BL16XU (SUNBEAM ID)

1. Introduction

BL16XU, which is referred to as SUNBEAM ID, together with its sister beamline BL16B2, 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 operated by the SUNBEAM Consortium, which is a private organization comprised of 13 companies* (12 firms and one electric power group). BL16XU and BL16B2 began operations in September 1999, and the beamline use contract was renewed in April 2018.

X-rays emitted from an undulator are monochromatized, shaped, and converged in an optics hutch. The experimental hutch contains four experimental devices. Figure 1 and Table 1 schematically depict and outline the characteristics of BL16XU, respectively.

2. Utilization

Figure 2 shows the utilization of BL16XU in the past decade. The vertical axis shows the proportions for users, excluding tuning and studying the beamline itself. The upper graphic depicts the utilization by field. In recent years, battery-related research, which is typified by lithium-ion batteries, is increasing. Additionally, semiconductors such as SiC and GaN are actively investigated.

The lower graphic shows utilization by equipment (technology). Utilization of HAXPES equipment, which was installed in 2014, is increasing. HAXPES is used mainly for semiconductor applications. Additionally, studies for bonded dissimilar material structures are being conducted.

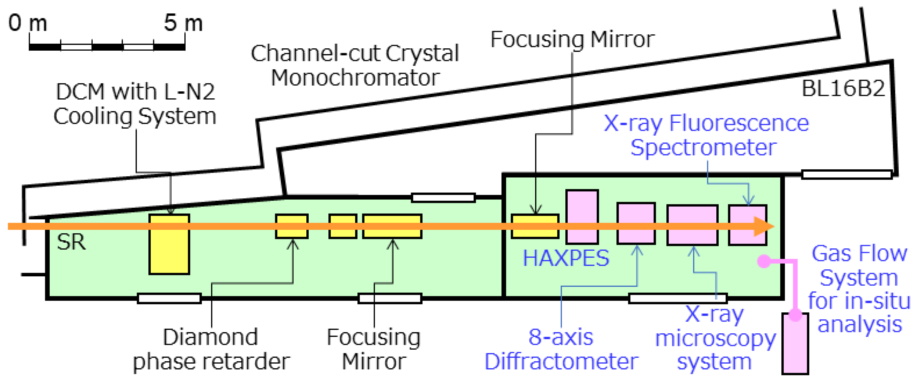

Fig. 1. Outline of BL16XU.

* Kawasaki Heavy Industry, Ltd., Kobe Steel, Ltd., Sumitomo Electric Industries, Ltd., Sony 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 Corp., Hitachi, Ltd., Fujitsu Laboratories Ltd., Mitsubishi Electric Corp.

Table 1. Characteristics of BL16XU

Light Source	In-vacuum X-ray undulator λ = 40 mm, N = 112
Energy range	4.5 - 40 keV
Energy resolution ($\Delta E/E$)	~ 10^{-4}
Photon intensity, beam size	~ 10^{12} photons/s , < 1 mm × 1 mm ~ 10^{10} photons/s , < 500 nm × 500 nm
Beam position stability	± 0.1 mm Horizontal ± 0.8 mm Vertical (5.0 - 30 keV)
Experimental facilities	HAXPES, XRD, XRF, Micro-beam (Microscopy), Gas flow system (corrosive or toxic gas are possible)

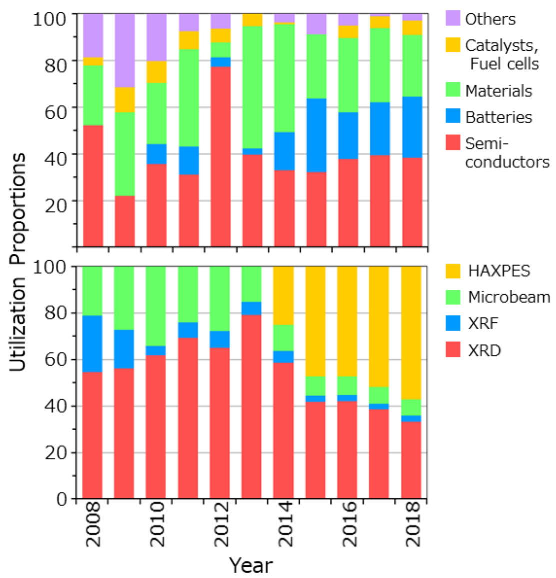

Fig. 2. Relative utilization times of BL16XU in the past decade.

3. Topics in 2018

Below research and upgrades conducted in 2018 are described.

3-1. X-ray diffraction

Pixel (two-dimensional) X-ray detector PILATUS 300K CdTe was installed for use of high-energy X-rays. Compared with the Si sensor, the CdTe is 10 times more sensitive at 40 keV and 30 times more sensitive at 70 keV.

We also installed a rotating spiral slit system to improve the precision of the gauge volume position using a two-dimensional detector. Using the detector and the spiral slit system (Fig. 3), the spatial resolutions are 0.7 mm along the incident beam and 0.1 mm in the orthogonal direction. The internal crystallographic characterizations such as residual stress will be carried out.

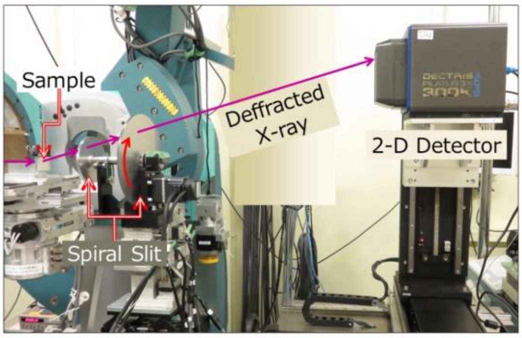

Fig. 3. Experimental apparatus for diffraction measurements.

3-2. Microscopy system

Prior to FY2018, microscopic analysis was carried out by scanning microbeam X-rays formed using a Kirkpatric-Baez mirror system. Advantages of scanning microscopy include high spatial resolution and ability to combine with diffraction or fluorescence analysis. However, its disadvantage is measuring time. Figure 4 shows the newly installed imaging microscope system equipped with FZP and high-resolution camera. Figure 5 shows a transmission image and XANES spectrum of Cu-mesh. Using this system, CT imaging, *in situ* analysis, and micro-XAFS can be performed to characterize electric devices in a package or *operando* analysis of inside batteries.

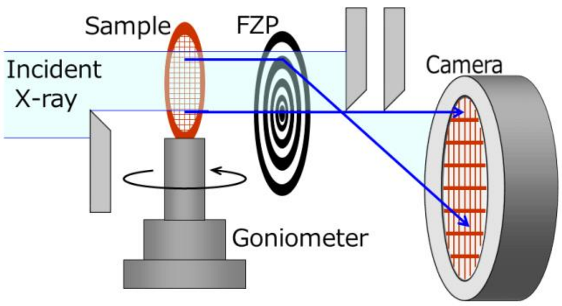

Fig. 4. Newly installed imaging microscope system equipped with FZP and high-resolution camera.

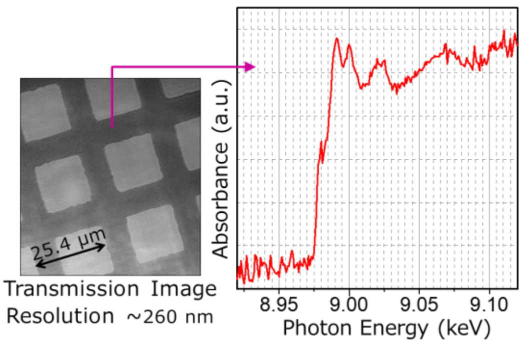

Fig. 5. Image and XANES spectrum of Cu-mesh.

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