28A, 2C/2008S2-003

Electronic structure of $SrVO_3$ thin films under epitaxial strain studied by angle-resolved photoemission spectroscopy

Shin-ichi AIZAKI[1], Kohei YOSHIMATSU[2], Teppei YOSHIDA[1*], Masaru TAKIZAWA[1], Makoto MINOHARA[2], Shin-ichiro IDETA[1], Kapil GUPTA[4], Priya MAHADEVAN[4], Koji HORIBA[2,3], Hiroshi KUMIGASHIRA[2,3], Masaharu OSHIMA[2,3] and Atsushi FUJIMORI[1]
[1]Department of Physics, The University of Tokyo, Tokyo 113-0033, Japan
[2]Deptartment of Applied Chemistry, The University of Tokyo, Tokyo 113-0033, Japan
[3]JST-CREST, Tokyo 102-0075, Japan
[4]S. N. Bose National Centre for Basic Sciences, Kolkata 700-098, India

Introduction

Pressure is an important parameter to control the physical properties of solids, especially of strongly correlated systems. Angle-resolved photoemission spectroscopy (ARPES) is one of the most powerful methods to study the electronic structure of solid, but unfortunately it is not possible to carry out ARPES measurements at high pressure. However, by epitaxially growing thin films grown on single crystalline substrates, one can effectively apply (anisotropic) high pressure through strain from the substrates and perform photoemission measurements under the high pressure. As for the high-T_c cuprates, Abrecht *et al.* [1] performed an *in situ* ARPES study of $La_{2-x}Sr_xCuO_4$ thin films with in-plane compressive strain, and found that the bandwidth increases and that the topology of the Fermi surface changed from that of unstrained bulk samples.

Recently, Takizawa *et al.* [2] fabricated perovskite-type $SrVO_3$ thin films having atomically flat surfaces using the pulsed laser deposition (PLD) technique and studied its electronic structure by *in situ* ARPES measurements. Clear band dispersions not only in the coherent quasi-particle part but also in the incoherent part were observed. In the present work, the electronic structures of $SrVO_3$ thin films epitaxially grown on $SrTiO_3$ (001) substrates have been studied by ARPES. With improved energy and momentum resolution, much more details of the band dispersions in the coherent part have been revealed.

Experimental condition

Epitaxial thin films of $SrVO_3$ were grown on single-crystal substrates of Nb-doped $SrTiO_3$ by the PLD method. ARPES experiments were carried out using a SES-2002 at BL-28A. We used circularly- polarized beam with hν = 66 eV. Electron momentum is expressed in units of π/a, where a = 3.905 Å is the in-plane lattice constant of the $SrVO_3$ thin film, which is identical to that of the $SrTiO_3$ substrate.

Result and Discussion

In Fig. 1, we compare the results of LDA band-structure calculation and the k_x-k_y plane cross section of the d_{xy} FS observed by ARPES for $SrVO_3$ bulk [3] and thin film. The slight tetragonal distortion (c/a ~ 0.978) is taken into account in the band-structure calculation for the thin film shown in Fig. 1(b). In the case of bulk $SrVO_3$, the shape of the observed d_{xy} FS well agrees with the result of LDA band-structure calculation. On the other hand, the experimental d_{xy} FS for thin film is significantly larger than the LDA result. In Fig. 1(c), the tight-binding fitted FSs for bulk and thin film $SrVO_3$ are compared. In Fig. 1(d), the FSs calculated using the LDA for bulk, thin film and thin film with extra ~ 30 % electrons are compared. The present result shows that the d_{xy} FS for thin film is enlarged compared to bulk by ~ 30 %. This indicates electronic charge redistribution in the surface region.

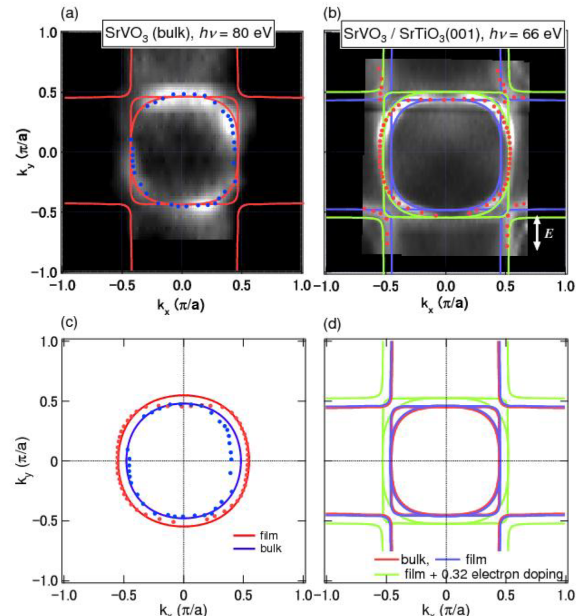

Figure 1: Comparison of ARPES results and band-structure calculation results for bulk [3] and thin film $SrVO_3$. (a) Bulk d_{xy} FS. (b) Thin film d_{xy} FS. k_F points determined by the MDC peak position at E_F are shown by dots. FS obtained by band structure calculations are shown by solid curves.

References

[1] M. Abrecht et al., Phys. Rev. Lett. **91**, 057002 (2003).
[2] M. Takizawa *et al.*, Phys. Rev. B **80**, 235104 (2009).
[3] T. Yoshida *et al.*, arXiv:1003.2269.

* yoshida@wyvern.phys.s.u-tokyo.ac.jp