Physicists explain why superconductors fail to produce super currents

June 27 2010

When high-temperature superconductors were first announced in the late 1980s, it was thought that they would lead to ultra-efficient magnetic trains and other paradigm-shifting technologies.

That didn't happen. Now, a University of Florida scientist is among a team of physicists to help explain why.

In a paper set to appear Sunday in the online edition of Nature Physics, Peter Hirschfeld, a UF professor of physics, and five other researchers for the first time describe precisely how the atomic-level structural elements of high-temperature ceramic superconductors serve to impede electrical current. Their explanation for how "grain boundaries" separating rows of atoms within superconductors impede current is the first to fit a phenomenon that has helped keep the superconductors from reaching their vaunted potential - and puzzled experimental physicists for more than two decades.

"Nobody understood why it was such a strong effect, or why the current was so limited by these grain boundaries," Hirschfeld said. "And that is what we have explained in this paper."

High-temperature superconducting ceramic wires are composed of rows of atoms arranged slightly askew to each other, as though one piece of graph paper had been melded atop another with the horizontal and vertical lines at less-than-perfect alignment. Lumps of electrical charge build up at the angles where the lines meet, acting like dams to interrupt the flow of electricity.

Hirschfeld and his colleagues' contribution was to conceive and construct a mathematical model that fit these observations "very nicely," he said. "We abstracted a very theoretical model of a single boundary" that can be applied to all such boundaries, he said.

Unfortunately the model does not suggest a way to break down the barriers, although Hirschfeld said it will give researchers a better tool to interpret results of past and future experiments. This gives the team hope that their model could, over time, lead to high-temperature superconductors with less restrictive grain boundaries. That would be a step toward helping the superconductors, which have found limited applications in areas such as powerful research magnets, reach their heralded potential.

Provided by University of Florida

Citation: Physicists explain why superconductors fail to produce super currents (2010, June 27) retrieved 23 April 2024 from https://phys.org/news/2010-06-physicists-superconductors-super-currents.html