High Energy X-ray Diffraction (BL04B2)

1. Introduction

The high energy x-ray diffraction beamline: BL04B2 was designed for diffraction and scattering experiments at high energy levels above 38 keV. Focused high energy and high flux X-rays are quite useful in structural studies of amorphous substances and liquids to measure the wide range of momentum transfer or diffraction studies of single-crystals and/or powders. Therefore, a single bounce bent-crystal monochromator was adopted to aim to efficiently focus high energy x-rays.

The construction on the major part of the beamline was finished in June 1999, followed by commissioning with operating tests for the end stations.

2. Beamline

Synchrotron radiation from a bending magnet is guided through a standard front-end into the experimental hall. Since the greater part of the area upstream of BL04B2 is too narrow for the beamline components to be installed, the front-end section has been extended by 16 m in the experimental hall and terminated with a double-Be window assembly. Horizontal divergence of the beam is limited to 0.73 mrad by a fixed mask. The optics hutch and the experimental hutch are separate. A part of the transport channel is accommodated in the optics hutch. The flight path between two hutches is composed of a Pb-shielded duct which is deflected horizontally 6 deg from the optical axis of the white beam. The flight path is terminated with a single Be window of 0.25 mm thickness.

To carry out experiments with high-energy, modest-resolution, and focused x-rays in this beamline, we adopted a single-bounce, bent-crystal monochromator which deflects the beam horizontally. The available Bragg angle is fixed to 3 deg, so that we can change the energy only discretely by changing the reflection net-planes. The monochromator mechanism is, in principle, the same as the standard mirror supports of SPring-8 used for the horizontal focusing of the X-ray undulator beam.

The monochromator was installed 46 m from the light source. The adjustable bending radius enables the operator to adjust the focus position to the equipment used in each experiment.

At 37.8 keV with Si 111 reflection, the flux density and beam size are measured at a position 15 m from the monochromator with an Ar-filled ionization chamber by the slit in front of the chamber. The peak flux density for an optimally bent crystal was 1.2×10^{11} photons/s/mm^2, providing a density ~70 times greater than that of a flat crystal (1.9×10^9 photons/s/mm^2). The beam size for the optimally bent condition was measured as 0.145 mm in the horizontal axis in a case where the incident beam size before the monochromator was limited to a height of 0.2 mm and a width of 4 mm at the slit. The positional change of the monochromator crystal due to bending caused the centers of the intensity profiles to move. A focused beam can be aligned with the optical axis by the tuning translation of a crystal.

3. End Station

Four kinds of experimental equipment are equipped in tandem in the experimental hutch.

1) A *two-axis diffractometer for high energy x-rays*: A high energy x-ray diffractometer with a horizontal scattering plane has been installed at the front of the experimental hutch for amorphous material diffraction experiments.
2) A *single crystal diffractometer with a cylindrical imaging plate*: This diffractometer is equipped with a three-circle goniometer and a cylindrical imaging plate, which has a sliding mechanism, enabling Weissenberg motion.
3) A *high pressure vessel*: The vessel permits measurements up to 2000 K and 2000 bar. Small angle x-ray scattering spectra for supercritical metallic fluids are measured using this vessel and a monochromatized x-ray beam at an energy level of 38keV.
4) An *imaging plate system for high energy x-rays*: A diamond anvil cell for high-pressure experiments is mounted on this diffractometer. This imaging plate detector also works in small angle experiments using the high pressure vessel.