Bigger and better quasicrystals

Quasicrystals fall into a new category of solid matter that has neither a crystal's regularly repeating atomic pattern nor an amorphous material's randomly scattered atoms. Discovered only two years ago (SN: 1/19/85, p.37; 3/23/85, p.188), they are now the center of an extensive, worldwide research effort (SN: 11/2/85, p.278). Recently, several groups have been striving to produce individual quasicrystals large enough for detailed measurements of their physical properties and atomic structure.

Now a group of French scientists reports in the Nov. 6 NATURE that it has succeeded in producing quasicrystals that not only are large but also have a unique shape. These quasicrystals were discovered at the Pechiney Research Center in Voreppe, France, as a by-product of a search for lighter aluminum-lithium alloys for aerospace applications.

The reported quasicrystals are about 0.5 millimeter in diameter. According to the Pechiney Corp., more recent experiments have yielded centimeter-sized samples. Until this year, the biggest examples of quasicrystalline grains were only a few microns across. This severely limited the types of experiments that could be done on the new material.

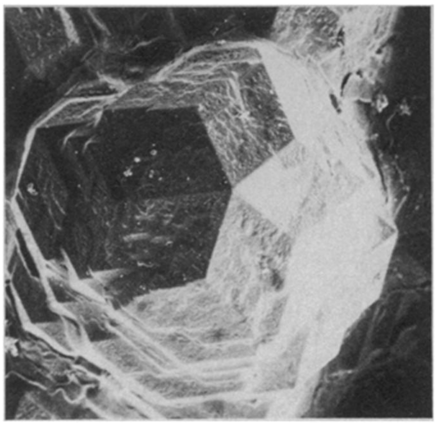
Consisting of a mixture of aluminum, copper and lithium, these "giant" single quasicrystals have the distinctive form of a triacontahedron — a polyhedron with 30 identical, diamond-shaped faces (see left photo). The meeting of five faces at each vertex provides direct visual evidence of the fivefold symmetry that appears to underlie quasicrystalline materials.

Such a triacontahedral form, say the Pechiney researchers, has never been seen before in crystallography and mineralogy.

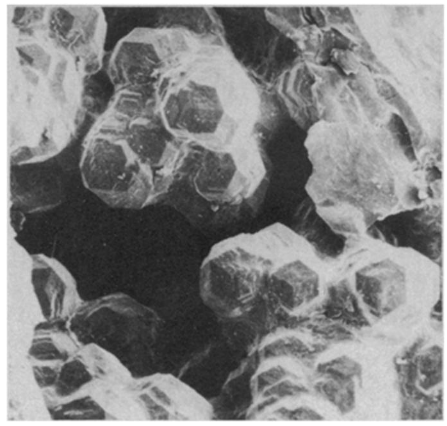
The researchers produce the quasicrystals by casting the metal mixture in a preheated graphite mold. Then they slowly cool the liquid alloy from 620° to 570°C, allowing an hour for solidification to occur. After the resulting ingot is cooled to room temperature, it is broken open to reveal well-defined stacks of faceted quasicrystals (right photo).

"Using such samples," the researchers say, "further work is needed to describe more precisely the microscopic and geometric features of this new morphology."

The growing of large quasicrystals, says Kevin Knowles of the University of Cambridge in England, "raises the real prospect that clear X-ray and neutron diffraction pictures of single quasicrystals will now be possible." This would make it easier to tell how atoms may be organized within quasicrystals. Moreover, with such large samples, it may be possible to



Pechiney



find out whether quasicrystals are, as some theorists predict, inherently brittle.

Other groups have also recently grown large quasicrystal samples from the same alloy. However, their methods generate quasicrystalline grains with a somewhat different appearance.

Charles Bartges and Earle R. Ryba of Pennsylvania State University in University Park, for example, can produce roughly cylindrical, quasicrystalline grains up to 0.2 mm in diameter and 3 mm long. Instead of cooling the alloy slowly, the investigators plunge the molten alloy, sealed in a tantalum crucible, into ice water. Then the solid is usually heat-treated.

The Penn State researchers have started to look at several quasicrystal properties, such as heat capacity and electrical conductivity. They have also made some of the earliest X-ray diffraction measurements on a single quasicrystal.

The results so far seem to show that the atomic structure within a quasicrystal is not "super-simple," says Ryba. "The reflections are broken up into one major peak and a couple of minor peaks," he says. Those minor peaks may be due to regularly spaced strains within the material.

With bigger and better single quasicrystals now available, many such controversial questions may soon be settled. The Pechiney center is ready to consider requests for samples from scientific laboratories worldwide. *— I. Peterson*

Spinning a large telescope from glass

In the Atacama Desert of northern Chile lies one of the world's major concentrations of astronomical observatories. There, if plans announced last week by the University of Arizona in Tucson, the Carnegie Institution of Washington, D.C., and the Johns Hopkins University in Baltimore are carried through, Carnegie's site at Las Campanas will get an 8-meter-diameter telescope. This will be the largest in the Southern Hemisphere.

The southern skies are as interesting — in certain cases more interesting — to astronomers as the northern skies. But due to lack of land, people and economic development in the Southern Hemisphere, telescopes there have been far less numerous and smaller than those in the north. Four meters is as large as telescopes get in the Southern Hemisphere, and the largest now at Las Campanas is 2.5 meters. The Northern Hemisphere now has a 5-meter telescope (on Palomar Mountain in California) and a 6-meter telescope (on Mt. Semirodriki in the Crimea). A 10-meter telescope, the Keck Telescope of California Institute of Technology and the University of California, is under construction in Hawaii.

The 8-meter mirror for Las Campanas will be cast by a new technique developed by J. Roger Angel of the University of Arizona, in which the casting is done in a rotating furnace (SN: 2/16/85, p. 106). The spin gives the mirror a parabolic surface that lessens the amount of grinding to be done in the finishing process and the amount of glass necessary for the casting. The back of the mirror blank is in the form of a honeycomb rather than being solid. This, too, lessens the amount of glass, the expense and the weight, all of which have been limits on the size of single large telescopes.

Eight meters is the size of the large casting machine now being built by Angel and his collaborators under the stands of the University of Arizona football stadium in Tucson. If some other current plans work out, the same furnace will cast two 8-meter mirrors that the University of Arizona, Ohio State University, the University of Chicago and a fourth, unnamed, partner plan to put on Mt. Graham, near Willcox, Ariz. Angel's method has been used successfully for smaller mirrors, especially a 1.8-meter mirror for the Vatican Observatory located in Castel Gandolfo, Italy.

How these smaller mirrors work out will affect the final decision of the institutions involved in the new southern telescope. So far, they are committed only to the design. A later review will determine whether construction goes ahead.

— D.E. Thomsen