Electron Correlation Energy near the Mott Transition of $La_xSr_{1-x}TiO_3$ by Soft-X-ray Emission Spectroscopy

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Introduction

$La_xSr_{1-x}TiO_3$ with perovskite structure is derived from changing the band filling in strongly correlated metal on the verge of Mott transition. The effective mass deduced from the Drude model and the electric specific heat increases with increasing La doping for x>0.5, indicating the effect of the electron correlation energy (U_{dd}) [1-3].

In this study, the electronic structure of $La_xSr_{1-x}TiO_3$ has been investigated by soft-X-ray emission spectroscopy (SXES). At the t_{2g} resonance SXES spectra, the Raman scattering at ~2 eV is attributed to the d-d transition between the occupied Ti 3*d* state and unoccupied Ti 3*d* state [4-5]. The purpose of this measurement is to determine directly the magnitude of the U_{dd} through the study of *d-d* transition.

Experimental

SXES spectra were measured using a soft-X-ray spectrometer installed at the undulator beamline BL-2C in Photon Factory. Synchrotron radiation was monochromatized using a varied-line spacing plain grating whose average groove density is 1000 lines/mm. The spectra were measured at depolarized configuration. The energy resolution was smaller than 0.4 eV at *hv*=450 eV.

Result and Discussion

Figure 1 shows the SXES spectra as a function of La doping at the t_{2g} resonance of Ti in $La_xSr_{1-x}TiO_3$ (x=0.05, 0.10) and $SrTiO_{3-\delta}$, where the abscissa is the Raman shift that is energy shift from the elastic scattering. Comparing each spectrum, we can find that the intensities of the elastic peak as well as the @ peak increase with increasing La. In the optical conductivity spectra [2], the intensity at E_F increases with increasing La, indicating the Drude photoresponse. The increasing of intensity at Raman shift=0 eV indicates the Drude peak overlapping with elastic peak. On the other hand, the photoemission spectra show two features at 1.5 eV and E_F within the band gap below E_F that are attributed to the Ti 3*d* states. In the case of t_{2g} band, there is typically no large-band splitting and so the contribution to the Raman scattering is due to the electron correlation energy (U_{dd}/2). From the previous information, we suggest that the Raman scattering near ~2.2 eV corresponds to the transition between the coherent and the incoherent bands. This is in a good agreement with the result estimated from the analysis of Ti 2*p* core level photoemission spectra. The @ peak dos not shift much by doping. On the other hand, the U_{dd} does not depend on La doping in this small doping region. This fact reflects the results of the effective mass and the specific heat [1].

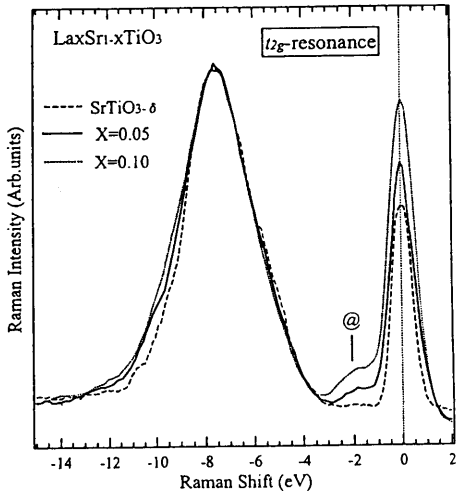

Fig. 1 Comparison of the t_{2g} resonance SXES spectra of $La_xSr_{1-x}TiO_3$ (x=0.05, 0.10) and $SrTiO_{3-\delta}$.

References

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