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Pseudogap formation above the superconducting dome in iron-pnictides

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1 Introduction

The pseudogap (PG) reported in the normal state of the high transition temperature (T_c) copper oxide superconductors remains a mysterious state of matter. It has been attributed to several mechanisms such as a precursor pairing and a novel form of spin and/or charge order. Origin of the PG phase in copper oxides superconductors is still extensively debated and no consensus has been reached. In order to obtain further insights into the relationship between the high-T_c superconductivity and the PG formation, investigation of the PG phase in other high-T_c superconductors is required.

Iron-pnictides are another class of high-T_c superconductors whose parent compound shows stripe-type antiferromagnetic ordering at T_N accompanying a lattice distortion from tetragonal to orthorhombic structure at T_s. Although several studies have been reported on the PG formation, the PG phase has not been completely established in the phase diagrams of the iron pnictides. In particular, only one ARPES study has shown the presence of a normal state energy gap in momentum space for $Ba_{0.75}K_{0.25}Fe_2As_2$ (Ref. 1). The overall picture of the PG formation in the multiband electronic structure has not been clarified so far. In this work, we investigate the PG formation in the momentum-resolved electronic structure of $BaFe_2(As_{0.7}P_{0.3})_2$ (AsP122) and its evolution with temperature.

2 Experimental

Single crystals of $BaFe_2(As_{1-x}P_x)_2$ with x = 0.30 were grown by a self-flux method [2]. Synchrotron-based ARPES measurements were carried out at BL 28A of Photon Factory. A VG-Scienta SES-2002 analyzer and circularly and *p*-polarized light were used with the total energy resolution of 10 meV. The crystals were cleaved in situ at T = 10 K in an ultrahigh vacuum of 5×10^{-11} Torr.

3 Result and discussion

The AsP122 system shows quasi-two dimensional FSs above $T_{N,s}$. Three hole-FSs (α, β, γ) and two electron-FSs (δ, ε) exist around the Brillouin zone (BZ) center and the BZ corner, respectively. T-dependences of the EDCs at k_F for ε, δ, γ and α/β bands at x = 0.30 are displayed in Figure 1 (a-d). The coherence peak near Fermi level (E_F) is clearly observed at low T especially for the hole bands. If we take a close look at E_F, all of the bands show the depression of the spectral weight with lowering T. In order to extract the intrinsic T-dependent part of the spectral weight, the EDCs are symmetrized with respect to E_F, and further normalized by the smoothed EDC recorded at the highest T (150 K) as shown in figure 1 (e-h). Normalized EDCs in all bands indicate the suppression of the spectral weight near E_F roughly below ~120 K. Since this gap-like structures concomitantly evolve both in the electron and hole bands, the T-dependent gapped feature in the EDCs in the normal state should be then attributed to PG formation in the total density of states. We thus consider that the hole and electron bands show nearly comparable PGs of ~ 20 meV for optimally-doped AsP122.

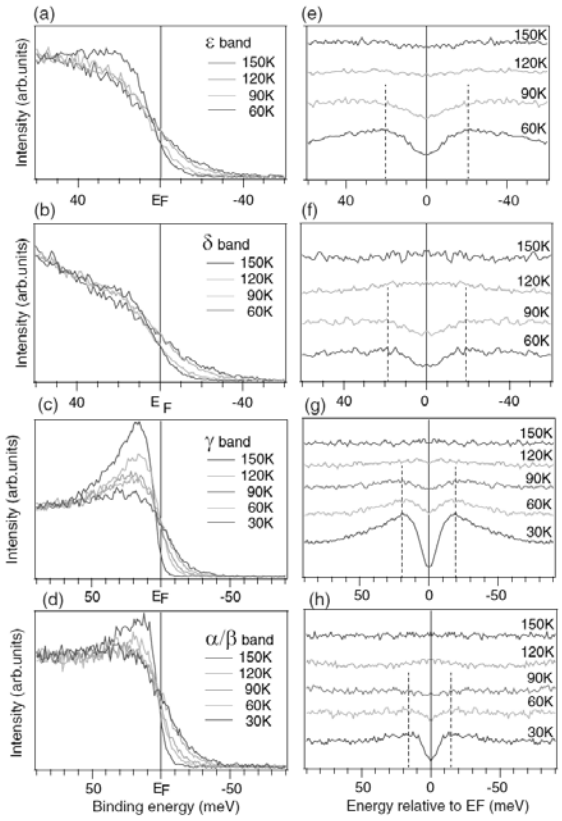

Fig. 1. (a-d) *T*-dependence of the EDCs for x = 0.30 measured at k_F of the ε band, δ band, γ band and α/β band, respectively. (e-h) The EDCs in (a-d) symmetrized with respect to E_F and further normalized by the smoothed EDC at 150 K, respectively. Broken lines indicate the PG energy.

4 References

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5 Production

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