Chemical State Change of Pt(111) under Different Cleaning Condition

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Noble metal catalysts such as Pt, which accelerate CO oxidation reaction, are widely used in exhaust gas purification catalysts for automobiles and other vehicles. In our previous research [1-3], we had been studying Cu-Pt alloys, which have been attracting attention as an alternative material. It is extremely important to first confirm the exact chemical state change of Pt(111) in order to proceed with the research on alternative materials, which has been done in previous studies [1-3]. In this study, changes in different surface cleaning conditions using Ar^+ sputtering and annealing were measured by synchrotron radiation photoelectron spectroscopy.

The measurements were performed at synchrotron radiation photoelectron spectroscopy (PES) beamline BL-7 of the SR Center, Ritsumeikan University. Ar^+ sputtering was performed for 1 hour at an acceleration voltage of 1 kV and a partial pressure of Ar of 6.5 × 10^{-3} Pa. Annealing was performed by gradually increasing the temperature, holding at 800 °C for 5 minutes, and then gradually decreasing the temperature for a total of 30 minutes. The PES spectra were obtained by using a hemispherical electron energy analyzer, SCIENTA SES2002. The energy resolution was set to be ~200 meV. The measurements were performed at room temperature under the UHV of ~3×10^{-8} Pa.

Figure 1 shows the chemical state change after Ar^+ sputtering. The peaks around the binding energies of 9 eV and 12 eV in the untreated state are clearly reduced after Ar^+ sputtering and the bonds with oxygen and other elements adsorbed on the surface have been released, resulting in a decrease in binding energy of Pt 4*f* and an increase in the surface component of Pt 4*f* at lower binding energy side.

Figure 2 shows the chemical state change after annealing. The peaks around the binding energies of 20 eV and 25 eV appear due to CO-based gases on the surface. The peak intensities are clearly reduced after repeated annealing. Although it was not possible to completely remove CO-based adsorbates, repeated annealing suggested that they could be removed.

References

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[3] Momoko Yoshimi, Kazuma Ide, Takeru Yagi, Kei Mitsuhara, and Masaru Takizawa, *MEMOIRS OF THE SR CENTER RITSUMEIKAN UNIVERSITY*, *2020*, **22**, 36.

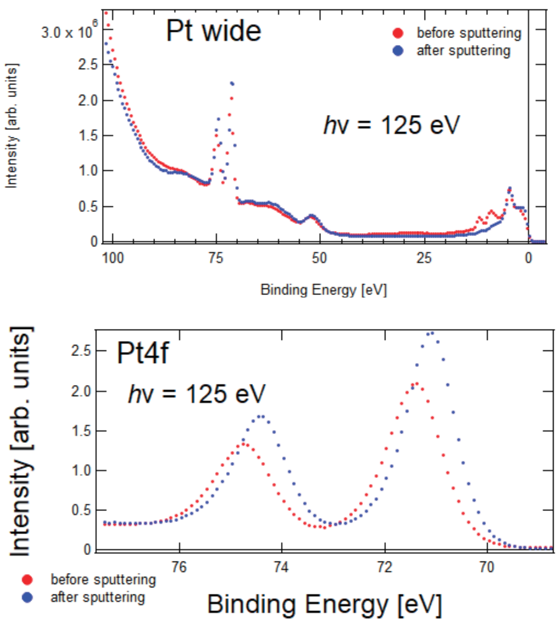

Fig. 1 PES spectra (wide region and Pr 4*f*) of Pt(111) before and after Ar+ sputtering.

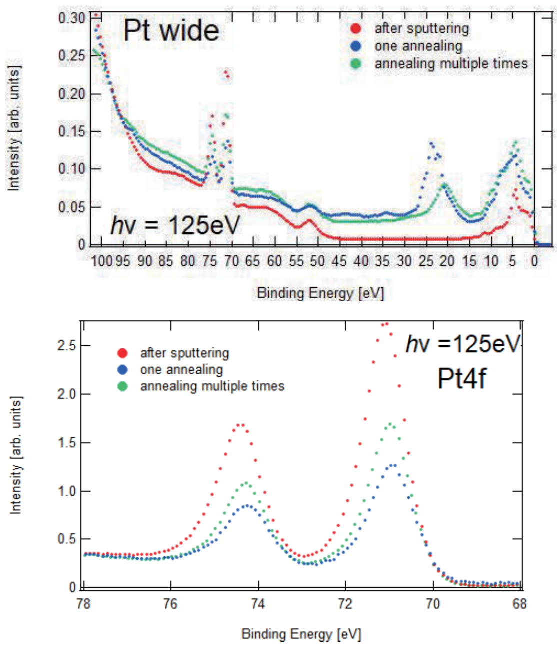

Fig. 2 PES spectra (wide region and Pr 4*f*) of Pt(111) before and after annealing.