28A/2009S2-005

Angle-resolved photoemission study of $PrFeAsO_{0.7}$

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Introduction

In order to understand the mechanism of superconductivity in the recently discovered iron-based superconductors [1], it is necessary to clarify their electronic structures. Angle-resolved photoemission spectroscopy (ARPES) is a powerful technique for this purpose. While the 122 system has been extensively investigated by ARPES, few results have been reported for the 1111 system so far [2, 3, 4, 5, 6]. Because the 1111 system has a higher superconducting temperature (T_c) than that of the 122 system, the electronic structure of the 1111 system may have a clue for understanding the superconductivity in the iron-based superconductors. Therefore, ARPES study of the 1111 system has been strongly desired.

In this work, we have performed a high-resolution ARPES study of $PrFeAsO_{0.7}$ and investigated Fermi surfaces (FS's) and the temperature dependence of energy gaps.

Experimental condition

High-quality single crystals of the electron-doped compound $PrFeAsO_{0.7}$ (T_c =42 K) were synthesized by a high-pressure method as described in Ref. [7]. The ARPES measurements were carried out at BL-28A of Photon Factory (PF) using incident photons of $h\nu$ = 42.5, 80 eV circularly-polarized. A SCIENTA SES-2002 analyzer was used with the total energy resolution of 15 meV and momentum resolution of ~ 0.02 =(π/a), where a = 4.0 Å is the in-plane lattice constant. The crystals were cleaved *in situ* at T = 20 K in an ultra-high vacuum better than 1 $\times 10^{-10}$ Torr giving flat mirror-like surfaces which stayed clean all over our measuring time (~2 days).

Result and Discussion

Figure 1 (a) shows the result of FS mapping for the $PrFeAsO_{0.7}$ sample at low temperature (~20 K) using photon energy $h\nu$ = 80 eV. In this plot, the photoemission intensity has been integrated over $E_F \pm 5$ meV. One can clearly observe a large nealy circular hole pocket with k_F ~ 0.6(π/a) and a small nearly circular hole pocket with k_F ~ 0.3(π/a) centered at the point of the two-dimensional Brillouin zone. The large size of the hole pocket has been reported by the previous ARPES studies for the 1111 iron-based superconductors [2, 3, 4, 5, 6] and relects heavily hole-doped electronic states. This occurs because the cleaved surface in the 1111 iron pnictides is electronically polar and electronic charges must reconstract after cleaving.

Figure 1 (b) shows temperature dependence of the symmetrized energy distribution curves (EDC's) at Fermi momenta (k_F 's) indicated in (a). One can clearly see energy gaps at low temperature and the size of the gaps is 15 meV. While the peak feature disappears with increasing temperature, suppression of the spectra at E = 0 meV still remains far above T_c. Thus, pseudogap-like behavior of the energy gaps has been observed. The observed energy gaps seem not to be superconducting gaps because they do not completely close above T_c. The origin of the gaps can be ordered states which come from remnant of spin density wave or superconducting fluctuation. In order to conclude about this issue, further investigation is required.

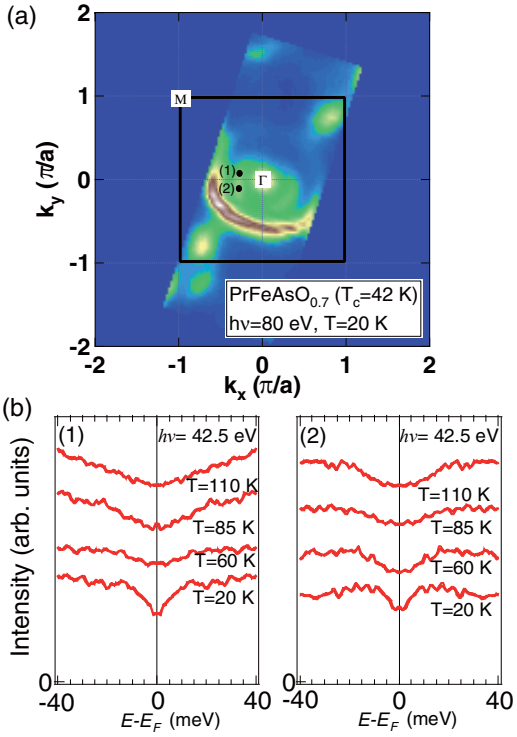

Fig. 1 Temperature dependence of energy gaps in $PrFeAsO_{0.7}$. (a) Fermi surface mapping taken at $h\nu$ = 80 eV. (b) Symmetrized EDC's at k_F 's indicated in (a).

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