BL16B2
SUNBEAM BM

1. Introduction

BL16B2, which is a SUNBEAM BM beamline, together with its sister beamline BL16XU, was built to develop various industrial materials by utilizing the high-brightness beam at the large-scale synchrotron radiation facility in SPring-8. It is utilized and operated by the SUNBEAM Consortium, a private organization comprising 13 companies * (12 firms and one electric power group). BL16B2 began operations in September 1999, and the beamline use contract was renewed in April 2018. In August 2020, we received an interim evaluation and obtained a "continuation" evaluation result.

X-rays emitted from a bending magnet are monochromatized, shaped, and converged in an optics hutch. The experimental hutch contains a diffractometer and a multipurpose experimental table for XAFS and imaging measurements. Figure 1 and Table 1 show a schematic and the characteristics of BL16B2, respectively.

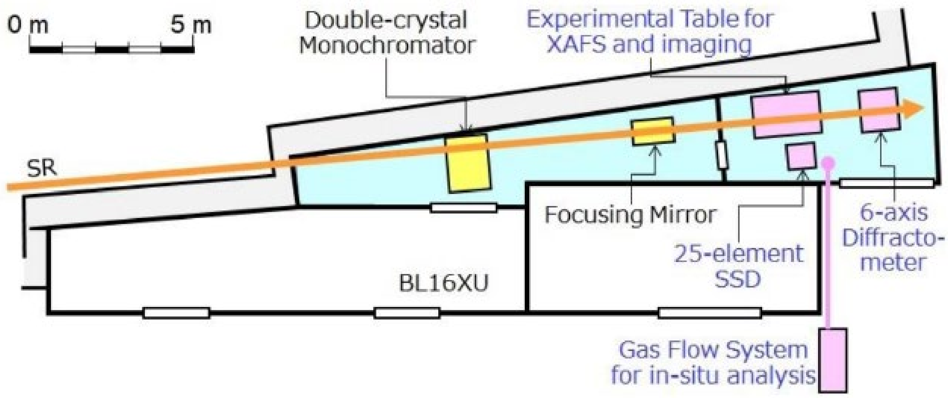

Fig. 1. Outline of BL16B2.

Table 1. Characteristics of BL16B2.

Light source	Bending magnet
Energy range	4.5–113 keV
Energy resolution ($\Delta E/E$)	$\sim 10^{-4}$
Photon intensity, beam size	$\sim 10^{10}$ photons/s <60 mm (H) × 5 mm (V) without focusing mirror <0.1 mm (H) × 0.1 mm (V) with focusing mirror
Experimental facilities	XAFS, Topography, Imaging, XRD, Gas flow system (corrosive or toxic gas is possible)

*Kawasaki Heavy Industry, Ltd., Kobe Steel, Ltd., Sumitomo Electric Industries, Ltd., Sony Group Corp., Electric power group (Kansai Electric Power Co., Inc., Central Research Institute of Electric Power Industry), Toshiba Corp., Toyota Central R&D Labs., Inc., Nichia Corp., Nissan Motor Co., Ltd., Panasonic Holdings Corp., Hitachi, Ltd., Fujitsu, Ltd., Mitsubishi Electric Corp.

2. Utilization

Figure 2 shows the utilization of BL16B2 in the past decade. The vertical axis shows the proportions of users, excluding the tuning and studying of the beamline itself. The upper graph, which depicts the utilization by field, confirms that BL16B2 is used in various industrial fields. The lower graph shows utilization by equipment (technology).

In BL16B2, XAFS and imaging measurements are widely performed. In XAFS measurements, we have been improving usability by creating two-dimensional XAFS measurement software and 25SSD data analysis software. For imaging measurements, we launched a He introduction system to reduce the carbon contamination of spectroscopic crystals.

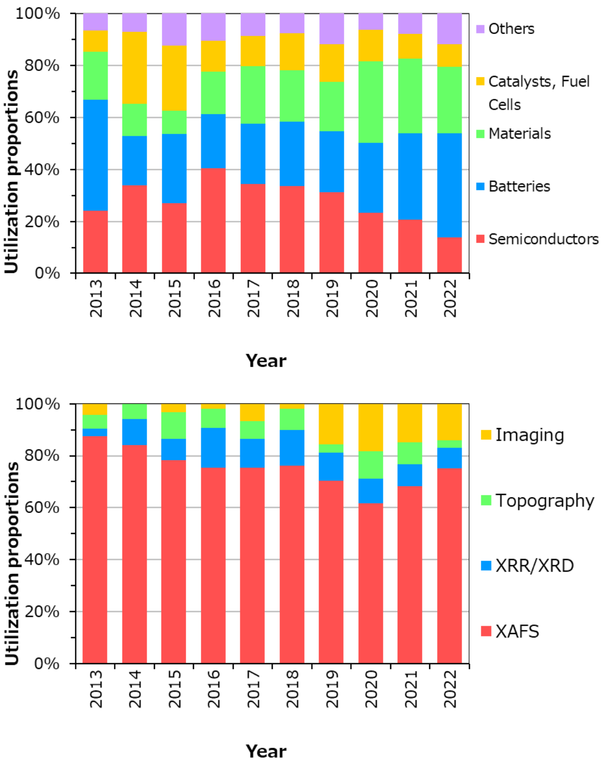

Fig. 2. Relative utilization times of BL16B2 in the past decade.

3. Topics in FY2022

Below, the research and upgrades conducted in FY2022 are described.

3-1. Improvement of X-ray-beam-image quality with He gas induction

Depositions of hydrocarbon on the monochromator crystals cause severe image degradation in X-ray imaging experiments, and periodic cleaning of the monochromator crystals using O_3-ashing had been required every six months.

Recently, it has been found that introducing He gas into the beamline could extend the period between O_3-ashing cleanings [1], [2] since the adsorption of hydrocarbon molecules was prevented owing to the decrease in the mean free path length. To establish 24-hour He-gas introduction operation, a robust and stable He-gas supply over 24 hours and an interlock system to handle any trouble that may arise in supplying the gas are required. To satisfy the above conditions, a new He-gas introduction system with a mass-flow controller (MFC) and local interlock system using two vacuum gages and electrically controlled valves was fabricated [3], [4] (Fig. 3).

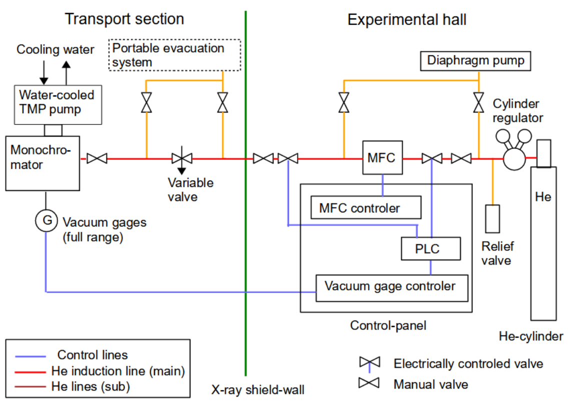

Fig. 3. Schematic of He-gas introduction system.

After investigating the relationship between the He-gas flow and the vacuum of the monochromator section, a suitable He-gas flow was selected, and the degree of vacuum was maintained by the MFC. Figure 4 shows the long-term variation of the monochromator vacuum over half a year; very stable vacuums were obtained.

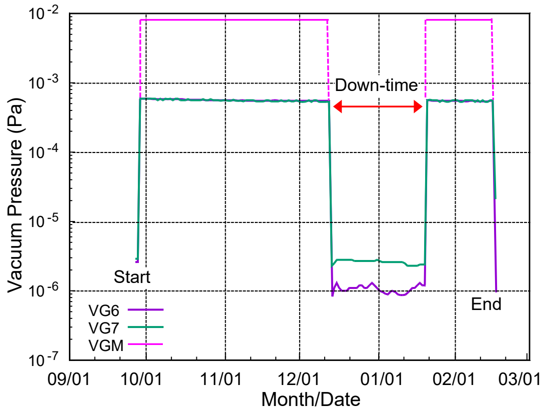

Fig. 4. Long-term vacuum stabilities (2021) at the Be-window section (VG6, VG7) and the monochromator section (VGM).

To evaluate He-gas introduction effects, Si111 topography images were observed with and without He-gas flow. Figures 5(a)–5(c) show asymmetric Si111 topography images obtained under various conditions. The X-ray energy was set at 18.9 keV, and the incident angle of the asymmetry Si(111) crystal was about 0.5 degrees, which enlarges the topography images vertically 20-fold. Experimental details have been described elsewhere [4]. As shown in Fig. 5(a), a very clear image was obtained after O_3 cleaning, but the deposition of hydrocarbons during the beamtime degraded the topography image, as shown in the area of the red square in Fig. 5(b). In contrast to these results, a very clear topography image was obtained after three months of beamtime with He-gas flow, as shown in Fig. 5(c).

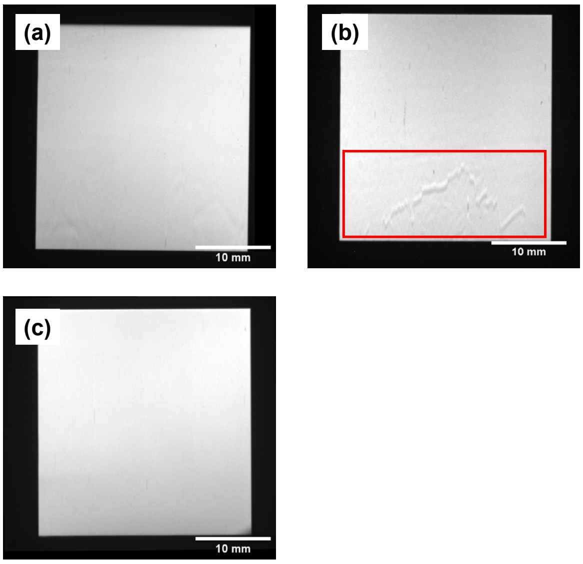

Fig. 5. Topography images of asymmetric Si111 reflection obtained under various conditions: (a) typical topography image after O_3 cleaning, (b) topography image obtained after three months of beamtime without He-gas introduction, and (c) topography image after three months beamtime with 10^{-2} Pa He environment.

It is expected that the new He-gas supply system will prevent the deposition of hydrocarbons on the monochromator crystals and extend the period between surface cleanings of the crystals, which will contribute to the development of various industrial materials.

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References:

[1] Uesugi, K. private communication.

[2] Suzuki, Y. (2001). JSR2001.

[3] Kawamura, T. et al. (2021). *SUNBEAM Annual*

Report with Research Results **10**, 11.
[4] Kawamura, T. et al. (2021). *SPring-8/SACLA Research Report* **9**, 567.