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 comprised of 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.

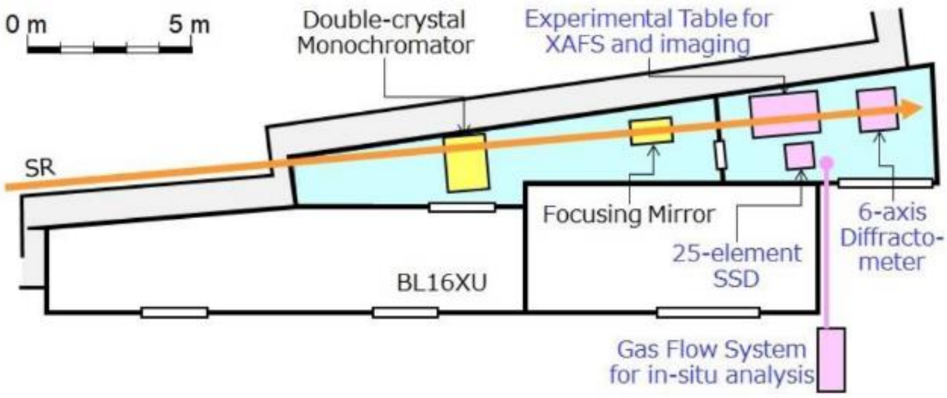

Fig. 1. Outline of BL16B2.

Table 1. Characteristics of BL16B2.

Light source	Bending magnet
Energy range	4.5–113 keV
Energy resolution ($\Delta E/E$)	~10^{-4}
Photon intensity, beam size	~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 holding 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.

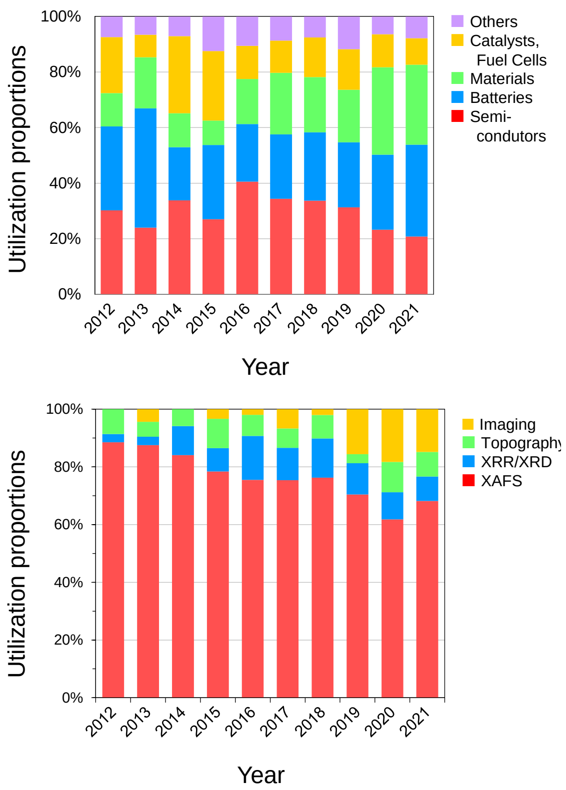

Fig. 2. Relative utilization times of BL16B2 in the past decade.

3. Topics in FY2021

Below, the research and upgrades conducted in FY2021 are described.

3-1. Three-dimensional crystallinity observation using fine X-ray section topography

"Noise-free X-ray imaging" at BL16B2 is listed as one of the research items in the third-phase research plan of the Sunbeam Community. This research theme is roughly divided into "the realization of a high-quality X-ray beam" and "the realization of a beam magnifying optical system using asymmetric Bragg reflection". Here, the latter was reported as a recent topic in BL16B2.

Figure 3 shows the schematic diagram of the X-ray section topography system [1]. The system basically consisted of an optical slit of 5-μm width and an X-ray camera (XSight, Rigaku). Moreover, a 2θ arm, a goniometer, and a sample holder are included. The pixel size of the X-ray camera was 1.3 μm, and the observation area was 2.6 × 2.6 mm^2.

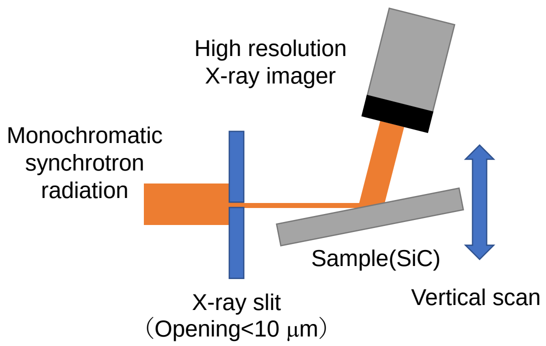

Fig. 3. Schematic diagram of X-ray section topography system.

Figure 4 shows the X-ray topographies taken by the (a) conventional method and (b) present section topography method, which were simply overlapped for comparison. The present section topography image clearly revealed the microstructure existing in the whole bulk region. In contrast, the conventional method provided information related to only very near the surface. Figure 5 shows the sliced images taken from the region every 2 µm from a 40-µm depth to the surfaces. The defects existing mainly at the interface between the substrates and the epitaxial layer are clearly observed.

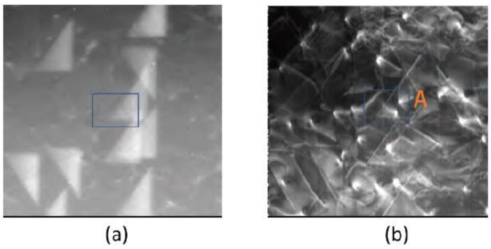

Fig. 4. X-ray topographies taken by (a) conventional method and (b) present section topography method, which were simply overlapped for comparison.

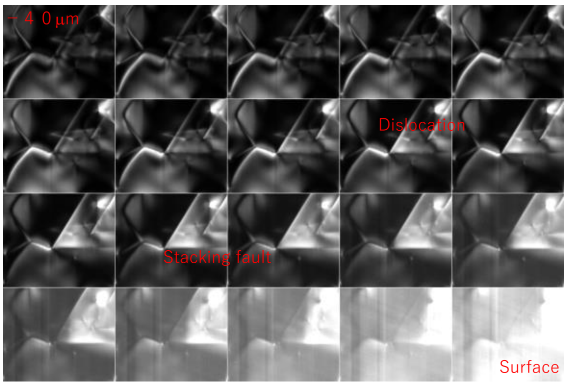

Fig. 5. Sliced images taken from the region every 2 µm from a 40-µm depth to the surfaces.

It is expected that the advanced imaging system contributes to the development of various industrial materials.

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Reference:

[1] Yoneyama, A. Konishi, K. & Shima, A. (2021). *SUNBEAM Annual Report with Research Results* **11**, 34.