28A/2006S2-001

Angle-resolved photoemission study of $Bi_2Sr_{1.6}Ln_{0.4}CuO_6$ (*Ln*=La, Gd) with controlled out-of-plane disorder

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In high-T_c cuprates, the effects of impurity or disorder have been widely discussed. The effects of Zn or Ni substitution in the CuO_2 plane have been studied by angle-resolved photoemission spectroscopy (ARPES) and the electronic structural change caused by the impurities has been revealed [1, 2]. Recently, in addition to the in-plane disorder, the importance of out-of-plane disorder has been pointed out [3, 4]. The out-of-plane disorder reduces T_c as in the case of in-plane disorder. We have performed ARPES study of $Bi_2Sr_{1.6}Ln_{0.4}CuO_{6+d}$ (*Ln*-Bi2201, *Ln* = La, Gd) with controlled out-of-plane disorder, where Gd-Bi2201 is much disordered than La-Bi2201, to reveal the effects of the disorder on the electronic structure.

The measured samples were optimally doped La-Bi2201 (T_c = 34 K) and Gd-Bi2201 (T_c = 13 K), which were prepared by the traveling solvent floating zone (TSFZ) method [3]. The ARPES measurements were performed at BL28A equipped with a SCIENTA SES2002 analyzer and a 5-axis *i*-gonio manipulator [5]. The photon energy was 50 eV. The total energy and angular resolution were set at ~15 meV and 0.3 degree, respectively. The measurement temperature was ~9 K. The samples were cleaved *in-situ* to obtain clean surfaces.

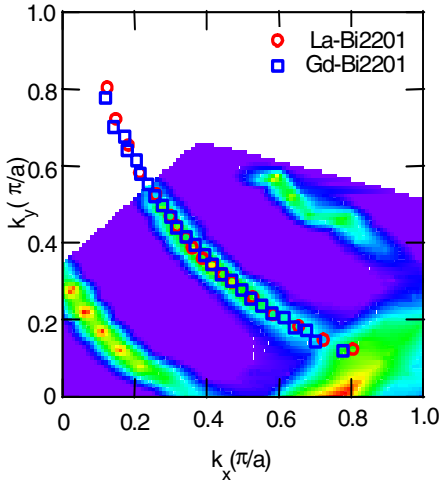

Fig. 1: *k*-space intensity plot of La-Bi2201. The open red circles and open blue squares show the Fermi surfaces of La-Bi2212 and Gd-Bi2212 determined from the MDC peak positions.

Figure 1 shows the *k*-space intensity plot for 20 meV around E_F for La-Bi2201. The circles and the squares in the figure shows the Fermi surfaces determined from the MDC (momentum distribution curve) for La- and Gd-Bi2201, respectively. The shapes of the Fermi surface did not change with disorder, which means the hole concentration is exactly the same and suggest that the next-nearest-hopping integral *t*' did not change with disorder.

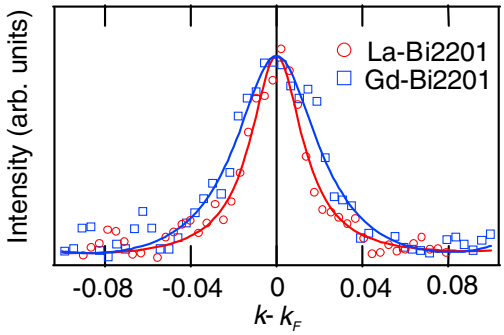

Fig. 2: MDC width along the nodal direction. The open circles are for La-Bi2201 and the open squares are for Gd-Bi2201.

Figure 2 shows the MDC at E_F along the nodal (0, 0)-(π, π) direction for La- and Gd-Bi2201. One can see the width of the MDC (Δ_k) becomes larger with increasing disorder, which is due to the increase of the scattering of carriers by the disorder and is consistent with the results of the in-plane residual resistivity. The results suggest that the scattering in the nodal direction plays an important role in the depression of T_c.

References

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