Al *L*-edge Study of Aluminum and Aluminum Oxide

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Aluminum, the most abundant metal in the Earth's crust, is widely utilized alongside its oxide counterpart, alumina [1, 2]. Given aluminum's propensity to react readily with oxygen, elucidating the mechanism by which aluminum transforms into alumina becomes crucial. In this study, we investigated the Al *L*-edge absorption spectroscopy and valence band states of aluminum exposed to an oxygen environment using X-ray absorption spectroscopy (XAS) and photoelectron spectroscopy (PES) at BL-7 of the SR Center.

The aluminum sample used in this study was a 0.50 × 10.0 × 10.0 mm polycrystalline aluminum plate with a purity of 99.999% (Nilaco). Prior to each experiment, the surface impurities of the aluminum were cleaned using the Ar^+ sputtering method (20 mA, 1 kV, $P_{Ar} \sim 6.5\text{-}7.0 \times 10^{-3}$ Pa) . Subsequently, the Al *L*-edge absorption spectra and valence band spectra for the cleaned sample were measured. Next, we gradually introduced oxygen into the analysis chamber, defining the exposure levels for this experiment in terms of Langmuir (1.3×10^{-4} Pa × 1 s = 1 L). We conducted two separate introductions: one at 10 L and another at 100 L. The Al *L*-edge absorption spectra and valence band spectra were measured for both sets of experiments.

The results shown in Fig. 1 depict the Al *L*-edge of aluminum after Ar^+ sputtering and 30 minutes after oxygen introduction for each experiment. Furthermore, Fig. 1 shows an increase in intensity at the photon energy of 76 eV concurrently with the formation of alumina.

Figure 2 shows the valence band spectra of aluminum after Ar^+ sputtering and 30 minutes after oxygen introduction for each experiment. It can be observed that the intensity of the Fermi level significantly decreased after the introduction of oxygen, as evident from the spectrum after sputtering. This led to the inference that alumina was formed.

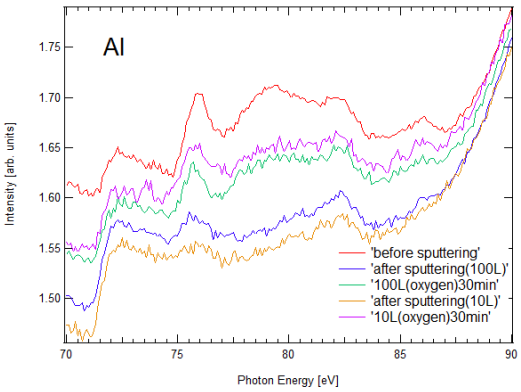

Fig. 1 Spectra of aluminum *L*-edge after Ar^+ sputtering and 30 minutes after oxygen introduction for each experiment.

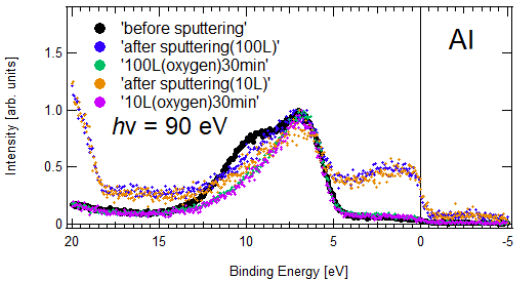

Fig. 2 Valence band spectra of aluminum obtained after Ar^+ sputtering and 30 minutes after oxygen introduction for each experiment.

References

[1] T.L. Duan, *et al*., Appl. Phys. Lett., **2013**, *102*, 201604.
[2] J. Cañas, *et al*., Appl. Surf. Sci. **2021**, *535*, 146301.