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Three-dimensional electronic structure of iron pnictides observed by angle-resolved photoemission spectroscopy

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Introduction

In order to understand the occurrence of superconductivity in iron pnictides, many aspects of their electronic structure are still to be uncovered, and angle-resolved photoemission spectroscopy (ARPES) is a powerful technique for this purpose. In this work, we have performed an ARPES study on the parent compound $BaFe_2As_2$ and the Co-doped superconducting compound $BaFe_{1.86}Co_{0.14}As_2$ (Ba122).

Results and discussion

The ARPES intensity plot in energy-momentum (E-k) space along cuts 1 (across Γ) and 2 (across X) for Ba122 taken at hν = 60 eV are shown, respectively, in panels (a) and (b) of Fig. 1. In the figure, $k_{//}$ denotes momenta along cut 1 or cut 2. Panel (a) shows hole-like bands crossing E_F and giving rise to the hole-like Fermi surfaces (FSs) around Γ. This is consistent with previous ARPES reports on these compounds [1]. However, a tiny structure having the features of an electron pocket is observed around Γ in this case. We have also investigated the possible three-dimensionality in the electronic structure (k_z dependence) predicted by most of the band-structure calculations on iron pnictides, in particular on 122 compounds [2]. From the photon-dependent ARPES data we have observed that the band dispersions and FSs around the BZ center strongly depend on the photon energy as can be seen by comparing panels (a) and (c) in Fig. 1. However, the ARPES data taken at the BZ corner (X point) suggest weak photon energy dependence as can be seen by comparing panels (b) and (d) of Fig. 1. The FS image plots at BZ center and corner are shown, respectively, in panels (e) and (f) of Fig. 1. It is clear that the FS at BZ center shows strong modulation along the k_z direction which suggests the three-dimensionality in the electronic structure as predicted by the band-structure calculations. However, the FS at BZ corner shows much weaker three-dimensionality. We have observed similar behavior in the Co-doped superconducting compound $BaFe_{1.86}Co_{0.14}As_2$ (not shown here). These observations suggest that the antiferromagnetism and superconductivity (SC) in the pnictides may have to be considered including the orbital-dependent 3D electronic structure, where FS nesting is not necessarily strong.

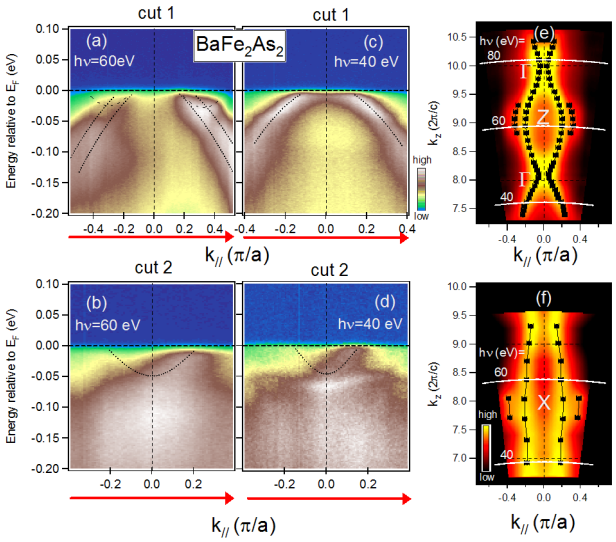

Fig. 1. ARPES E-k intensity maps for $BaFe_2As_2$ taken at T=10 K. (a), (c): Along cut 1 (across Γ). (b), (d): Along cut 2 (across X). The photon energies are indicated inside each panel. The black curves are guides to the eye. (e), (f): Fermi surface images of $BaFe_2As_2$ in the $k_{//}$-k_z plane obtained from the hν-dependent ARPES data taken, respectively, along cuts 1 and 2. Both inner and outer black dots represent the k_F values determined from MDC peak positions at E_F.

References

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