BL-28A/2012G075, 2012S2-001

Anisotropic electronic structure of $Ba(Fe_{0.96}Ru_{0.04})_2As_2$ in the magnetostructurally ordered phase

Liang LIU[1,*], Masafumi HORIO[1], Leo Cristobal C AMBOLODE II[1], Hakuto SUZUKI[1], Jian Xu[1], Teppei YOSHIDA[1], Atsushi FUJIMORI[1], Kanta ONO[2], Masamichi NAKAJIMA[3], Kunihiro KIHOU[3], Chul-Ho LEE[3], Akira IYO[3], Hiroshi EISAKI[3], Takuya MIKAMI[1], and Shinichi UCHIDA[1]

[1]Department of Physics, University of Tokyo, Bunkyo-ku, Tokyo 113-0033, Japan

[2]KEK, Photon Factory, Tsukuba, Ibaraki 305-0801, Japan

[3]National Institute of Advanced Industrial Science and Technology, Tsukuba 305-8568, Japan

1 Introduction

$BaFe_2As_2$, a typical parent compound of iron arsenide superconductors, exhibits a magneto-structural transition, below which an antiferromagnetic-orthorhombic (AFO) phase is formed. The resistivity measurement on detwinned samples has shown that the resistivity along the shorter axis with ferromagnetic spin alignment (often denoted as b axis) is higher than that along longer axis with ferromagnetic spin alignment (a axis) [1]. The in-plane electronic anisotropy that develops as temperature is lowered through the transition was also successfully revealed by optical spectroscopy [2] and angle-resolved photoemission spectroscopy (ARPES) [3].

The origin of the orthorhombic transition has been discussed from the perspectives of spin fluctuations or the orbital degree of freedom (an unequal occupation of d_{zx} /d_{yz} orbitals) [4], which could result in the anisotropy of resistivity. In contrast, recent experimental results have given evidence that the resistivity anisotropy originates from an extrinsic scattering effect of impurity atoms [2,5]. In order to further understand the relationship between the anisotropy in the resistivity and that in the electronic structure, we have performed an ARPES measurement of detwinned $Ba(Fe_{0.96}Ru_{0.04})_2As_2$ crystals.

2 Experiment

High-quality single crystals of $Ba(Fe_{0.96}Ru_{0.04})_2As_2$ (T_s= 128 K) were grown using the self-flux method. In order to detwin samples in the AFO phase, we applied a uniaxial compressive stress along the tetragonal (110) direction using a mechanical device like that reported in ref. [6]. Angle-resolved photoemission (ARPES) experiments were carried out at BL 28A of Photon Factory (PF) using circularly-polarized light with the energy of 63eV. The crystals were cleaved *in situ* and measured at T= 20 K in an ultra-high vacuum of ~$1x10^{-10}$ Torr.

3 Results and Discussion

Figure 1(b) shows the ARPES intensity map in the k_x-k_y plane obtained with the integration window of 10meV about E_F. One can see the anisotropy of FSs with the broken four-fold symmetry. Band dispersions along the high symmetry lines Z-X and Z-Y are shown in Fig. 1(c)-(d). The band around the X point crosses the Fermi level while the one around the Y point sinks below E_F, which is consistent with the splitting of bands with d_{zx} and d_{yz} orbital character in the AFO phase of $Ba(Fe_{1-x}Co_x)_2As_2$

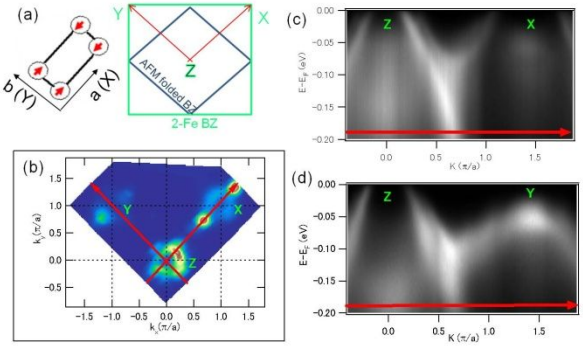

Fig. 1: Anisotropic electronic structure observed on detwinned $Ba(Fe_{0.96}Ru_{0.04})_2As_2$ single crystals in the AFO phase. (a) Schematic 2D BZ in the k_x-k_y plane with k_z=π, where Z-X is along the AFM axis and Z-Y is along the FM axis. (b) Fermi surface (FS) mapping in the k_x-k_y plane using the photon energy of 63 eV (k_z=π). (c-d) Corresponding spectral images along the high symmetry lines showed in Fig.1(b).

reported by Yi *et al*. [3]. As proposed in ref. [5], resistivity anisotropy in the underdoped $Ba(Fe_{1-x}Co_x)_2As_2$ is induced by the doped atoms anisotropically polarizing its surroundings and working as anisotropic scattering centers in the AFO phase while the origin of the different sign of the in-plane resistivity along the different axes may root in the anisotropic electronic structure of the AFO phase. Recently, the opposite in-plane resistivity anisotropy in FeTe was reported [7], which implies that some anisotropic features of the electronic structure may be 90 ^{o} rotated relative to the defined a/b axis in iron telluride.

References

[1] J.-H. Chu *et al., Science* **329**, 824 (2010).
[2] M. Nakajima *et al., Phys. Rev. Lett.* **109**, 217003 (2012).
[3] M. Yi *et al., Proc. Nat. Acad. Sci. USA* **108**, 6878 (2011).
[4] I. R. Fisher *et al., Rep. Prog. Phys.* **74,** 124506 (2011).
[5] S. Ishida *et al.,* arXiv: 1208.1575v1.
[6] Y. K. Kim *et al., Phys. Rev.* B **83** 064509 (2011).
[7] J. Jiang *et al.,* arXiv:1210.0397.

* liu@ wyvern.phys.s.u-tokyo.ac.jp