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Fermi Surfaces and Kink in the Energy Dispersions of Sr_2RuO_4

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Introduction

The sudden change of the group velocity, so-called the "kink", of the dispersing peak in angle-resolved photoemission spectroscopy (ARPES) spectra is widely reported in the high-temperature superconducting cuprates. Nevertheless, the interpretations of the kink for the cuprates have been controversial. In previous works, electronic coupling to a bosonic mode such as phonons or magnetic excitations has been discussed as the origin. Recently, we have found a similar kink in the dispersion of the layered perovskite strontium ruthenates [1]. This means that the kink is not peculiar to the cuprates. The layered strontium ruthenates with perovskite-based crystal structure are isostructural to the cuprates, while the electronic and magnetic properties are quite different. The electronic structure close to the Fermi level (E_F) of the layered ruthenates is derived not only from the in-plane Ru $4d_{xy}$–O $2p$ band but also from the out-of-plane Ru $4d_{yz,zx}$–O $2p$ ones, while for the cuprates a single in-plane Cu $3d_{x^2-y^2}$–O $2p$ band plays a crucial role. Therefore, ARPES study on the layered ruthenates is expected to provide insight into the origin of the kink in transition metal oxides.

Experimental

The present measurements were carried out at a new high-resolution and high-flux undulator beamline (BL-28) of the Photon Factory (KEK, Tsukuba). The sample goniometer used here provides independent polar and tilt rotations of the sample (R-Dec Co. Ltd., *i* GONIO LT) [2]. The beamline is equipped with a high-resolution, hemispherical electron analyzer (Gammadata-Scienta, SES-2002). In order to obtain clean surfaces without the replica of Fermi surface's in the bulk due to the surface rotation, we cleaved the single crystalline Sr_2RuO_4 samples *in situ* in ultrahigh vacuum at 160 K.

Results and Discussion

In order to elucidate the origin of the kink, we measured ARPES spectra of Sr_2RuO_4 along the high symmetry lines _M and MX. Figure.1 (c) shows the Fermi surfaces of Sr_2RuO_4. Since the Fermi surfaces are qualitatively consistent with the LDA band prediction (white lines) and the previous ARPES measurement, we judged that the sample quality is enough reliable to investigate the detailed band dispersions. Figures 1 (a) and (b) show the intensity plots along (0, 0)-(0, π) and (π, 0)-(π, π), respectively. The measured momentum area (black thick lines) is shown in Fig. 1 (c). A kink in the dispersion is clearly observed for the γ band, while not for the α and β bands. The result will play a key role for understanding the origin of the kink.

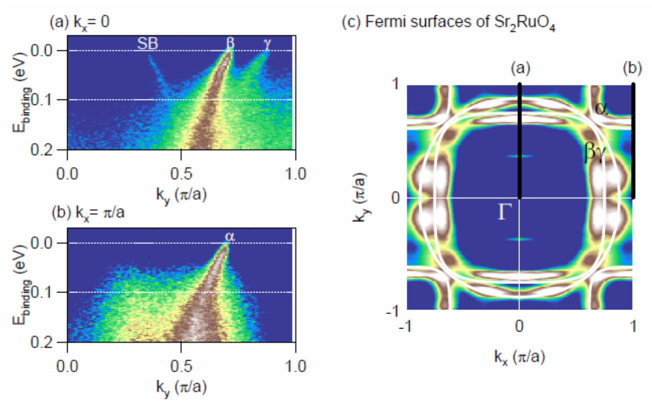

FIG. 1 (a) and (b) Intensity plots along (0, 0)-(0, π) and (0, π)-(π, π), respectively. (c) E_F intensity map. The measured momentum area in (a) and (b) are shown by the black thick lines. The white lines mean the Fermi surfaces based on the LDA calculation. All spectra were taken at a photon energy of 65 eV and at 30 K.

References

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