The Outline of Extremely Dense State BL10XU

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1. Outline of BL10XU

The BL10XU beam line has tandem experimental stations constructed for a high brilliance XAFS (X-ray absorption fine structure) and X-ray diffraction under high pressure. A standard in-vacuum type undulator for BL10XU is located at the low-b section in the SPring-8 Storage Ring and high brilliance, quasi-monochromatized synchrotron radiation (SR) beam, with a selectable energy above 5 keV, can be obtained by the undulator gap control. The transition channel and optical components are shown in Fig. 1. After the front-end components, SPring-8's standard double-crystal monochromator is mounted at a position 37.6 m from the light emitting source. By using (111) oriented Si crystals, monochromatized beam with the photon energies between 5 and 35 keV is introduced into experimental stations. A rhodium (Rh) coated double-mirror system to eliminate undesirable higher-order light can be inserted after the monochromator, which is especially suitable for use with a low energy beam below of less than ~15 keV. Two mirrors are mounted in a cavity, and the beam's incident angle is controlled by tilting this cavity. When the cavity is horizontal, a SR beam passes between these two mirrors without reflection.

2. Optical properties

Fig. 2 shows FWHM (full-width at half-maximum) monochromator rocking curves at the 1st Si crystal with respect to the photon energy. The typical rocking curve at 29.2 keV is shown in the inserted figure. FWHM decreases with an increase in photon energy. The dashed line indicates a theoretical calculation of an ideal case; FWHM of experimental results is 1.5-2 times larger than that of the calculation. This might be a result of a distortion in the 1st Si crystal caused by the direct water-cooling system. An improvement of crystal quality is in progress. In spite of this crystal imperfection, the monochromator has good energy resolution, as shown in Fig.3. It is K_2MoO_4 X-ray absorption spectrum at Mo-K edge of 20.003 keV. The pre-edge peak of Mo is clearly seen in this figure, indicating sufficient energy resolution for XAFS analysis.

Fig. 4 indicates the incidence angle dependence of double mirror reflectance at the photon energy of 10.03 keV. Above the incidence angle of ~5.5 mrad, the reflectance decreases rapidly. The solid line indicates results calculated by using optical constants derived by Henke et. al[1]. This calculation takes account of Rh surface roughness of 0.47 and 0.46 nm, evaluated by an interferometer. As the figure shows, experimental results correspond with theoretical predictions, indicating that the cavity's double mirrors are mounted precisely. Experiments confirm that the higher-order light is eliminated by the mirror insertion.

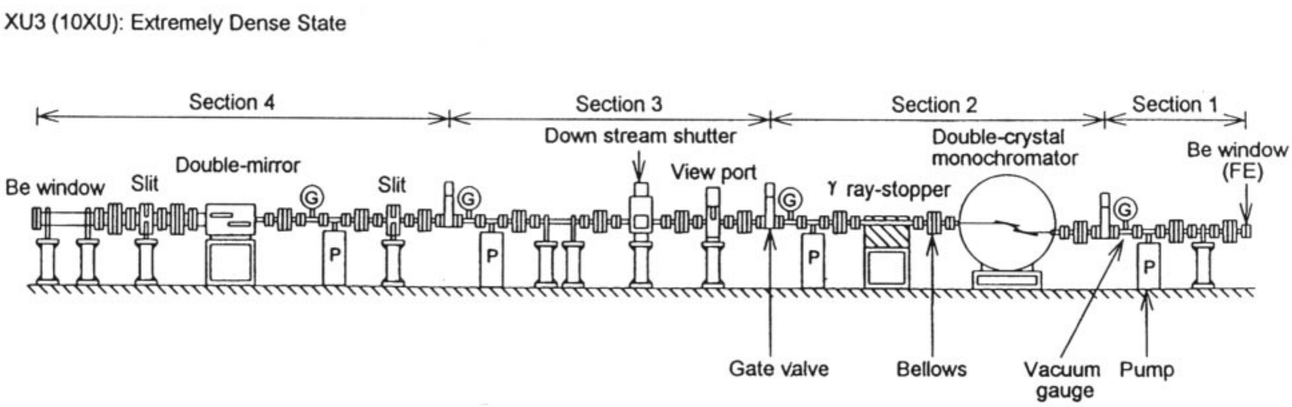

Fig.1 Transmission and optical components layout in the optical hatch of BL10XU.

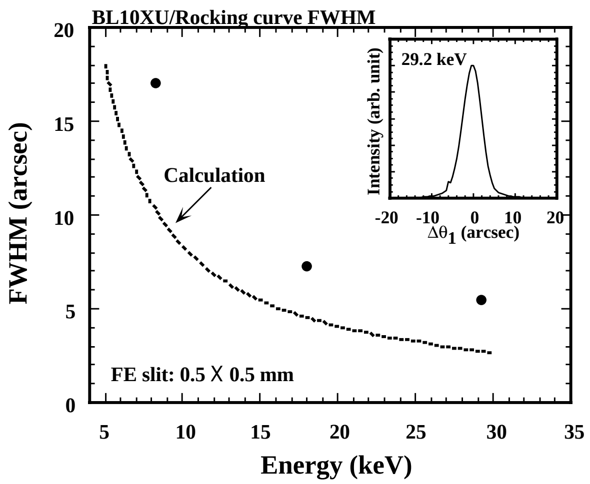

Fig.2 The photon energy dependence of FWHM of the monochromator 1st crystal rocking curve

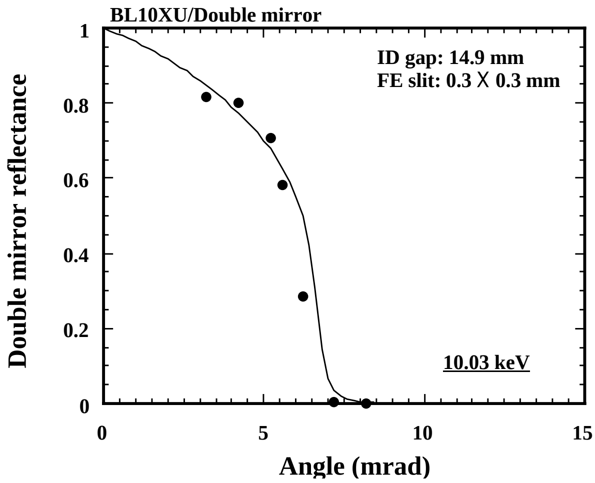

Fig.4 The angle dependence of the double mirror rreflectance.

3. Experimental stations

BL10XU has two experimental stations; a High Pressure Station and a High Brilliance XAFS Station. In the High Pressure Station, powder X-ray diffraction under high pressures up to 300 GPa generated by a diamond anvil cell (DAC) can be performed [2]. Diffraction patterns are accumulated into a computer by an imaging plate (IP) with an automatic reader that allows rapid data analysis. Since there are plans to use a Bragg-Fresnel lens for a SR focusing, all of the components such as the slit, collimator, the DAC and IP are mounted on a flat-head arm for 2q rotation. A cryostat and a laser-heating-system will be introduced in the near future to allow analysis over wide temperature range (10-3000K). In the High Brilliance a XAFS Station, XAFS measurement system using undulator gap control synchronized with monochromator scanning will be developed [3]. The XAFS using high brilliance undulator beam enable us to analyze local structures of diluted systems such as surface adsorption atoms. Moreover, new multi-channel measuring system with a pure Ge 100-elements solid state detector will be used. All detector elements are fabricated on a single Ge wafer. Each 5mm X 5mm element is separated by a dead layer of 10 µm, resulting in an almost 100% packing ratio on the wafer. The development of this detector is a key activity for High Brilliance XAFS Station.

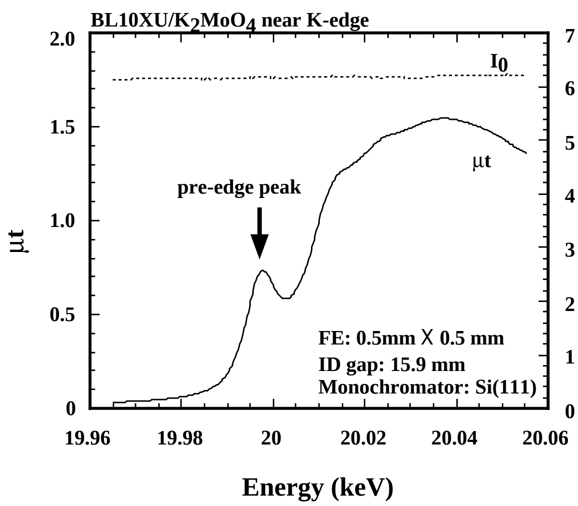

Fig.3 The absorption edge spectrum of K_2MoO_4

References

[1] B. L. Henke, E. M. Gullikson, and J. C. Davis, Atomic Data and Nucl. Data Tables, 54, 181 (1993) .
[2] N. Hamaya, SPring-8 Ann. Rep. 44 (1996).
[3] H. Oyanagi, M. Jinno, Y. Ueno, SPring-8 Ann. Rep. 46 (1996).