Electronic Structure Analysis of $SrTiO_3$ with Different Surface States

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$SrTiO_3$ (STO) is a transition metal oxide with a perovskite structure that has attracted attention as a substrate for organic transistors (OFETs) due to its high dielectric constant, surface electronic state, and insulating properties. Controlling carrier transport properties is important to improve the performance of OFETs, but it is difficult to control the surface electronic state. Therefore, in this study, ultraviolet photoelectron spectroscopy (UPS) and X-ray absorption fine structure (XAFS) measurements were performed to address the electronic structure of STO for different surface states.

Experiments were performed at BL-8 of SR Center, Ritsumeikan University. STO(100) substrates with 0.05 wt.% Nb and mirror-finished on one side were used. The STO substrate was introduced into an ultra-high vacuum chamber and annealed at 800°C for 10 min. A new untreated STO substrate was prepared and sputtered with He^+ for 30 min at an acceleration voltage of 0.5 kV and filament emission current of 20 mA. UPS and XAFS measurements were performed on the substrates.

Figure 1 shows the O *K*-edge XAFS spectra of STO. The peaks near 529 eV and 534eV are derived from O-Ti and O-Sr, respectively. The decrease in these peak intensities after He^+ sputtering is thought to be due to the modification of surface crystal structure.

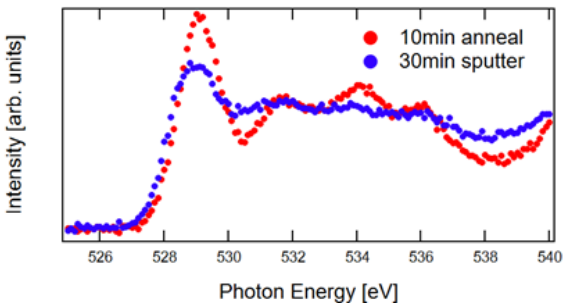

Fig. 1 O *K*-edge XAFS spectra of STO.

Figure 2 shows the UPS valence band spectra of STO with different surface states. According to a previous study, a Ti 3*d* derived peak was observed around 1 eV after high-temperature annealing above 200 °C [1]. Similar peaks were also observed after Ar^+ sputtering [2]. However, no new structure around 1 eV [Fig. 2(ii)] was observed in the present results, suggesting that insulating STO surface can be obtained. Note that the O 2*p* band around 3-8 eV [Fig. 2(i)] is not clearly resolved after He^+ sputtering. This is thought to be due to the modification of surface crystal structure, which is consistent with XAFS result.

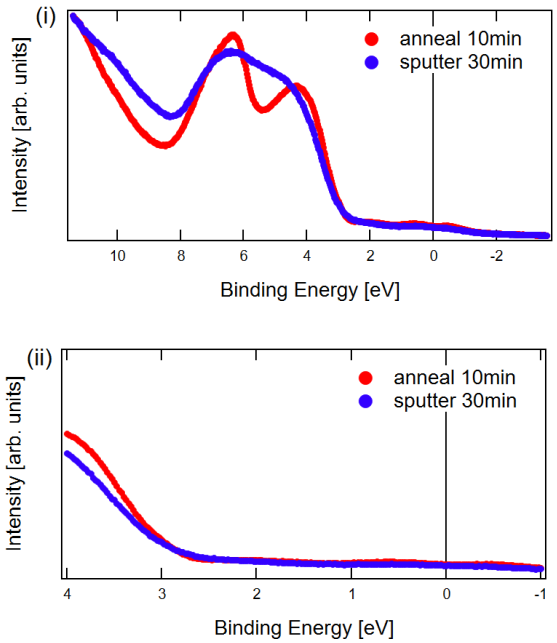

Fig. 2 UPS spectra of STO. (i) valence band and (ii) near the Fermi level.

References

[1] T. Yagi, Master thesis (2020).
[2] B. Psiuk *et al.*, Vacuum **131**, 14 (2016).