Thallium Superconductor Reaches 125 K

A little more than 2 years after the original, Nobel Prize–winning discovery of high-temperature superconductivity in copper oxide ceramics at 40 K, and almost exactly 1 year after the discovery of 90 K superconductivity in the "1-2-3" copper oxides, the floodgates seem to have opened. The recently announced bismuth-strontium-calcium copper oxide compound, which established the existence of a third type of superconductor with transition temperatures in the 95 K range, now appears to be the harbinger of a broad new class of such materials.

On 22 January, the same day that the bismuth discovery was announced by Japanese researchers, Allen Hermann and Zhengzhi Sheng of the University of Arkansas announced their discovery of a thallium-barium copper oxide material that achieves zero resistance to electrical current at 81 K. More recently, the same two researchers have found that the addition of calcium produces a new material that retains zero resistance up to 106 K. Both of the thallium compounds have exhibited the Meissner effect, in which they exclude magnetic flux; this is considered the most stringent test of superconductivity.

Finally, on 3 March, researchers at the IBM Almaden Research Center announced that a proprietary combination of the same elements—thallium, calcium, barium, copper, and oxygen—achieves zero resistance and displays the Meissner effect at 125 K, by far the highest critical temperature yet recorded. The IBM group included Victor Y. Lee, Adel Nazzal, Edward M. Engler, and Stuart S. P. Parkin.

Arkansas's Hermann told *Science* that the pace of recent events was brought home to him during the recent World Congress on Superconductivity, which met in Houston during the week of 22 February. "We gave our paper [on the thallium-calcium-barium copper oxide results] on Monday evening at 5 p.m.," he said. "By Tuesday morning DuPont had verified it. By Tuesday evening, Paul Chu's lab in Houston had verified it. And by Wednesday morning we got word that Tokyo had verified it. So it's been confirmed all over the world."

Hermann pointed out that the new, calcium-containing thallium compound exhibits many of the same practical advantages already displayed by the bismuth-containing superconductor, most notably the fact that it is much more stable than the 1-2-3 materials. Moreover, it can be produced by straightforward melt processing, and does not require a painstaking regimen of annealing after it is sintered. "The stability is excellent," Hermann said. "We've left samples around in the lab for 5 weeks without change."

The new material also resembles the bismuth compound in that it does not incorporate rare-earth metals such as yttrium, as do the 1-2-3 superconductors. In principle this should make it considerably cheaper to manufacture in bulk. Of course, thallium itself is in relatively short supply. Worse, it is highly poisonous. (One current use is in pesticides.) On the other hand, Hermann, for one, did not see either of these issues as insurmountable. "I don't think either bismuth or thallium is magical. There's a whole family of these compounds, and I think we're going to find easier ways to make them."

One key parameter for large-scale applications of any superconductor is its critical current, the maximum electrical current density that it can carry before the superconductivity fails. Unfortunately, said Hermann, no one has yet been able to make a meaningful measurement of that quantity in the thallium material because no one has been able to prepare a sample having a single crystalline phase. That will surely be a top priority in the months to come. Intriguingly, however, x-ray diffraction analysis of the material has identified two very different structures, *both* of which are superconducting at essentially the same temperatures.

In one phase, said Hermann, the elements thallium, calcium, barium, and copper are in the ratio 2:1:2:2. Moreover, the crystalline structure in this case turns out to be quite similar to that of the bismuth superconductor. Both feature two parallel planes of copper oxide separated by a plane of calcium atoms. Indeed, these copper oxide planes appear in all the high-temperature superconductors, and are thought to provide the pathways for supercurrents to propagate. (Most researchers have now dismissed the idea that the supercurrents are carried along one-dimensional copper-oxygen chains.)

In the second phase, however, things are quite different, said Hermann. The four metallic elements are in the ratio 2:2:2:3, and the crystalline structure has three copper oxide planes separated by calcium planes. "I think there are whole families of compounds out there with these copper oxide planes," he says. "We just have to learn how to make them and stabilize them." ■

M. MITCHELL WALDROP

A Monkey Virus in Human Clothing

In the spring of 1986, Max Essex of the Harvard School of Public Health claimed to have isolated a new AIDS virus relative from West Africans, one of the achievements that helped him to earn a share of the 1986 Lasker Award. It turns out, however, that the virus he isolated is not of human origin after all, but is instead a monkey virus that causes an AIDS-like disease in macaques.

Essex, Phyllis Kanki, and their Harvard colleagues had originally detected the existence of the West African virus, which they called HTLV-4, on the basis of antibodies carried by healthy prostitutes in Senegal. This work showed that the new virus is distantly related to the AIDS virus, but much more closely related to the STLV-3s, a group of monkey viruses that were also being studied in the Essex laboratory. Apparently, during the search for HTLV-4, the cell cultures somehow became contaminated with a macaque STLV-3, which the Harvard workers then isolated in the guise of the human virus.

Doubts about the provenance of the putative human virus surfaced about a year later, primarily because the HTLV-4 genome turned out to be remarkably similar to that of STLV-3 (*Science*, 19 June 1987, p. 1523). AIDS researchers were quick to speculate that Essex was the victim of laboratory contamination, but he steadfastly maintained that he could detect no traces of it.

However, results reported by Ronald Desrosier and his colleagues at the New England Regional Primate Center in the 18 February issue of *Nature* provide strong evidence that HTLV-4 is a macaque STLV-3. Writing in that same issue, Essex and Kanki agree that the two viruses should be considered the same, unless proven otherwise.

"We decided that it was better to let people make the assumption that we can't distinguish them, than to go on with all the hoopla," Essex says, although he is still not completely convinced that HTLV-4 is a macaque virus contaminant. Nevertheless, he concedes that "at this point, I would have to say that it is more likely than not."

Desrosier's report does not disprove the existence of a West African variant of the AIDS virus. The original identification of the virus came in the antibody work, and other investigators, including Luc Montagnier and his colleagues at the Pasteur Institute in Paris, have isolated the West African virus, which now goes by the name HIV-2. ■ JEAN L. MARX