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Tohoku Univ. WPI-AMIR
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Direct determination of superconducting-pairing symmetry in electron- and hole-doped iron-based superconductors

-Important step toward complete understanding of superconducting mechanism-

＜Content＞

The research group headed by Prof. T. Takahashi in WPI and Dr. T. Sato in Department of Physics has revealed the superconducting mechanism of new iron-based high-temperature superconductors. They have succeeded in determining the superconducting-pairing symmetry by using ultrahigh-resolution angle-resolved photoemission spectroscopy.

The research result is published online in *Proceedings of National Academy of Sciences (PNAS)* in the week of April 6th in the U.S. eastern time.

＜Background＞

After the discovery of iron-based high-temperature superconductor $LaFeAsO_{1-x}F_x$ by Prof. Hosono in Tokyo Institute of Technology in February 2008, intensive researches have been performed to elucidate the mechanism of superconductivity and also to search for new superconducting materials with higher superconducting transition temperatures (T_c). The T_c value has already exceeded 50 K and is actually the highest except for copper-oxide superconductors discovered 23 years ago. Characteristic properties of iron-based superconductors are (i) electrons of iron atoms, which are believed to be the foe of the superconductivity, play a central role in realizing the superconductivity, and (ii) the superconductivity emerges by both hole- and electron-doping into the parent compound. To elucidate the superconducting mechanism, intensive researches to determine the pairing symmetry of Cooper pairs are now urgently in progress because the pairing symmetry is the key ingredient to establish the superconducting mechanism. One of essential questions in iron-based superconductors is whether the paring symmetry is the same or not between electron- and hole-doped materials. This problem is crucial in understanding the superconducting mechanism of iron-based superconductors, but has not

been resolved yet.

＜Research＞

The research group of Tohoku University has directly observed the superconducting gap of an electron-doped Fe-based superconductor $BaFe_{2-x}Co_xAs_2$ and has succeeded for the first time in directly determining the pairing symmetry. The pairing symmetry exhibits a *s*-wave character as in the hole-doped counterpart. The present result unambiguously indicates the electron-hole symmetry and the multi-band nature of superconductivity in iron-based superconductors.

＜Future aspect＞

The present research result will certainly contribute to establishing of the model to explain the high-temperature superconductivity in iron-based materials. In addition, the present result definitely gives a clear strategy to synthesize a new iron-based superconductor with a higher T_c based on the multi-band *s*-wave mechanism.

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＜Contact＞

＜About research＞

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<Figures>

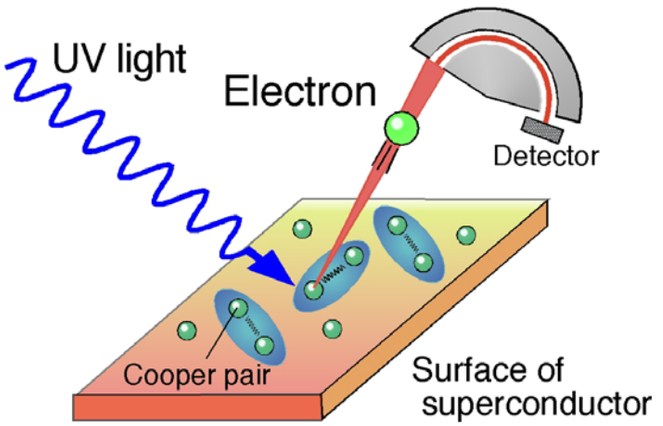

Fig. 1: Angle-resolved photoemission spectroscopy of superconductors

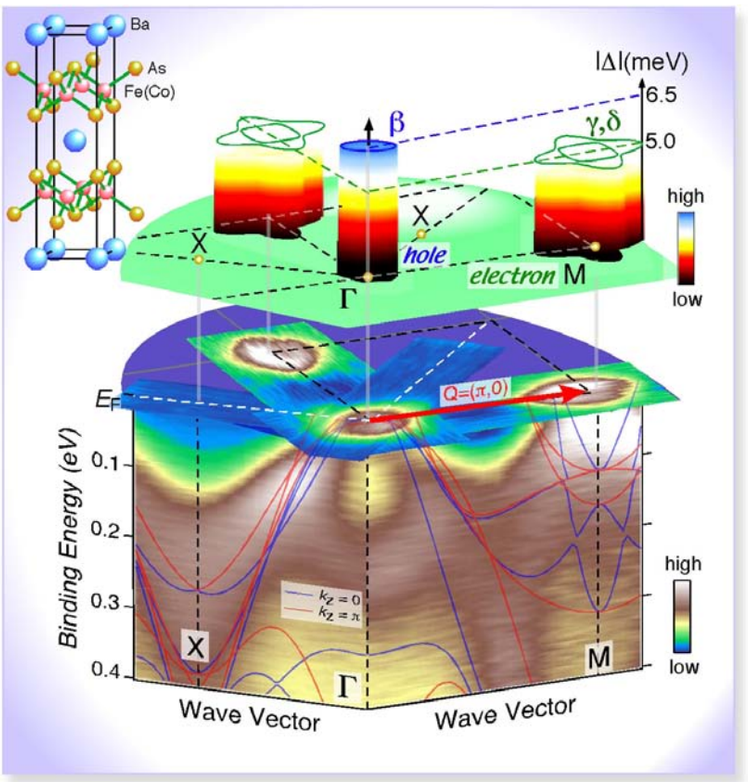

Fig. 2: Electronic structure and superconducting pairing symmetry of electron-doped FeAs superconductor. Top: Fermi-surface dependence of the magnitude of superconducting gap. Superconducting gap shows s-wave symmetry with the size of 6.5 and 5.0 meV on the β Fermi surface at Γ point, and electronlike Fermi surfaces at M point, respectively. Bottom: Band structure and Fermi surface of electron-doped FeAs superconductor.