BL27SU
Soft X-ray Photochemistry

1. Introduction

BL27SU is a soft X-ray undulator beamline dedicated to soft X-ray spectroscopy and microscopy under normal ambient pressure (helium) or high-vacuum condition. The beamline consists of two branches, B and C. The B-branch provides higher X-ray energies of 2.1–3.3 keV using a Si (111) channel-cut monochromator, and the incident X-ray is focused into a spot of about 10 μm at the sample position using a Kirkpatrick-Baez (KB) mirror [1,2]. This branch is mainly available for elemental and chemical XRF/XAFS mapping and μ-XAFS measurements. The C-branch is equipped with a varied-line-spacing plane grating monochromator (VLP-PGM), upgraded in FY2018 [3], and is available for lower X-ray energies of 0.17–2.2 keV.

In FY2020, a full-field transmission X-ray micro-spectroscopy (TXM-XAS) system was developed and installed at the C-branch.

2. Development of a TXM-XAS system

Micro-spectroscopy methods that combine a high spatial resolution with X-ray absorption spectroscopy (XAS) are powerful tools to provide 2D or 3D information about the distribution of an element, electron density, the chemical (valence) state of an element, symmetry around an X-ray-absorbing atom, and other physicochemical information. The full-field-type X-ray micro-spectroscopy method is one of the micro-spectroscopy methods and has been developed mainly in the hard X-ray region because of the high X-ray transmittance. Compared with the scanning-type method, this method can give a one-shot 2D image to reduce measurement time to obtain 2D XAS imaging data. However, applying the full-field-type method has been challenging because transmissivity is extremely low in the soft X-ray region. Recently, improvements in sample preparation techniques, such as focused ion beam (FIB) systems, have resulted in the fabrication of thin samples for application to the full-field-type method even in the soft X-ray region. Therefore, we report the details of the installation of the TXM-XAS system installed at the C-branch.

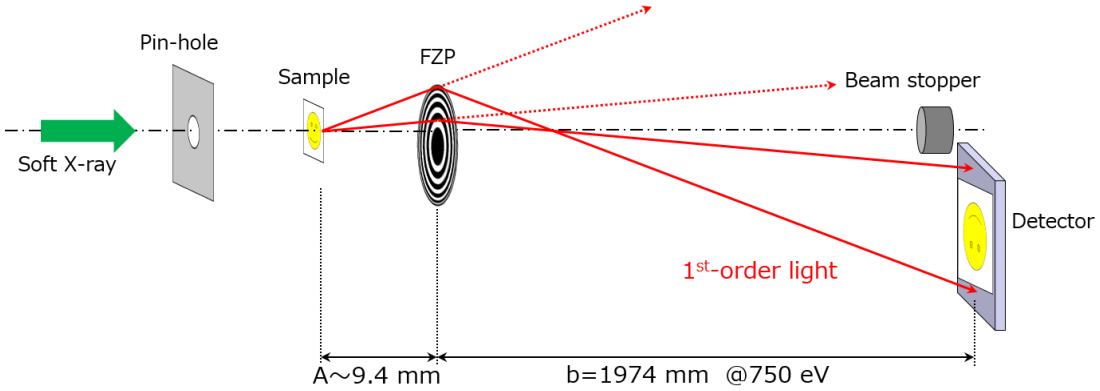

Fig. 1. Schematic view of the TXM-XAS system at BL27SU.

Figure 1 shows a schematic of the TXM-XAS system. The X-rays monochromatized by the VLS-SGM are shaped by pin-hole optics and are irradiated to the sample. Transmitted X-rays from the sample are magnified by the Fresnel zone plate (FZP: NTT-AT C100/155, focal length f = 9.4 mm at 750 eV) and then projected onto the CCD detector with a pixel size of 13 μm. This system's magnification power of about 200 corresponds to an effective pixel size of about 65 nm.

Figure 2 shows the transmission image of a Cu mesh (#1000) taken at the X-ray energy of 750 eV for 20 s. In addition, the horizontal and vertical intensity profiles are extracted at the positions shown by red lines in Figure 2. The spatial resolutions in the horizontal and vertical directions were evaluated as 203 and 128 nm, respectively, from the full width at half maximum (FWHM) for the differential intensity profile. This TXM-XAS system is expected to have a spatial resolution of 100 nm, but the improvements for some problems are necessary in the future and the system will be opened to users soon.

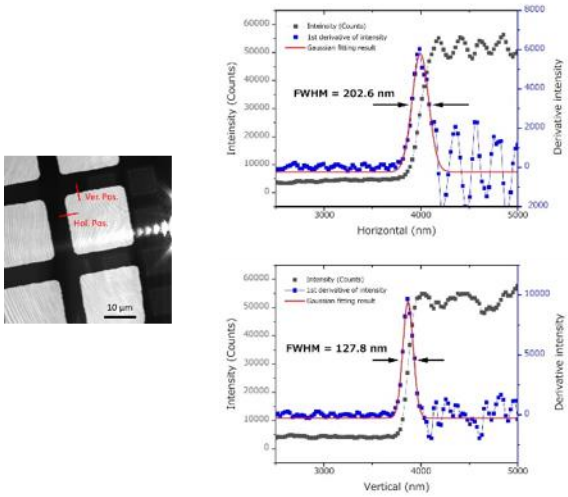

Fig. 2. Transmission image of Cu mesh obtained using the full-field TXM system (left) and horizontal and vertical intensity profiles (right).

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References:

[1] Tamenori, Y. et al. (2011). *SPring-8/SACLA Annual Report FY2010*, 74–75.
[2] Tamenori, Y. et al. (2013). *SPring-8/SACLA Annual Report FY2012*, 69–71.
[3] Tsuruta, K & Tamenori, Y. (2019). *SPring-8/SACLA Annual Report FY2018*, 56–58.