Chemical State Mapping of Oxidized Cu Plate

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Chemical mapping on solids is an important technology used in various materials researches. Element distribution is typically studied by scanning electron microscopy (SEM) combined with energy dispersive spectroscopy of emitted x-ray. On the other hand, photoemission spectroscopy mapping is also a promising method which can unveil the difference of chemical state of elements in addition to the spatial distribution.

Here, we demonstrate the chemical state mapping at SA-1 of the SR Center at Ritsumeikan University using a scanning soft and hard x-ray photoemission spectroscopy apparatus, PHI Quantes (ULVAC-PHI, Inc.). Both soft x-ray photoemission (SXPES) by Al Kα emission (1486.6 eV) and hard x-ray photoemission (HAXPES) by Cr Kα emission (5414.7 eV) can be performed. As a sample, we chose a copper plate oxidized by flame [1], on which different species of copper oxide are distributed.

Figure 1 show the magnified part of the photo of the sample taken at the introduction chamber of the apparatus. The white square shows the area which was investigated in this study. First, Cu 2p XPS was measured by using bulk sensitive HAXPES at the three points shown by the arrows. The results are shown in Fig. 2, where the colors of the spectra correspond to the colors of the arrows of the measured points shown in Fig. 1. The Cu 2p XPS lineshape at the red arrow is essentially the same with that of Cu^{+} in Cu_2O [2]. On the other hand, the lineshapes at the green and blue arrows are quite similar with that of Cu^{2+} in CuO [2].

Based on the two different spectra, chemical stated mapping has been performed. The result is shown in Fig. 3, where red and green areas show the area where Cu 2p XPS identical to Cu_2O (Cu^{+}) and CuO (Cu^{2+}) was observed. Therefore, we can conclude that chemical state mapping of Cu has been successfully demonstrated.

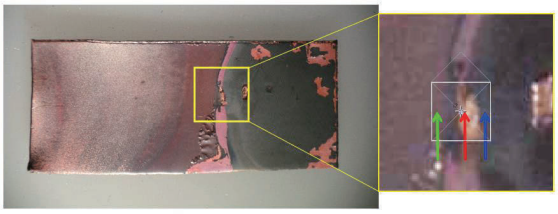

Fig. 1 Analyzed area and points in the photo of the sample. Arrows show the points at which the spectra in Fig. 2 are measured. The white square corresponds to the area which was analyzed in Fig. 3.

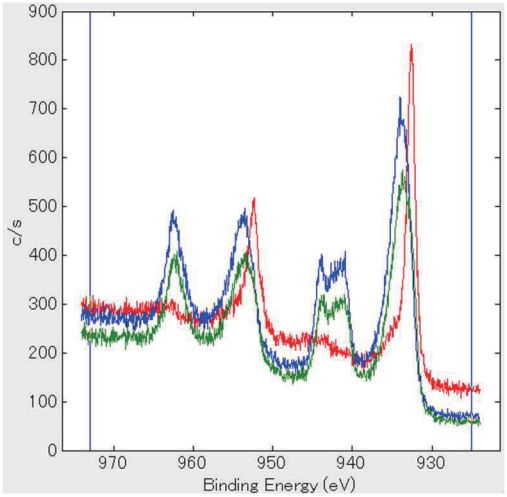

Fig. 2 Cu 2p XPS spectra measured at three points arrowed in Fig. 1. The colors of the spectra correspond to those of arrows.

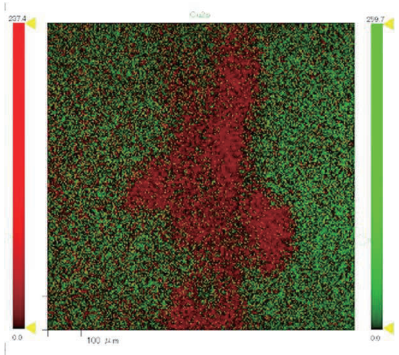

Fig. 3 Chemical state map based on the difference in Cu 2p XPS found in Fig. 2. Red and green areas consist of CuO and Cu_2O, respectively.

References

[1] A. Irizawa, *Journal of JSSRR*, **2021**, *34*, 163.
[2] P Jiang, et al., *J. Chem. Phys.* **2013**, *138*, 024704.