XAFS (BL01B1)

1. Introduction

The beamline BL01B1 was constructed to study XAFS (X-ray absorption fine structure) spectra in a wide energy range (3.8-113 keV) with various techniques [1]. The beamline facilities have been stably opened to users under accumulation ring operation of 100 mA mode. XAFS measurement has been taken for the elements from Ca K (4.0 keV) to Bi K (92 keV). This report describes the current status of BL01B1 including newly installed facilities and the research activities of users. For an outline of the construction plan of BL01B1, see Ref. [2].

2. Beamline Operation

The main X-ray optics at BL01B1 are a first collimating mirror, double-crystal monochromator and second focusing mirror in the vertical direction at the sample position (Fig. 1).

To cover a wide energy range from 3.8 to 113 keV, an adjustable inclined double-crystal type monochromator was adopted. The use of this monochromator has made it possible to rapidly switch the net plane of the crystals between Si(111), Si(311) and Si(511) without breaking the vacuum chamber. Also, to obtain the cut off energy of X-ray desired at the sample, the glancing angle of mirrors was adjusted from 1 to 7 mrad.

A semi-automatic computer control program and operation manual was developed for users to switch the monochromator net plane and the glancing angle of the mirrors. The realignment of the optical elements is completed within 40 min and operated by users. The control programs are written in a commercially available application software program (LabVIEW, National Instruments Co.)

There was no serious trouble in beamline operation after the introduction of an indirect water-cooled flat Si(311) crystal for the monochromator first crystal. The X-ray optics performed well without any significant drift by heat load under 100 mA of ring current.

3. New Facilities

3.1 Measurement Equipment

For the fluorescence mode's XAFS, a 19-elements Ge single-element solid state detector (19-Ge-SSD) with a digital X-ray processor system was borrowed from BL44B2. The Lytle detector, which has several types of solar slit and an ionization chamber of 100 mm long, is under development. A thermoelectrically cooled Si-PIN photodiode detector was prepared. It is conveniently used for setting the sample position, especially for grazing angle mode's XAFS for thin film samples.

For the conversion electron yield mode's XAFS, two types of detectors were developed. One has a rotational sample holder of 50 mm of diameter normal to the holder plane to neglect the diffraction effect in crystalline sample. Another has a fixed sample holder.

3.2 High Power Pulse Laser

For the XAFS study of photo-excited state of sample, a high power pulse laser to use sample excitation can be borrowed from BL44B2 (Fig. 2). The laser consists of a YAG laser, 1.2 J@1055 nm with 6 ns pulse width, and a dye laser allowing from UV to infrared light. The safety interlock system for the laser was equipped in the experimental hutch.

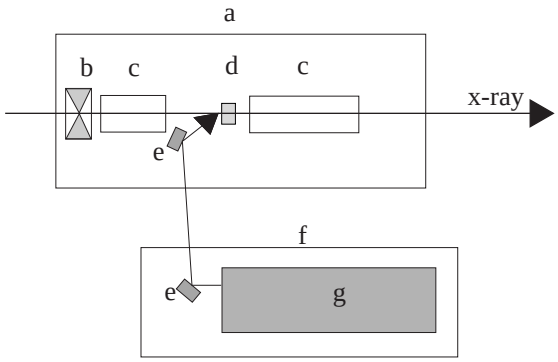

Fig. 2. Arrangement of high power laser. a, experimental stage; b, slit; c, ionization chamber; d, sample; e, mirror; f, laser stage; g, laser.

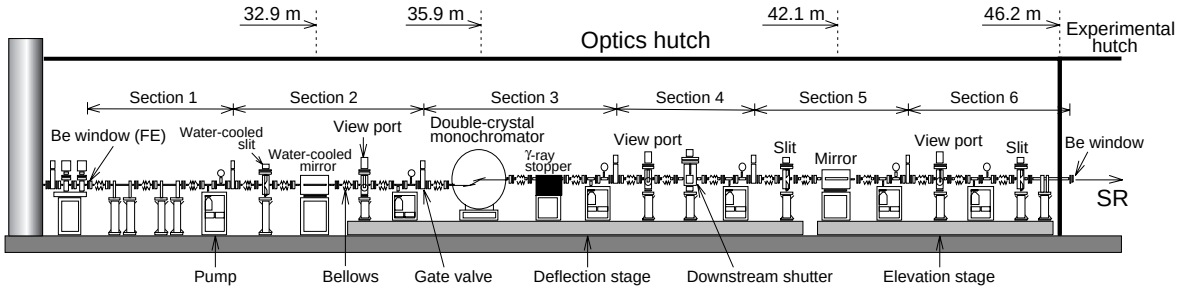

Fig. 1. Schematic view of BL01B1 transport channel

3.3 Monochromator for UV-infrared Light

For the optical XAFS experiments, a monochromator with photo-multipliers for UV to infrared light can be borrowed from a user group. This system is able to be arranged on a vertical translation stage in experimental hutch.

References

[1] T. Uruga *et al*., J. Synchrotron Rad. **6** (1999) 143.

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

Light Source	
Type	Bending magnet B1
Critical energy	28.9 keV
Source size	σ_x = 0.182 mm
	σ_y = 0.058 mm
	$\sigma_{y'}$ = 0.065 mrad
	@10 keV
Horizontal beam divergence	1.5 mrad

X-rays at Sample	
Energy range	Si(111): 3.8-37 keV
	Si(311): 7.1-72 keV
	Si(511):11.2-113 keV
Energy resolution ΔE/E	Si(111): $>2\times10^{-4}$
	Si(311): $>3\times10^{-5}$
	Si(511): $>2\times10^{-5}$
Photon flux	10^{9}~10^{11} photons/s
Focused beam size:	0.06-0.2(V)*10(H) mm
Higher energy contaminants:	$<10^{-5}$

Facilities in Experimental Station

(i) Measurement

- Gas-flow type ion chamber
  Gas: He, N_2, Ar, Kr, and its mixture
- Xenon gas-closed type ion chamber
- Lytle type detector
- Single- and 19-elements Ge solid-state detector
- Si-PIN photodiode detector
- Conversion electron yield detectors

(ii) Sample

- Water-cooled electric furnace with Capton window
  Control range of temperature: 295~1070 K
- Muffle furnace with Capton window
  Control range of temperature: 295~1870 K
- Cryostat with Capton window
  Control range of temperature: 10 ~ 300K

(iii) Optics

- θ-2θ stage with Z stage
- Vertical translation stage
- Stepping motor driven 4D-Slit