Electronic State Analysis of Pt and Cu_3Pt under O_2 and CO Exposure

Muneaki Tani and Masaru Takizawa
Department of Physical Sciences, Faculty of Science and Engineering, Ritsumeikan University, 1-1-1 Noji-Higashi, Kusatsu 525-8577, Japan

Precious metal catalysts, such as Pt, which accelerate the CO oxidation reaction, are widely employed in exhaust gas purification catalysts for automobiles and other vehicles. In our previous research [1], we focused on studying Cu-Pt alloys, which have gained attention as an alternative material. To advance our investigation into alternative materials, it is critical to compare the precise electronic state changes of Pt and Cu_3Pt. In this study, we conducted surface cleaning using Ar^+ sputtering. Subsequently, we examined the electronic state changes upon exposing the cleaned surfaces to O_2 and CO, utilizing synchrotron radiation spectroscopy.

The measurements were performed at synchrotron radiation photoelectron spectroscopy (PES) beamline BL-7 of the SR Center, Ritsumeikan University. To obtain clean and more reactive surfaces, Ar^+ sputtering was conducted for 1 hour at an acceleration voltage of 1 kV and an Ar pressure of 6.5×10^{-3} Pa. 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 $\sim 3\times10^{-8}$ Pa.

Figure 1 shows the chemical state changes after O_2 exposure (0 to 1000 L) to Pt and Cu_3Pt surfaces. Pt 4*f* peak position shifts slightly toward higher binding energy side for Pt surface (red and blue lines), while it does not shift for Cu_3Pt surface, indicating that oxygen preferably binds to Cu rather than Pt.

Figure 2 shows the chemical state changes after CO exposure (0 to 1.0 L) to Pt and Cu_3Pt surfaces. For both surfaces, new electronic state around 72 eV appears, which is a characteristic feature of CO adsorption on top Pt site [2]. Furthermore, Pt 4*f* peak position shifts slightly toward higher binding energy side for Pt surface (red and blue lines), while it does not shift for Cu_3Pt surface, suggesting that the interaction of CO and Pt becomes weakened for Cu_3Pt alloy.

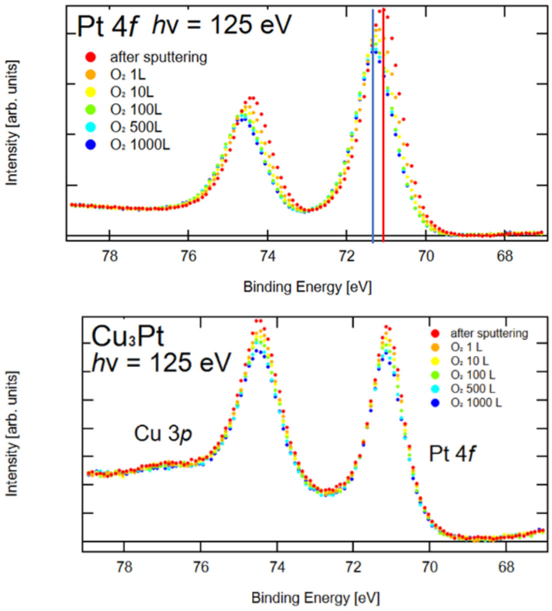

Fig. 1 Pt 4*f* PES spectra of Pt and Cu_3Pt before and after O_2 exposure.

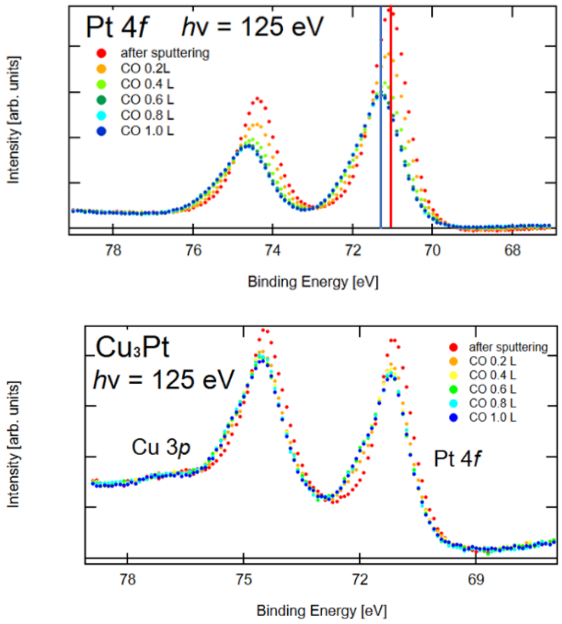

Fig. 2 Pt 4*f* PES spectra of Pt and Cu_3Pt before and after CO exposure.

References

[1] M. Yoshimi, Master thesis (2022).
[2] Ö. Bjorneholm *et al*, Surf. Sci. **315**, L983 (1994).