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Low-energy angle-resolved photoemission spectroscopy of Fe-based high-T_c superconductor $Ba_{1-x}K_xFe_2As_2$

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The recent discovery of high-T_c superconductivity in iron pnictide compounds has generated fierce debates on the high-T_c mechanism. The parent compounds of iron pnictide superconductors exhibit long-range antiferromagnetic order below T_N accompanied by the structural phase transition. By doping hole or electron carriers, the magnetic and structural phase transitions are suppressed and eventually the superconductivity emerges. To clarify the superconducting mechanism, it is essentially important to understand the doping-induced evolution of the low-energy band structures responsible for the emergence of the superconductivity. The understanding of the superconducting gap character is also critically important, since it is intimately related to the superconducting pairing interactions. To elucidate these points, we have performed high-resolution angle-resolved photoemission spectroscopy (ARPES) on $Ba_{1-x}K_xFe_2As_2$.

ARPES measurements were performed using MB Scientific A1 spectrometer at the beamline 7U of UVSOL-II. We used low-energy photons ($h\nu$ = 6-25 eV) to excite photoelectrons. The energy resolution was set to 8-14 meV.

Figure 1 (a) shows the ARPES spectral intensity of optimally hole-doped $Ba_{0.6}K_{0.4}Fe_2As_2$ (T_c = 37 K) measured at 17 K along the red line in the Brillouin zone shown in the inset. We clearly observed a hole-like band centered at the Γ point. In Fig. 1(b), we show the ARPES spectrum measured at the Fermi wave vector of this band. A sharp quasiparticle peak together with a leading-edge shift toward higher binding energy is clearly seen, indicating a superconducting gap opening. The superconducting gap size (Δ) estimated from the peak position is about 10 meV. This is significantly larger than the value (~5.5 meV) expected from the weak-coupling theory, suggesting an anomalously strong-coupling nature of the superconductivity in this compound. In this presentation, we also discuss the doping dependence of the electronic structures in relation to the occurrence of the superconductivity.

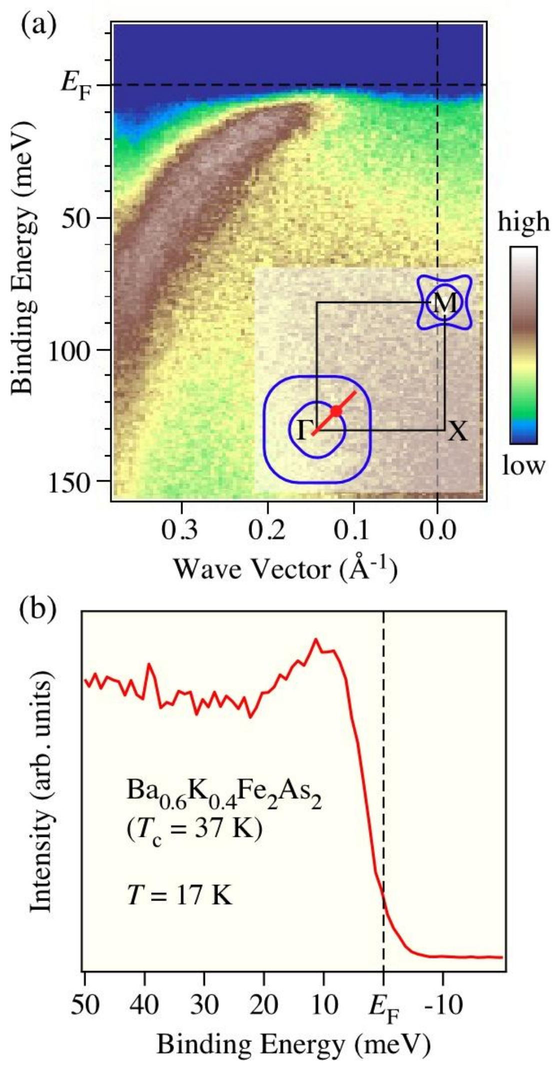

Fig. 1. (a) ARPES intensity plot near the Γ point of $Ba_{0.6}K_{0.4}Fe_2As_2$ (T_c = 37 K) as a function of binding energy and wave vector measured at 17 K with 21 eV photons. The inset indicates schematic Fermi surfaces (blue curves) and the measurement location (red line). (b) High-resolution ARPES spectrum near E_F at 17 K measured at the Fermi vector of the hole-like band (red circle).