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Composition dependence of the three-dimensional Fermi surfaces in the iron pnictide superconductor $BaFe_2(As_{1-x}P_x)_2$

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Introduction

While most of experimental results on the iron-pnictide superconductors show an nodeless superconducting gap [1], recent studies of $BaFe_2(As_{1-x}P_x)_2$ [2] show signatures of a superconducting gap with a line node in the results of penetration depth, thermal conductivity measurements [3]. In $BaFe_2(As_{1-x}P_x)_2$, the substitution of P for As suppresses magnetic order and induces superconductivity with maximum T_c~ 30 K at x~0.3. With more P substitution, the T_c decreases and eventually disappears at x~0.7. In our previous angle-resolved photoemission spectroscopy (ARPES) study, we revealed the three dimensional Fermi surfaces of the optimally doped $BaFe_2(As_{1-x}P_x)_2$ with x ~ 0.38 [4]. In this work, we have performed ARPES studies of the same system to reveal the composition dependence of the electronic structure in relation to the superconductivity.

Experimental condition

High-quality single crystals of $BaFe_2(As_{1-x}P_x)_2$ with x=0.6 (T_c= 8 K) and 0.9 (no superconducting) were grown using the self-flux method. ARPES measurements were carried out at BL-28A using a circularly-polarized light with photon energies ranging between 46 and 67eV. A Scienta SES-2002 analyzer was used with a total energy resolution of ~15 meV and a momentum resolution of ~ 0.02 π/a, where a =3.92 Å is the in-plane lattice constant. The crystals were cleaved *in situ* at T=10 K in an ultra-high vacuum ~5×10^{-11} Torr.

Result and Discussion

Results of Fermi surface (FS) mapping in the $k_{//}$-k_z plane were obtained by changing the photon energy as shown in Fig. 1 (a) and (b), where the direction of $k_{//}$ is parallel to the Γ-X direction. The intensity plots were obtained by assuming an inner potential V_0=13.5 eV. We have observed at least two hole FS sheets around the Brillouin zone (BZ) center, and two electron FSs around the BZ corner. While the x= 0.6 result shows at least two warped cylindrical hole Fermi surfaces around the Γ point, the two hole FSs in x=0.9 become disconnected around the Γ point. This disconnection deteriorates the nesting properties and, therefore, may lead to the suppression of the superconductivity.

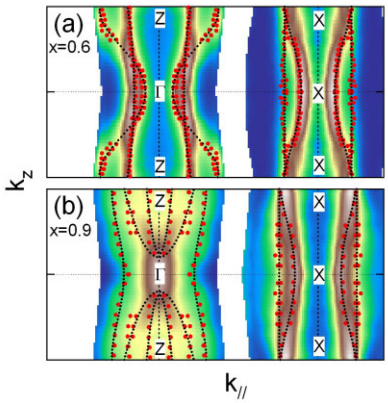

Fig. 1: Fermi surface mapping of $BaFe_2(As_{1-x}P_x)_2$ in the $k_{//}$-k_z plane obtained by changing the photon energy. Fermi surfaces are obtained by symmetrising the intensity with respect to the symmetric line.

References

[1] H. Ding *et al.*, Europhys. Lett. **83**, 47001 (2008).
[2] S. Kasahara *et al.*, Phys. Rev. B **81**, 184519 (2010).
[3] K. Hashimoto *et al.*, Phys. Rev. B **81**, 220501 (2010).
[4] T. Yoshida *et al.*, Phys. Rev. Lett. **106**, 11701 (2011).

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