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Superconducting gaps in overdoped $Ba_{1-x}K_xFe_2As_2$

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1 Introduction

Iron-pnictide superconductors have been extensively studied by angle-resolved photoemission spectroscopy (ARPES) especially the compound $Ba_{1-x}K_xFe_2As_2$ (BaK) [1,2,3]. However, there is still little consensus on the superconducting (SC) gaps mainly due to the photon energy dependence and the complicated line shape observed in the ARPES data of this compound. In order to get more insight into this issue, using ARPES we have investigated the SC gaps in overdoped (OD) BaK compound which has been less explored by ARPES compared to the optimally-doped case.

2 Experiment

The samples under study were high-quality single crystals of OD BaK with x ~ 0.5 grown by the KAs flux method. ARPES measurements were performed at BL-28A of Photon Factory (PF) with hν = 34 eV with a VG-Scienta SES-2002 used as electron analyzer. The Fermi level (E_F) calibration of the samples was done by referring to that of gold and the energy resolution was set to ~8-10 meV. The samples were cleaved at a temperature T ~ 12K in an ultra-high vacuum.

3 Results and Discussion

Figure 1 shows the ARPES data of BaK with x ~ 0.5: The FS map around the Brillouin zone (BZ) center is displayed in panel (a1) and the energy-momentum (E-k) plot of the cut represented by the black arrow in panel (a1) taken below T_c is displayed in panel (b1) and the corresponding energy distribution curve (EDC) at the Fermi momentum (k_F) point of the inner hole-like band is displayed in panel (c1). Similar data corresponding to the electron pocket at X point of the BZ is displayed in panels (a2), (b2) and (c2) respectively. In order to estimate the SC gap size, we fit the EDCs with a BCS spectral function represented by a black solid line. From this fit, we estimate the SC gap size to be ~ 3 meV on the hole-like band (c1) and ~ 10 meV on the electron-like band (c2). These results support a two-gap scenario in BaK compound which should be considered while discussing the superconductivity in iron-pnictides based on the spin-fluctuation scenario that expects a similar SC gap size on both the hole and electron FS sheets connected by a nesting vector [3,4]. Moreover, here we have estimated the SC gap size at only one kz value (kz ~ π) corresponding to hν = 34 eV [2], which requires that we extend this work to other kz values by considering different photon energies which is now under progress.

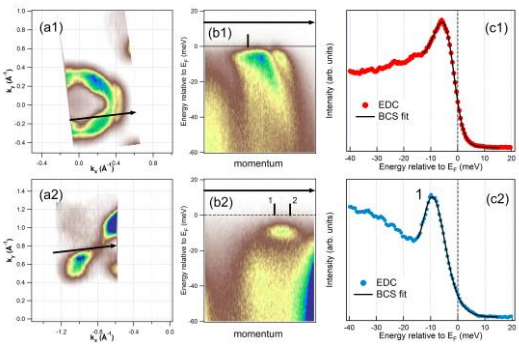

Fig. 1: ARPES data of BaK with x ~ 0.5 measured at BL-28A of PF with hν = 34eV at T ~ 12K: (a1) FS map around the BZ center. (b1) E-k plot of the cut represented by the black arrow in panel a1. The black bar indicates the k_F position determined from the momentum distribution curve (MDC) peak position. (c1) Raw EDC corresponding to the E-k plot in panel b1 and its fit with a BCS spectral function (black solid line). (a2-c2) Similar data taken on the electron pocket.

References

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