Beamline BL01B1 (XAFS)

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1. Introduction

The beamline BL01B1 is designed for XAFS measurement in a wide energy range (4.5-97 keV) for many applications and types of materials. An outline of the beamline design and related research issues were described in ref. [1, 2].

The beamline using synchrotron radiation (SR) light was installed in July 1997, and opened to users from October of that year. In the first stage of construction, the main target was to allow users to carry out conventional XAFS measurements in the energy range from 4.5 to 97 keV with sufficient stability. This report describes the current status of BL01B1.

2. X-Ray Optics

The x-ray optics are configured to obtain beam characteristics suited to XAFS measurement, i.e. the fixed exit beam having high photon flux and high energy resolution, high photon density, and low higher-harmonics contaminant at the sample position. The main x-ray optical elements consist of the first vertical collimation mirror, double-crystal monochro-mator and second vertical refocusing mirror. All of the beamline components are standard for the SPring-8 bending magnet beamline.

The monochromator is an adjustable inclined double-crystal type to handle a wide energy range with a single pair of Si(311) crystals [3]. It takes about 30 min to change the net plane between Si(111), Si(311) and Si(511) and to realign the monochromator to fix the exit beam position. The first crystal is an Si(311) water-cooled fin type, and the second crystal is an indirect water-cooled flat one. A bent second crystal to focus the beam in the sagittal direction is under development, and now the bending device is being improved.

The first collimation mirror and second refocusing mirror were adjusted to obtain the designed performance [2]. The measured characteristics of the beam reflected from the mirrors are as follows. The energy resolution, dE/E, is about $2*10^{-4}$ for the Si(111) plane and $5*10^{-5}$ for the Si(311) one at 9 keV, which is several times higher than the characteristics without a collimation mirror. The size of the vertically focused beam is smaller than 0.2 mm at the sample position. A ratio of higher energy harmonics smaller than 10^{-5} can be achieved. It takes about 30 min to realign the optics by changing the glancing angle of the mirrors.

The components downstream of the first mirror, i.e. the monochromator, γ-stopper and slit, are mounted on the inclined stage. They can be controlled within the accuracy of an inclined angle of 10 μrad.

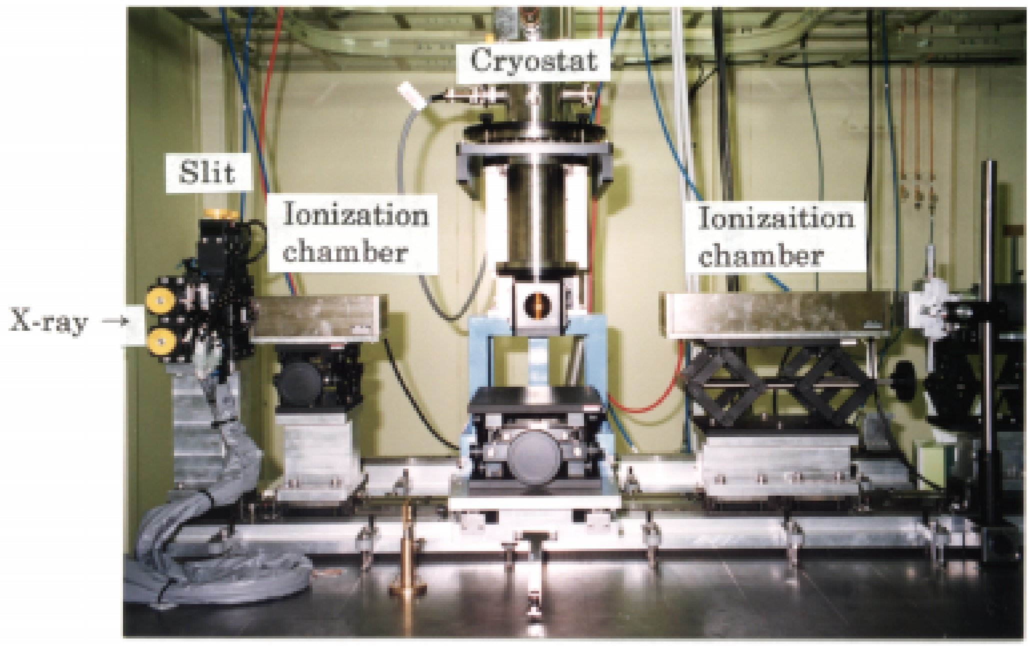

Photo 1 Facilities in experimental hutch.

3. Experimental hutch

The facilities for standard XAFS measurement planned at the first phase were installed in the experimental station. The configuration is described in ref.[1] and shown in Photo. 1.

It is possible to measure the transmission mode's XAFS with ionization chambers and the exited spectra with a Lytle detector. Four types of ionization chambers were prepared: gas-flow type (17 cm long and 31 cm long) and Xe-gas-closed type (17 cm long and 31 cm long).

The sample temperature can be controlled by a cryostat (range, 6.5-300 K; stability, ±0.1 K; cooling rate, 1 hr from 298 K to 6.5 K) and two water-cooled electric furnaces (maximum temp., 1140 K and 1870 K).

The four-blade slit system was installed to control the beam profile incident on the sample. The blades are made of tantalum at 3 mm thickness.

The measurement facilities were arranged on a vertical translation stage (1.2×2 m). The height of the stage is adjusted for a SR beam ranging from 0 to 250 mm with a 0.5 μm step, which depends on the glancing angle of the mirror.

The performance of above facilities were tested and showed good performance.

4. Control

The energy scan of the XAFS measurement is controlled from a personal computer. It now typically takes about 25 min to get a data set of 500 points with acquisition time of 1 sec for each point.

In the high energy region, the Darwin widths of the Si(311) and Si(511) planes of the monochromator crystal become very narrow (< 1 arcsec above 30 keV). On the other hand, error occurs on the Bragg angle of the first crystal on the order of sub-arcsecond during the scanning motion. Accordingly, the fluctuation of the exit beam intensity was observed during the energy scan. To overcome this situation, we have realized fast correction of the first crystal's Bragg angle by using digital piezo actuator. Typically, angle correction takes several more minutes for each XAFS scanning.

The changes in the net plane of the monochromator crystals and in the glancing angle of the mirrors require realignment of a series of optics. We made tables of the position of the optical elements for each arrangement and used them to develop semi-automatical computer control.

References

[1] S. Emura et al., SPring-8 Annual Report 1996, 82 (1996).

[2] S. Emura, this report

[3] T. Uruga et al., Rev. Sci. Instr. 66, 2254 (1995).