SUPERCONDUCTIVITY

C_{60} Enters the Race For the Top

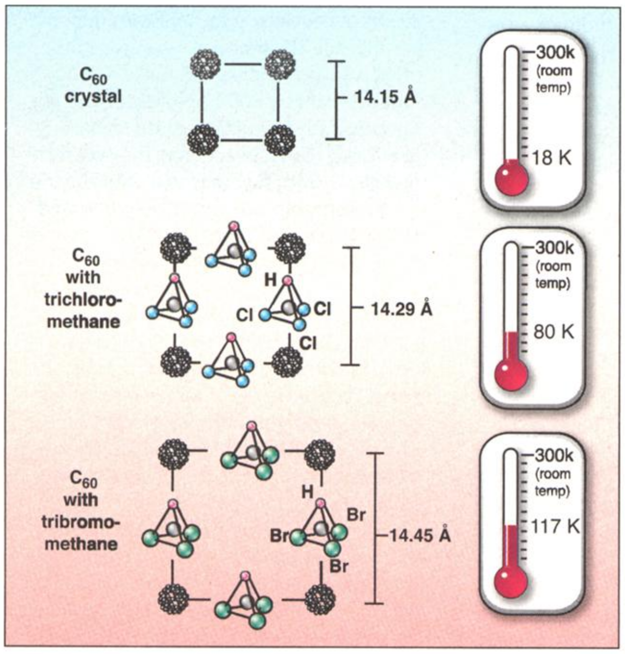
In the mid-1980s, the discovery of 60-atom carbon spheres (C_{60}) and high-temperature superconductors came as two major surprises. Now an international trio of researchers led by physicist Hendrik Schön of Lucent Technologies' Bell Laboratories in Murray Hill, New Jersey, has combined these two feats. In a paper published online this week by *Science* (www.sciencexpress.org), Schön's team reports that by placing a crystal of C_{60} spiked with other compounds in the heart of a transistor, they can turn it into a high-temperature superconductor capable of conducting electricity without resistance up to 117 kelvin (K).

"This is huge," says Art Ramirez, a condensed matter physicist at Los Alamos National Laboratory in New Mexico. C_{60}-based transistors spiked with new compounds might well superconduct at higher temperatures, perhaps even at room temperature, Ramirez says. Moreover, the crystals that Schön's team created are far easier to craft into electronic components than the standard high-temperature superconductors made from copper oxide–based ceramics, a property that could pave the way to new high-speed computers based on the technology. "This is what people have been trying to do all along" with high-temperature superconductors, Ramirez says.

This week's report follows up a discovery that Ramirez, then at AT&T Bell Labs, and colleagues made in 1991. The researchers found that crystals made of the soccer ball–shaped C_{60} molecules would superconduct at 18 K if they were spiked with alkali metals to make them better conductors of electrons. Superconductors can also work by conducting positively charged "holes," which are essentially electron vacancies in a material. In the late 1990s, Schön and his colleagues began to suspect that they could push the threshold temperature for superconducting (called the critical temperature, or T_c) higher if they could coax the C_{60} to conduct holes instead of electrons. Doing so, they and others determined, would increase a property in the material known as the density of states, the number of charges the material can harbor at key energy levels. That number is closely tied to the superconducting temperature.

Boosting the number of holes in C_{60} was difficult. The traditional strategy of doping the material with other compounds—in this case, ones that added holes—made the C_{60} crystal fall apart. But last year, Schön and Bell Labs colleagues Christian Kloc and Bertram Batlogg hit upon a novel solution: building a transistor around the crystal and using its charge-carrying ability to flood the crystal with holes. The scheme worked. As the trio reported in the 30 November issue of *Nature*, the C_{60} transistor started superconducting and kept it up at temperatures as high as 52 K.

This week's report, which more than doubles that record, shows that Schön and his colleagues had another trick up their sleeves as well. This time they added another way of increasing the material's density of states: expanding the distance between individual C_{60} molecules in the crystal, a property known formally as the material's lattice constant. C_{60} has a lattice constant of 14.15 angstroms. "If you expand the lattice, the density of states becomes larger and the T_c increases," says Schön.



Warming up. Spacing out C_{60} crystals with other molecules nudged them toward room-temperature superconductivity.

According to Schön, Kloc—the group's crystal grower—tried numerous additives and ultimately hit on two compounds, trichloromethane and tribromomethane, that did the trick. The former expands the lattice constant to 14.29 and the latter to 14.45. The compounds hiked the material's density of states, touching off an exponential increase in T_c.

That huge jump bodes well for researchers, Ramirez says. "They need to expand [the lattice constant] to something like 14.7, and that will be room temperature." So far, nobody knows whether any additive will push C_{60} to that magic number without making the crystal fall apart. But now that the word is out, other groups are sure to try their luck. "This is a footrace now," Ramirez says.

Even if C_{60} proves not to be a room-temperature superconductor, it could still have a big impact on applications. Ceramic superconductors are "extremely difficult" to fashion into transistors and other electronic components, Ramirez says, because the interfaces where they join with other materials typically harbor imperfections that trap electric charges moving through the devices. The problem can be overcome by growing devices one atomic layer at a time. But that's difficult and costly.

Organic materials appear far more forgiving, Ramirez says: "With essentially a shoestring effort, [Schön's team] gets incredible device quality and performance." Because superconducting electronics are extremely fast and are ideal for detecting minute magnetic fields, a new supply of C_{60}-based superconducting devices could revolutionize fields as disparate as high-speed computing and medical imaging. For researchers of all stripes, that would be another welcome surprise.

–ROBERT F. SERVICE

LONGEVITY

Hints of a 'Master Gene' For Extreme Old Age

As children, siblings fight over their toys, and even as they age, many are reluctant to share. But for sisters and brothers who have reached age 90 or more, what they share—their DNA—may be key to why they've lived so long. Preliminary evidence, published in the 28 August issue of the *Proceedings of the National Academy of Sciences*, suggests that genetics plays a major role in the ability to survive to extremely old ages.

"If it turns out to be true, it's really important for gerontology," says George Martin, a pathologist at the University of Washington, Seattle. Indeed, if the results hold up, they promise to overturn some ideas about the mechanisms of aging—and they might eventually provide clues about how to slow the process.

For decades, researchers have fiercely debated whether the extreme longevity that clusters in some families stems from purely environmental factors or also has genetic roots. And if the fountain of youth has a genetic component, researchers have won-

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