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Performance of PF BL-13A, a Vacuum Ultraviolet and Soft X-ray Undulator Beamline for Studying Organic Thin Films Adsorbed on Surfaces

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1 Introduction

A vacuum ultraviolet and soft X-ray undulator beamline, BL-13A, is mainly dedicated to the study of organic thin films adsorbed on well-defined surfaces, using angle-resolved photoelectron spectroscopy (ARPES), X-ray photoelectron spectroscopy (XPS), and X-ray absorption spectroscopy (XAS). Details of BL-13A have been described in previous papers [1,2]. In this paper, we report on the present status of the BL-13A and the apparatus for ARPES, XPS, and XAS.

2 Photon-energy resolution and photon intensity

The advantage of the BL-13A is that both high photon-energy resolution and high photon intensity can be achieved simultaneously [1,3]. In the initial stage, the measured photon intensity was one order of magnitude lower than the calculated value [2]. We attributed the reduced photon intensity to the small acceptance angles in the measurements (ca. 0.06 mrad (vertical) × 0.2 mrad (horizontal)) and contamination of the optics. To address this, we increased the acceptance angles to ca. 0.4 mrad (vertical) × 0.27 mrad (horizontal) using a new quadruple mask [4] and we removed the carbon contamination of the optics using oxygen activated by 0th-order synchrotron radiation [5]. To estimate the photon-energy resolution ($E/\Delta E$), we measured the photoionization spectra of rare gasses (He, Ar, and Ne) and nitrogen (N_2) in four different photon-energy regions at about 64.1 eV (He, Fig. 1), 244.4 eV (Ar, Fig. 2), 401.1 eV (N_2, Fig. 3), and 867.1 eV (Ne, Fig. 4). The measured photon-energy resolutions and photon intensities at the ring current of 450 mA are summarized in Fig. 5.

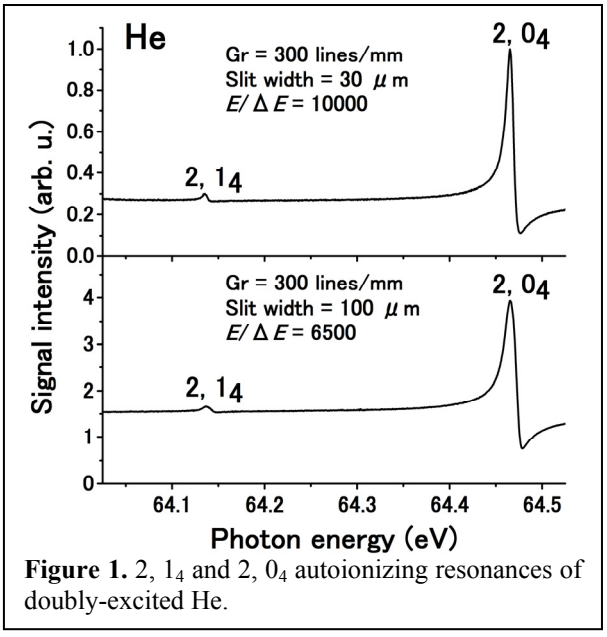

Figure 1. 2, 1_4 and 2, 0_4 autoionizing resonances of doubly-excited He.

3 Apparatus for the study of organic thin films on surfaces using ARPES, XPS, and XAS

Figure 6 shows the apparatus used for the study of organic thin films adsorbed on surfaces using ARPES, XPS, and XAS. The apparatus consists of the main ultrahigh vacuum (UHV) chamber equipped with an

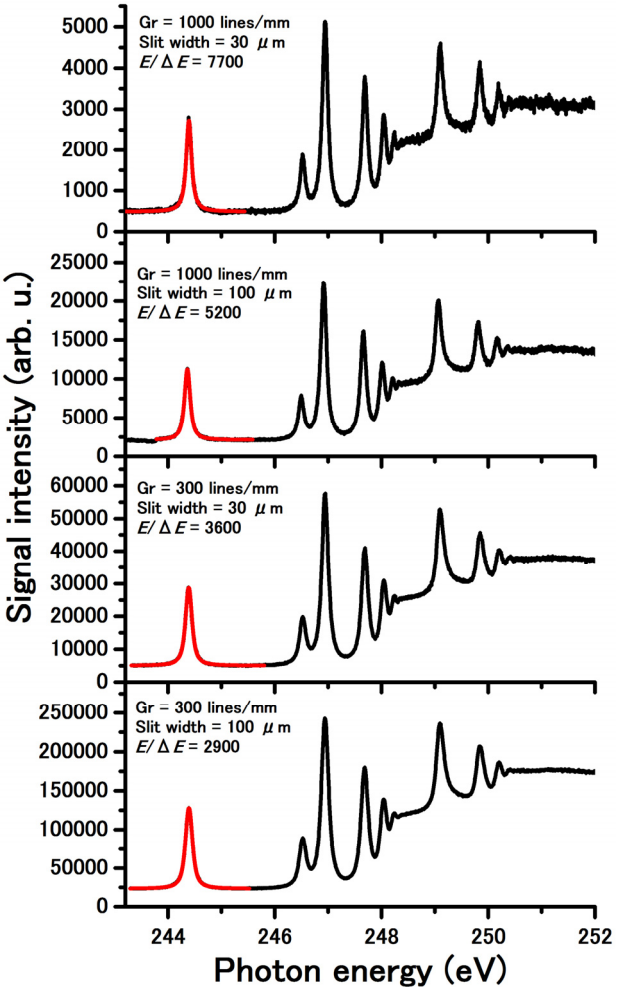

Figure 2. Photoionization spectrum of Ar taken in the region of $2p \rightarrow nl$ Rydberg transition.

electron-energy analyzer (Gamma Data/Scienta, SES200), a sample-preparation UHV chamber, and a UHV chamber for the evaporation of organic materials. The sample can be transferred among UHV chambers with a transfer rod. The sample-holder acceptors in the main and sample-preparation chambers are both equipped with a sample heating and cooling system. To estimate the overall electron-energy resolution, we measured a series of electron spectra in the Fermi region of an evaporated gold film at 5–9 K. The best overall electron-energy resolution was about 12 meV at a photon energy of 30 eV as shown in Fig. 7.

References

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[5] A. Toyoshima *et al.*, J. Synchrotron Rad., in press.

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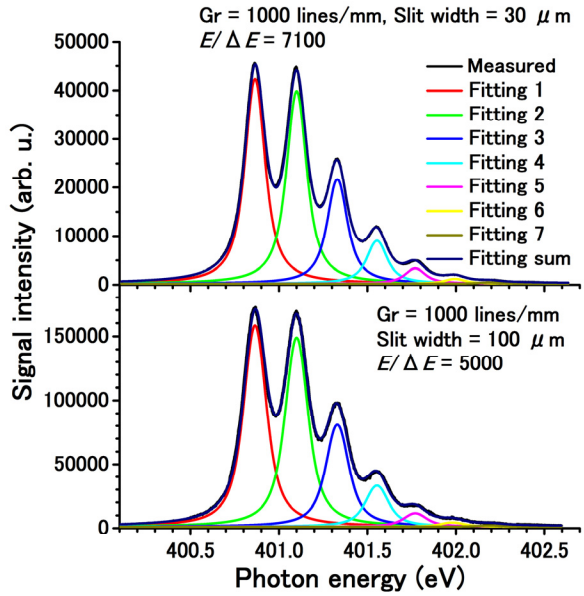

Figure 3. Photoionization spectrum of N_2 taken in the region of $1s \rightarrow \pi^*$ transition.

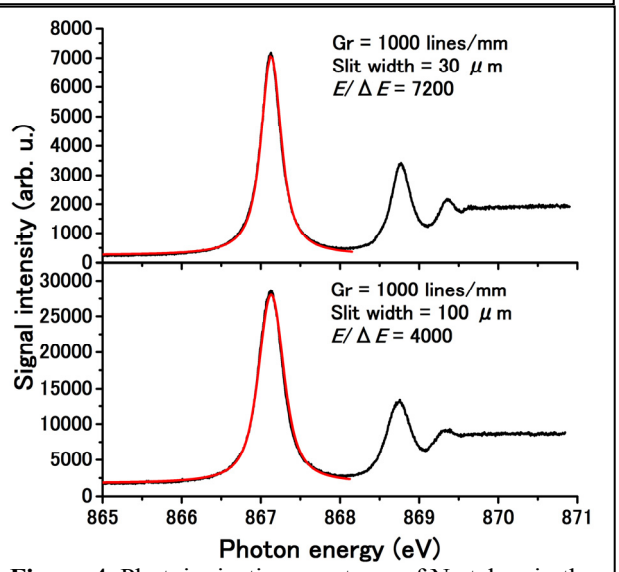

Figure 4. Photoionization spectrum of Ne taken in the region of $1s \rightarrow np$ transition.

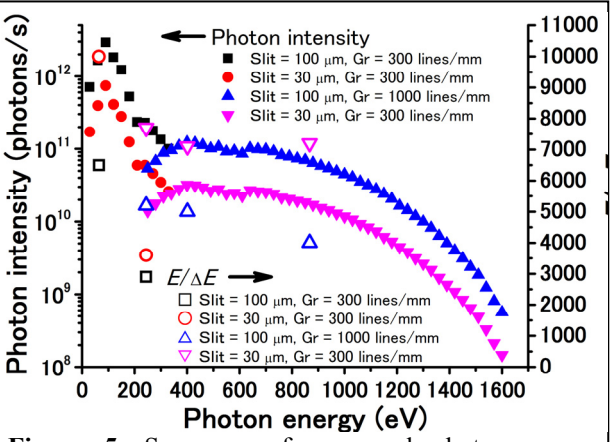

Figure 5. Summary of measured photon-energy resolutions ($E/\Delta E$) and photon intensities when the ring current is 450 mA.

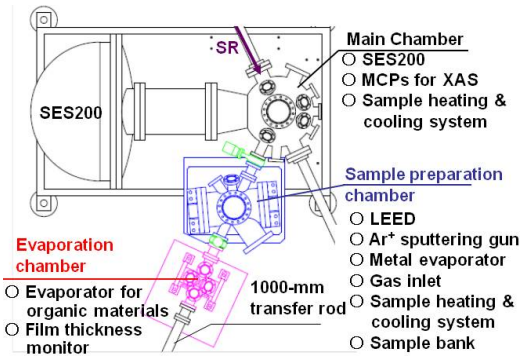

Figure 6. Apparatus for studying organic thin films adsorbed on well-defined surfaces using ARPES, XPS, and XAS.

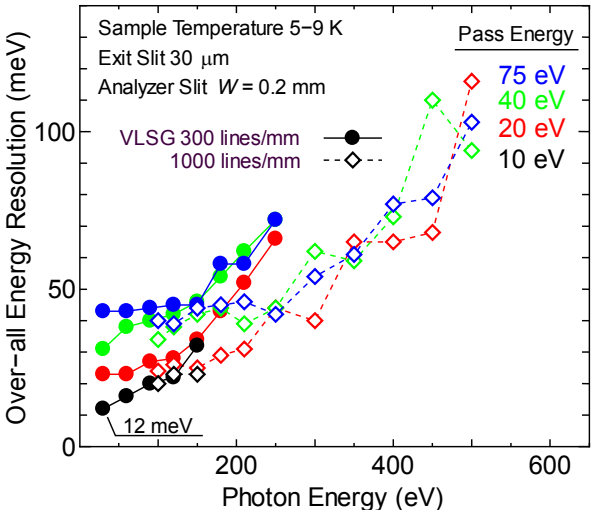

Figure 7. Overall electron-energy resolution as estimated with an electron-energy analyzer and an evaporated gold film at 5–9 K.