in biology? But his aim is broader: he seeks to understand some of the general principles that enable living organisms to produce organized structures at the atomic, nano-, meso- and macroscales.

That's a question of such scope that there can't be a simple answer. But Stoneham outlines some of the common mechanisms identified in the multiscale appearance of pattern and form in both the living and the inorganic worlds. In doing so he shows that it is by no means necessary for biology to keep these processes under tight genetic control. We might call that the pedantic solution: to somehow encode in DNA the positions of all the individual elements in a pattern. Obviously this does not happen in many instances; the precise locations of a diatom's skeletal pores or an angelfish's stripes do not match up from one organism to the next. But equally, biology does achieve genetically encoded precision in, say, the positioning of limbs during embryogenesis.

At the atomic scale and thereabouts, materials patterning can often be achieved from simple considerations of packing geometry and minimal-energy configurations of molecules. The meso- and macroscales require more ingenuity. For the former, Stoneham identifies five common determinants of structure: equilibrium energy minimization, dynamic control in near-equilibrium (precipitation or nucleation, say), configurational entropy on a complex energy landscape, geometrical guidance (epitaxy and templates for example) and growth instabilities such as those involved in dendrite formation.

But among the big unknowns are how to control macroscopic form and — closely related — how to stop growth, for example so that a shell attains a specific size. Sometimes packing of the component parts might set natural size limits (as in virus protein shells), sometimes the supply of new material can be cut off. But the use of soft moulds to shape hard materials remains puzzling — or to look at it the other way, Stoneham says, how come a growing mushroom can crack concrete?

Philip Ball