Department of Physics & Astronomy

PHYSICS NEWS FLASH

Dai Group's Latest Breakthrough Featured in Nature Materials

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Professor Pengcheng Dai's group has tackled a long-standing materials issue that may clear one more obstacle in understanding superconductivity. The results are published in "Microscopic annealing process and its impact on superconductivity in *T'*-structure electron-doped copper oxides," which appears in the March issue of *Nature Materials* and also merits a commentary in the journal's News and Views section.

The Dai group continues to make important strides in unveiling how certain metals are structured to give them superconducting properties at high temperatures. Materials that move electric current along with no resistance have potential economic implications (loss-free power transmissions or magnetic levitating trains, for example) that make this science highly relevant for fields like computing and transportation. Understanding the fundamentals behind superconductivity, however, continues to be a challenge.

All parent compounds of high-temperature superconductors contain copper oxide layers that are antiferromagnetic (AF)—they have no net magnetism. They become superconducting when either electrons or "holes"—a vacant electron position that behaves like an electron with a positive charge—are added in a process called doping. But while hole-doping quickly destroys the AF order and induces superconductivity, electron doping doesn't produce the same results. Electron-doped materials must undergo an *annealing* process to become superconducting. They are placed in an oxygen-reduced atmosphere to remove a small amount of oxygen. The role of this reduction process has long been an unresolved issue in understanding these materials since their original discovery.

By using X-ray and neutron scattering data, the Dai group discovered that removing oxygen also removes copper deficiencies and creates oxygen vacancies in the materials. The annealing process, then, repairs disorder in the copper oxide plane and provides itinerant carriers for superconductivity. This suggests that the fundamental mechanism for superconductivity in hole- and electron-doped copper oxides is the same.

Hye Jung Kang (Ph.D. 2005) is lead author on the paper. She is now part of the NIST Center for Neutron Research. Professor Dai and Shiliang Li, a post-doctoral research associate in his research group, are among the article's co-authors. A link to the paper and further information about the Dai Group is available on their Web site at http://pdai.phys.utk.edu/.