Bell Labs Wins Long-Running Patent Battle over High-T_c Superconductor

The breakthrough discovery of high-T_c superconductivity in the 1980s still promises eventual widespread exploitation.

A key battle in securing US patent rights to yttrium barium copper oxide (YBCO), the first superconductor with a transition temperature exceeding the boiling point of liquid nitrogen (77K), has been won by Bell Laboratories, the research arm of Lucent Technologies.

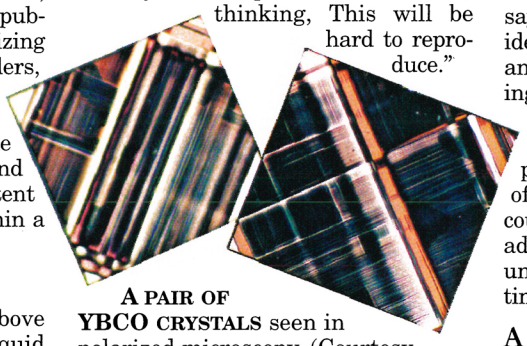
Bell Labs was the first of three organizations to file for a patent on YBCO in March 1987, followed by a fourth nearly a year later. The US Patent Office, however, awards patents based on the earliest discovery date, rather than the filing date. Its decision in Bell Labs' favor, reached this past fall but not yet public, capped a dozen years of scrutinizing the lab records of the four contenders, which, in addition to Bell Labs, included IBM's Almaden Research Center in San Jose, California, the US Naval Research Laboratory, and the University of Houston. The patent itself is expected to be issued within a year or so.

YBCO frenzy

The race for superconductivity above 77K, for which cooling with liquid nitrogen promised cheap and practical applications, was triggered in 1986 when Georg Bednorz and Alex Müller of IBM's Zurich research laboratories reported that the resistance of lanthanum barium copper oxide plunges to zero at 35K. "Anything over 23K was a Holy Grail. Nobody believed anything would be higher," recalls Northwestern University's John Rowell, a consultant to the superconductor industry. Oxide materials in particular had been thought a dead end.

Pretty much everyone agrees that Houston's Paul Chu and the University of Alabama's Maw-Kuen Wu and colleagues were the first to make YBCO. After finding that they could increase the transition temperature of the Zurich material by applying pressure, Chu explains, they tried to simulate pressure: "That's why we replaced lanthanum with yttrium. Yttrium is smaller, and increases the pressure in a sense." That logic turned out to be faulty, but the result was superconductivity at 93K. Word of the achievement unleashed a research frenzy.

Scientists around the world immediately set to work to identify the superconductor in Chu and Wu's multiphase material. "I remember seeing the resistance data for the first time. It was awesome," says the Electric Power Research Institute's Paul Grant, who was at IBM-Almaden at the time, and was a coauthor of that company's patent application. "But the x-ray diffraction pattern had about 50 peaks. It was a terribly mixed phase. I remember thinking, This will be hard to reproduce."



A PAIR OF YBCO CRYSTALS seen in polarized microscopy. (Courtesy of Debra Kaiser, National Institute of Standards and Technology, and David Larbalestier, University of Wisconsin—Madison.)

But within 48 hours, he had. So had others. They raced to determine the structure and composition. Several groups found that the superconducting phase was orthorhombic and had yttrium, barium, and copper in a ratio of 1:2:3, plus seven oxygen atoms. The US patent is expected to cover the so-called 1-2-3 copper oxide superconductors, which include materials made with rare earth atoms substituted for yttrium, or alkali metals used in place of barium.

In the end, the rights race came down to Bell Labs and IBM. "It was essentially declared a tie," says Grant. "And in a tie, the first to file wins."

Even so, Grant feels that IBM should have won the YBCO rights. "Bell Labs didn't take proper data to estimate the volume of the superconducting fraction," he says, referring to the patent office's criterion that the sample be 90% pure and superconducting above 70K. Not so, counters Bell Labs' Bertram Batlogg, citing his team's x-ray diffraction, magnetic, and transport data. And, he stresses, Grant's claim is irrelevant: "The sample had to be 90% pure. There was no word about a superconducting fraction. The records show that we were the first to invent, the first to file, and the first to publish '1-2-3.' We had it first by more than a week. That was long in those days."

IBM didn't appeal the patent office's ruling, but the company might apply for US patents for parts of its recipe for making YBCO. "That's more or less how our patents are distributed in Europe," says Grant. "The Bell patent goes to identifying the composition of matter, and the IBM patent goes to processing—how to cook it in oxygen." There's also still the possibility that Zurich's Bednorz and Müller could get patents for their earlier discovery of high-T_c superconductors—"which could wind up covering everything," adds Grant. "None of this will matter unless lots of money is made some time—and that's really up in the air."

A way to go

The potential applications of high-T_c superconductivity are mainly in power generation and electronics, but they haven't yet been developed for widespread use. "YBCO is where it's really going to happen, if it's going to happen," says David Larbalestier, who specializes in making superconducting wires at the University of Wisconsin—Madison. YBCO is less anisotropic than other known high-T_c superconductors, so it can carry a higher current density at larger magnetic fields. It's also cheaper to make.

According to Carl Rosner, chair of Intermagnetics General Corp, "The biggest challenge to manufacturers is to be able to develop things at a competitive cost—all high-T_c materials have a way to go. It clearly will be a few years, at least, before applications really take off." Meanwhile, the stocks of high-T_c superconductor R&D companies have recently skyrocketed. And, with rights kicking in only once the patent is awarded, Bell Labs stands to profit financially from the fact that the decision on who should win the US rights to YBCO has dragged on for so long. **TONI FEDER**