Parent-compound superconductors without doping

~Towards a true picture of high-T_c superconductivity by thin-film synthesis~

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Motivation

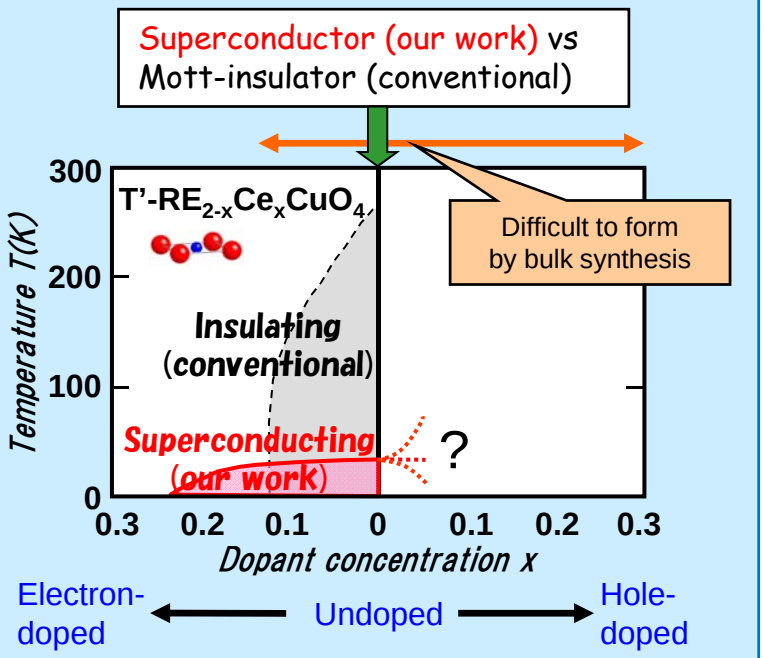
Cuprates are the materials with the highest superconducting transition temperatures (T_c's). However, it is not well-understood that such high T_c's are achieved within the cuprates. Via thin-film synthesis of new superconductors, we are approaching the true mechanism of high-T_c superconductivity.

Originality

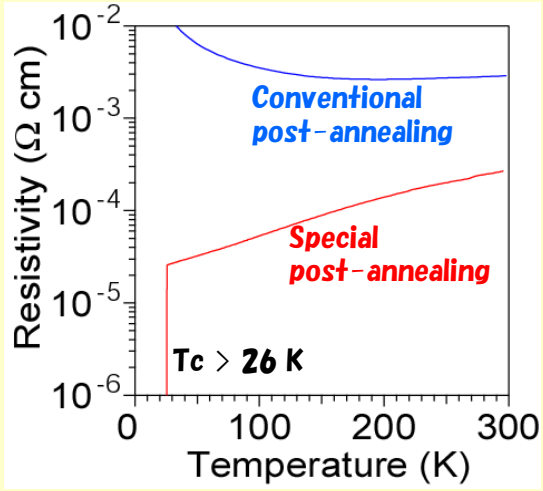
It has been commonly believed that the parent compounds of high-T_c cuprates are Mott-insulators and carrier doping is necessary to induce superconductivity. In contrast, we have recently shown that a series of parent compounds become superconducting without doping.

Impact

Our results urge an essential revision of the electronic phase diagram within the cuprates. The correct phase diagram will lead us to the true mechanism of high-T_c superconductivity, which is useful for improving the T_c's in the cuprates, and eventually guides us towards entirely new superconductors with higher- T_c's.



◆ Revised electronic phase diagram for cuprates with square-coplanar CuO_2 plane



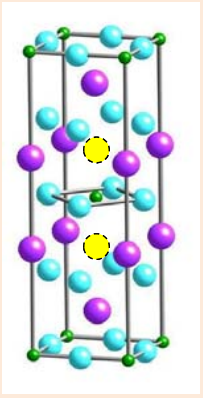
◆ Resistivity–Temperature characteristics of Pr_2CuO_4 thin films

Superconductivity is obtained in the MBE-grown parent compound film through a special post-annealing process. Its T_c is higher than that of the electron-doped cuprates.

What is different in between insulating vs superconducting Pr_2CuO_4?

Despite their nominally same crystal structure and chemical formula, apparently an insulating and a superconducting RE_2CuO_4 exist. Most likely the difference arises from a difference in residual impurity oxygen (yellow), which is known to be harmful to superconductivity.

It is plausible that a more thorough removal of such kind of impurity is achieved by a special post-annealing process, which is optimized taking Into account of the grain size of the film.



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