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 conditions. The beamline consists of two branches named B and C. The B-branch provides high X-ray energy of 2100–3300 eV using a Si (111) channel-cut monochromator, and the incident X-ray is focused onto an approximately 10 μm spot at the sample position using Kirkpatrick–Baez (KB) mirrors [1,2]. This branch is mainly available for physicochemical analysis based on elemental X-ray fluorescence (XRF) mapping and micrometer-scale X-ray absorption spectroscopy (μ-XAS) measurements. The C-branch is equipped with a varied-line-spacing plane grating monochromator (VLS-PGM) upgraded in FY2018 [3], and is available in a low X-ray energy range of 170–2200 eV. In this branch, μXRF mapping, μ-XAFS measurement, and X-ray emission spectroscopy (XES) are available.

Here, we report on the resolution of the VLS-PGM problem at the C-branch and the installation of the on-the-fly mapping program at the B-branch.

2. Repairing of VLS-PGM switching system at C-branch.

A malfunction of the VLS-PGM switching axis in the C-branch occurred in early October of the 2022B period, making it impossible to change the X-ray energy range. The malfunction was caused by deformed guide wires, and the VLS-PGM was repaired by replacing the wires. At the end of October, the VLS-PGM was adjusted using the 1st harmonic of the Figure-8 undulator, and energy calibration and flux intensity distribution plots were performed to achieve the same performance as before the malfunction. Then, user operation of the C-branch was resumed around the end of November. To check the performance of the VLS-PGM, XANES measurements at the N K-edge in boron nitride (BN) were repeated in the partial fluorescence yield (PFY) mode on a G3 grating (groove density of 600/mm). Figure 1 shows the results of spectra measurement repeated 10 times. The results show that the repeatability was less than 0.1 eV, which is sufficient for practical use.

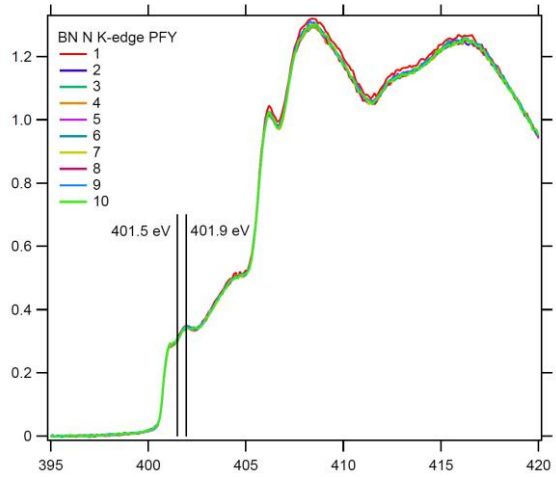

Fig. 1. XANES spectra at the N K-edge in BN. The results of 10 repeated measurements are shown. The horizontal axis is photon energy (eV).

3. Installation of on-the-fly mapping program at B-branch.

To realize μ-XRF mapping with high efficiency, the on-the-fly mapping system has already been installed in the C-branch. However, the system has not yet been installed in the B-branch. Depending

on the samples, users desire μ-XAFS and μXRF measurements on both the C- and B-branches for different target elements, and an on-the-fly program with the same interface will improve user convenience. In addition, the obtained μXRF mapping can be displayed by the display software developed at BL37XU [4].

Figure 2 shows the μ-XRF images of the Martian Nakhlite meteorite Y000593, obtained with X-ray energy of 2,500 eV. A focused beam of 15 × 15 μm^2 was used to acquire data at 20 μm/step for a 480 × 480 μm^2 scan area. The μ-XRF image of the on-the-fly scan with an exposure time of 1 s/point shown in Figure 2(b) is of equal or better quality than that of the step scan with an exposure time of 1 s/point shown in Figure 2(a). Note that the μ-XRF image obtained at each scan showed no misalignment, and the mapping statistics were almost equal. The total measurement time to obtain the μ-XRF image is about 29 minutes for the step scan and about 13 minutes for the on-the-fly scan, which is less than half the measurement time by step scan because of no waiting time.

To obtain higher-resolution images than Figure 2(a) and (b), we attempted to acquire μ-XRF images with a short exposure time in small steps. Figure 2(c) shows the result of an on-the-fly scan of the same area with an exposure time of 0.3 s/point in 5 μm/step. The total measurement time was about 24 minutes, which is faster than the step scan time

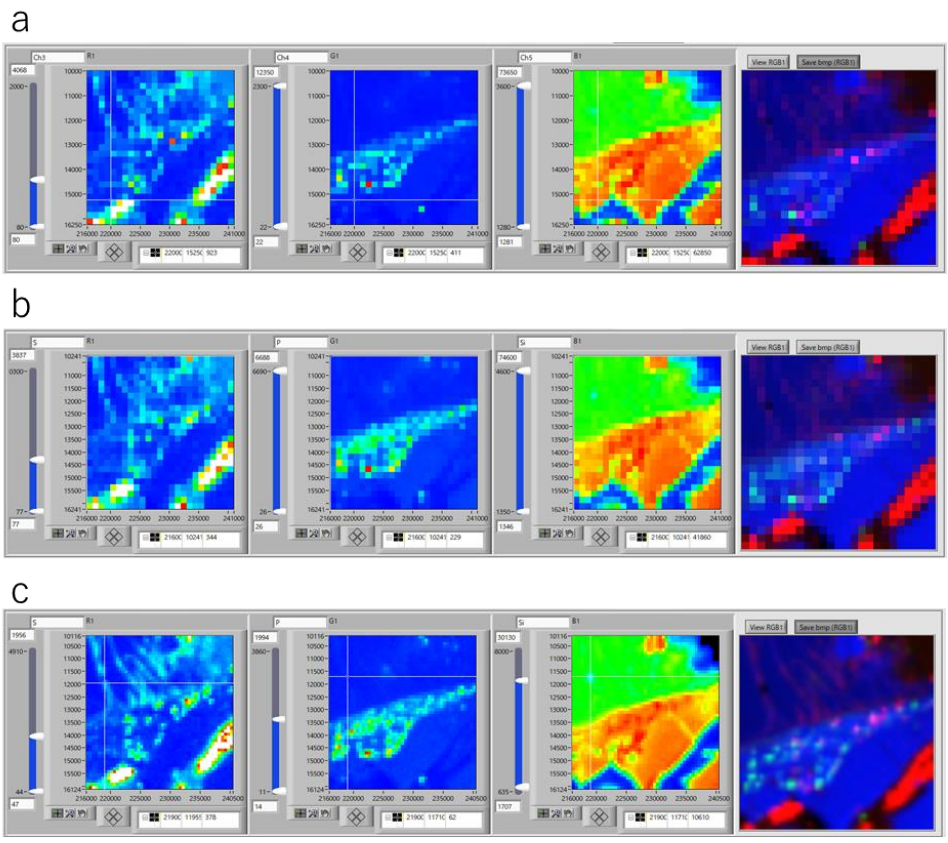

Fig. 2. XRF images of the Martian Nakhlite meteorite Y000593 obtained with X-ray energy of 2,500 eV. (a) Step scan with an exposure time of 1 s/point, (b) on-the-fly scan with 1 s/point, and (c) on-the-fly scan with 0.3 s/point. The distribution plots indicate S, P, and, Si from the left side. RGB image on the right side consists of S (red), P (green), and Si (blue).

of about 29 minutes. Therefore, images with better spatial resolution can be obtained, which is expected to improve the throughput of μ-XRF mapping in the B-branch.

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References:

[1] Tamenori, Y. Kinoshita, T. & Muro, T. (2011). *SPring-8/SACLA Annual Report FY2010*, 74–75. [in Japanese]
[2] Tamenori, Y. Kinoshita, T. & Muro, T. (2013). *SPring-8/SACLA Annual Report FY2012*, 69–71. [in Japanese]
[3] Tsuruta, K. & Tamenori, Y. (2019). *SPring-8/SACLA Annual Report FY2018*, 56–58.
[4] https://bl37xu.spring8.or.jp/