Takakura, Pay Gómez and co-authors unveil an elegant model in which the positions of all atoms are determined (within an arbitrarily large three-dimensional volume). Their approach is much like assembling the pieces of a puzzle: the X-ray data reveal the clusters and where to put them, and the structures of closely related crystalline materials (called approximants) show how to fill in the glue regions with atoms. Having constructed the model, the authors tested it against the original X-ray data and found excellent agreement.

In choosing this alloy, the authors took advantage of several factors. One was that this phase, which was discovered in 2000 by Tsai *et al.*[7], contains only two elements. All but one of the other known stable quasicrystalline alloys are ternary; hence, the binary offered a clear advantage in chemical simplicity. Another was the good contrast between the two elements in X-ray scattering, which is a problem in many of the ternaries. Third, the result is far-reaching because numerous other phases have been derived from this binary 'parent' by ingenious chemical substitution[8], and one can expect their structures to be derivative as well as their compositions.

Knowledge of atomic structure can facilitate manipulation of physical properties[5]. For instance, Kimura *et al.*[9] have proposed a way to design thermoelectric materials from approximants and quasicrystals. It builds on the premise that these materials can be described as weakly connected heavy rigid clusters, as shown in Fig. 2. Chemical modification can enhance this description and lead to good thermoelectric properties, an approach that is made far more systematic if the atomic structure is available.

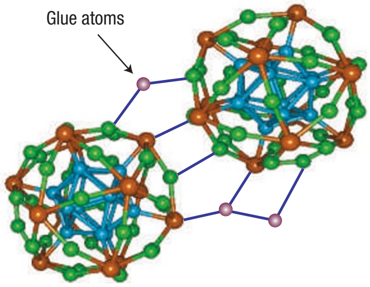

Figure 2 Icosahedral clusters in icosahedral Al–Pd–Re–Ru. The regions between clusters are highly schematic[9]. Copyright (2006) Materials Research Society.

Quasicrystals represent a challenging extreme in structural complexity. New tools and concepts, such as those needed to solve the structure of the Cd–Yb quasicrystal, have been developed in response to this challenge. It is exciting to observe that they are spreading to other complex materials. For instance, the European Union has funded a collaborative network of European scientists to study complex, but crystalline, metallic alloys. These alloys bear certain similarities to quasicrystals, such as a cluster-based structure. The consortium has already discovered a new dislocation mechanism that is a localized stress-induced phase transition[10]. Structural complexity in metallic alloys undoubtedly holds many more surprises.

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MATERIAL WITNESS

Virtuosi's choice

As some of the most discriminating materials consumers, musicians have a reputation for conservatism that verges on superstition. The materials scientists who labour to provide instrument-makers with an alternative to a rare traditional material, such as pernambuco — the material of choice for violin bows until the source tree, *Guilandia echinata*, became an endangered species — can expect scant thanks. Try as they might to point out that a carbon-fibre composite bow has superior mechanical properties (and less chance of shearing off at the head), the violinist is sure to insist that it just doesn't 'play' as well.

This acute sensitivity, if not subjectivity, towards musical materials raises the question of how far their selection can be quantified, for example with the materials selection charts pioneered by Mike Ashby at Cambridge University. That is the subtext of a survey of woods used in musical instruments by Ashby's former student Ulrike Wegst, now at the Max Planck Institute for Metals Research in Stuttgart (*Am. J. Bot.* **93**, 1439–1448; 2006).

Materials selection charts are two-dimensional spaces in which the coordinates are two properties – density and Young's modulus, say. Each material has a specific location on this plane. Materials applications often demand a compromise between at least two such quantities, in which case the candidates are those that fall within the appropriate elliptical field on the map.

Wegst shows how the acoustical properties that determine a wood's suitability for a type of instrument – a xylophone bar, say, or a violin's soundboard or a clarinet body – can be classified according to just a few parameters, such as the speed of sound, the density, and the loss coefficient that describes damping.

There are other considerations too, however. Fine-grained woods allow a smooth finish that improves tonal quality and permits accurate cutting. Woodwind instruments must resist significant swelling when exposed to moisture. The woods used in the moving parts of pianos must be tough and wear-resistant. The darwinian environment of the musical marketplace has usually identified the most suitable materials without the benefit of accurate scientific testing.

Such trial and error has created traditions for which scientific justification, if it exists, remains elusive. The hammershanks — the sticks that hold the hammers — in the finest piano actions are subject to the most exacting selection. Generally made from birch, they are hand-tested for elasticity, then dropped onto a hard surface and classed, according to the sound of the impact, as dark, medium or bright. Different classes are used in different parts of the piano. The instrument-makers insist on the value of this labour-intensive method for sound quality, but we have to take their word for it.

Doubts about the availability of specialist woods — African blackwood, favoured for clarinets, is also endangered — are sometimes forcing acceptance of new materials. Carbon-fibre violin bows have overcome the initial reservations and are now welcomed for more forceful playing. But in other cases there may be a case for trying to understand apparent conservatism before dismissing it.

Philip Ball