High-resolution retarding field analyzer for photoelectron holography of individual chemical states at surfaces

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Photoelectron holography of individual chemical states (PHICS) is a method for studying non-periodic local structures with multiple chemical states. Recently, PHICS was successfully applied to the structural analysis of As atoms doped in silicon [1]. A concentric hemispherical analyzer (CHA) was used for this study. Our next step is to apply PHICS to local structural studies of surface adsorbates. Unlike studies of dopants in crystals, time-consuming measurements with sample angle scans against a CHA is unfavorable for surface studies, given the time-dependent surface degradation. A display-type photoelectron analyzer with a wide acceptance angle and a high resolving power (E/ΔE) is required. Here, we introduce our wide-angle high-resolution retarding field analyzer (RFA) [2]. This analyzer is installed in an experimental station opened to public use at the soft-x-ray beamline BL25SU of the synchrotron radiation facility SPring-8 in Japan.

RFAs are a traditional type of analyzers widely used for, for example, LEED. However, conventional three-grid RFAs are not satisfactory for PHICS, because their E/ΔE are ~100 and too low to resolve chemical shifts of core-level photoemission spectra. We conducted numerical simulations and found a grid deployment method that can increase the E/ΔE of a three-grid RFA without deteriorating its acceptance angle and angular resolution [2]. Figure 1 shows our RFA currently mounted on the aforementioned station. The acceptance angle in design is ±49°. Figure 2 shows an Au 4f photoemission spectrum measured with a photon energy (hν) of 700 eV, indicating that the E/ΔE is sufficiently high to resolve the spin-orbit splitting. The estimated E/ΔE is 1100, which enables PHICS. Figure 3 shows the result of a test measurement of C 1s photoelectron hologram using single-crystalline graphite. The hν was 900 eV and the band width was 1 eV. A clear hologram pattern was observed. We will explain the method of increasing the E/ΔE and our continuing development for further increase. We will also explain the setup of the experimental station for potential users.

References:

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[2] T. Muro, T. Ohkochi, Y. Kato, Y. Izumi, S. Fukami, H. Fujiwara, and T. Matsushita, Rev. Sci. Instrum. **88**, 123106 (2017).

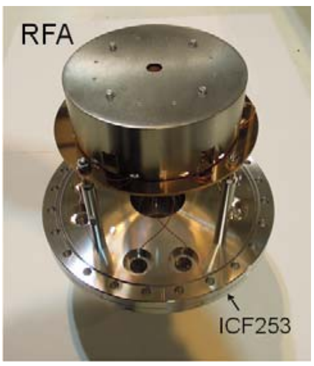

Fig. 1

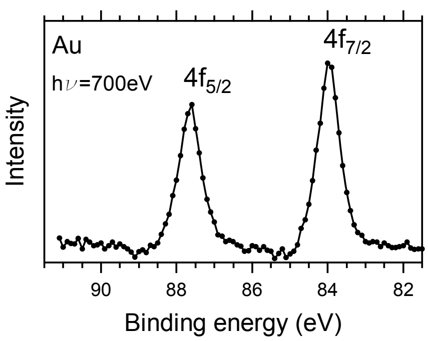

Fig. 2

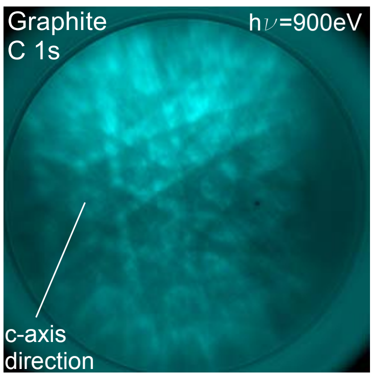

Fig. 3