Photoemission study of Cu_2O nano-surface fabricated by hyperthermal O_2 molecular beam

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Dioxygen (O_2) dissociation on transition metal surfaces is of considerable research and practical interest both because many important industrial oxidation processes are heterogeneously catalyzed by transition metals and feature O_2 as the oxidizing agent and because O_2 dissociation is the first step toward the corrosion of various metals. In the present experiments, we have elucidated oxidation processes of Cu(110) surface using O_2 molecular beam with hyperthermal energy of 2.3 eV.

All experiments were performed at the surface reaction analysis apparatus at BL23SU. A Cu (110) sample was cleaned by the repetition of sputtering with Ar^+ ions and annealing at 873 K, until no impurities could be detected by X-ray photoelectron spectroscopy (XPS) and low-energy electron diffraction (LEED) showed a sharp 1×1 pattern with low background. The O-1s photo-emission peak was measured using synchrotron radiation after the exposure of the Cu(110) surface to a proper amount of hyperthermal O_2 molecular beam.

Figure 1 shows the oxygen-uptake curve for the incidence of 2.3- and 0.23-eV O_2 beam on Cu(110) along the surface normal. With increase of O_2 dose, the amount of adsorbed O atoms increases. For the 0.23-eV O_2, the tentative saturation coverage of 0.5 ML is reached at the exposure of the surface to about 6×10^{15} O_2 molecules. A mixed LEED pattern of 2×1 and c(6×2) was observed at that coverage. On the other hand, for the 2.3-eV O_2, the O coverage increases gradually above 0.5 ML with O_2 dose, although the sticking probability is lower in the initial stage of oxidation in comparison with the 0.23-eV O_2. A Cu_2O compound was formed on the surface during the gradual oxidation process for the 2.3-eV O_2, confirmed by the binding-energy shift of O1s. In this stage, a collision-induced oxidation plays an important role [1].

In conclusion, we demonstrated that a hyperthermal O_2 molecular beam is a powerful tool for the fabrication of Cu_2O.

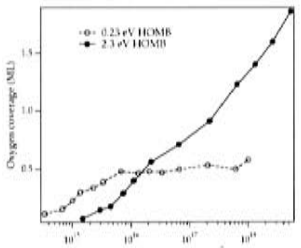

Fig. 1. Oxygen uptake curve

[1] M. Okada et al. *Journal of Chemical Physics*, **119**, 6994 (2003); K. Moritani et al., *Journal of Vacuum Science & Technology A*. (2004) in press.

Measurement for the polarization of light in the use of photoemission diffraction from Si(100) or Ge(100)

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In the soft x-ray region, photon polarization measurement method for any photon energy has not been fully established, because a phase retarder cannot work in whole soft x-ray region. It was investigated that the azimuthal shift of forward focusing peaks in photoelectron angular distribution (PEAD) pattern depends on the photon helicity[1]. The azimuthal shift measurement for the well-known crystal would give the information of the photon helicity.

The well-known Si(100) and Ge(100) crystals were selected as a sample in this experiment. The Si wafer surface was prepared by chemical treatment using hydrofluoric acid, and the Ge wafer surface was prepared by annealing and flashing treatment. The photon energy was set to be 1000eV, and the measured kinetic energy of Ge 3s emission was 820.1eV. The observed PEAD pattern for Ge(100) is shown in Fig. 1. The rectangle is a region around the forward focusing peak caused by the 1st nearest neighbor atom. Then the close-up of the region is measured with changing the ID23 phase, which is shown in Fig. 2. The results for Si(100) are also displayed in the figure. The FWHM of the forward focusing peak of Ge is not remarkably different from that of Si, and the forward focusing peaks moves in the same direction with changing ID phase. The result implies that the electric field of the photon on the sample is rotated in a clockwise direction at positive phase value. In near future, the helicity value will be calculated in the use of a theoretical fitting.

1) H. Daimon, *Phys. Rev. Lett.* **86**, 2034 (2001).

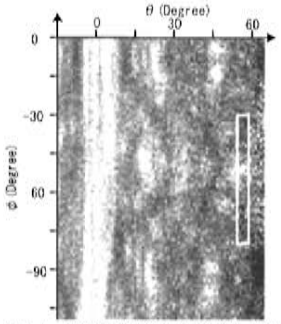

Fig. 1. Measured Photoelectron diffraction pattern of Ge(100). The ID23 gap and phase were set to be 49mm and 38.2mm, respectively. That is a configuration to generate the circularly polarized light. The white rectangle is a measured region for Fig.2.

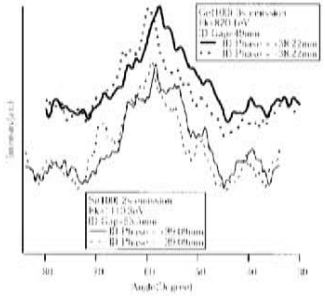

Fig. 2. Measured forward focusing structure of first nearest neighbor with plus phase value of ID phase.