JAERI Material Science I (BL14B1)

1. Introduction

BL14B1 is one of three JAERI beamlines used in SPring-8. It is used for experiments using X-rays generated by a bending-magnet in the storage ring. Most of the experiments in BL14B1 concern the field of structural physics, for example, phase transition under high-pressure conditions, the surface structure of an electrode and so on. But some tasks using the new beamline technique are also being carried out in BL14B1 in collaboration with JASRI. A notable example of which is the new monochromator crystal cooling technique for a bending-magnet beamline, which was tested during 1999.

2. Design and Test of a New Type Monochromator Crystal

In the past, the heatload problem arising from the radiation of a bending-magnet had not been so severe. Therefore, an indirect water-cooled silicon crystal was used as the first-crystal of a standard double crystal monochromator for the bending-magnet beamline of SPring-8. However, after the storage-ring was operated at a current of 100mA in June 1999, the crystal deformation brought about by the heatload has been remarkable and a sufficient cooling system is required to handle the bending-magnet beamline.

Once a fin-cooled silicon crystal [1], which is always used at the insertion device beamline, was adopted in some of the bending-magnet beamlines. It was pressed on the holder by screws with an o-ring seal. This was able to reduce the deformation due to cramping but the o-ring was early damaged by the synchrotron radiation. Moreover, the intensity of the monochromatic beam was not sufficient because of the crystal deformation by the pressure of the cooling-water in a vacuum. To solve these problems, the mechanical crystal deformation and the radiation damage to the seal, JAERI and JASRI researchers designed a new direct water-cooling monochromator crystal.

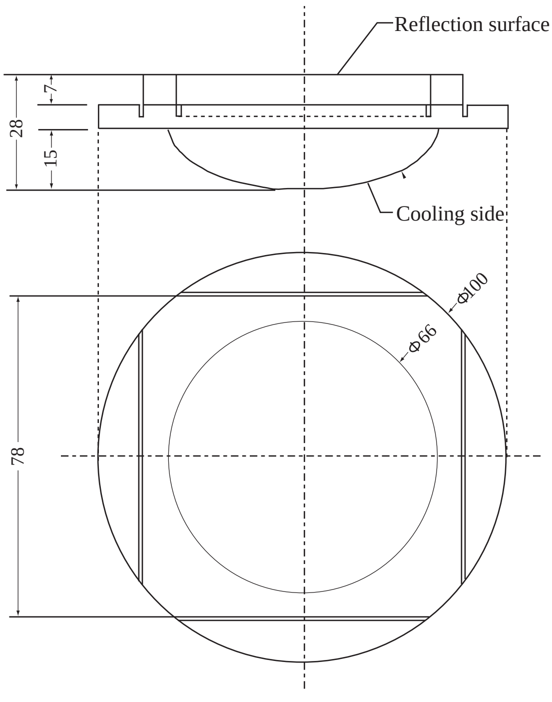

Fig. 1. The model of the type new direct water-cooling crystal.

A schematic view of the new monochromator crystal is shown in Fig.1. It is shaped like a basin. The cooling-water flows along the surface of the sphere. The crystal was machined by engineers at NEC. The body had such a sufficient thickness that the crystal deformation due to water-pressure in the vacuum was insignificant. Furthermore, it could not be damaged by radiation, because it was mounted on a holder sealed by an indium sheet.

The performance test for this monochromator crystal was carried out at BL14B1. A photograph of the monochromatic beam exiting from the monochromator is shown in Fig. 2. The incident beam size was restricted within 40mm width and 5mm height by a beamline slit upstream from the monochromator. The storage ring was operated at a current of 70mA. Fig. 2(upper) shows the profile of a beam reflected using the Si(111) plane with an X-ray energy of 7.1keV. Fig.2 (lower) shows a Si (333) plane used with an energy of 21.5keV and aluminum of 1mm thickness. As there was a possibility of higher harmonics being reflected over the same region where the fundamental was being reflected, we concluded that the crystal deformation was negligible. But the heatload effect was not been completely removed with this system in the 100mA operation. We will continue research into monochromator crystals on the basis of these results.

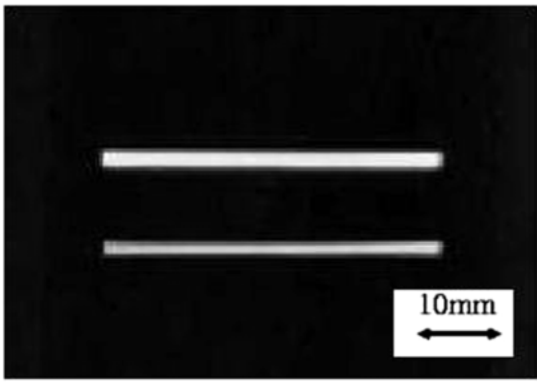

Fig. 2. Beam profiles reflected by an owan type crystal.

References

[1] T. Ishikawa, SPring-8 Annual Report 1997 (1997) 40.

Light Source	
Type	Bending Magnet
Horizontal Acceptance	1.5mrad

Optics
Double Crystal Monochromator
Si(111),(311),(511): interchangeable in vacuum
Sagittal focusing
Collimating and Focusing Mirrors
First : Si, Rh-coated
Second : Fused Quartz, Rh-coated

X-rays at sample	
Energy range	
for monochromatic beam	: 5.0-90keV
for white beam	: 5.0-150keV
Energy resolution	:$\Delta E/E \sim 10^{-4}$

Experimental Stations

In the white beam hutch

A multi-anvil type high-pressure apparatus system

- 180 ton press with a DIA type multi-anvil apparatus.
- High pressure (<15GPa) and high temperature (<1,500K) can be generated.
- A Ge SSD for an energy dispersive diffraction study.
- Two-dimensional detectors : an imaging plate and a CCD detector for an angle-dispersive diffraction study.
- A solar slit to reduce the background noise for an angle-dispersive diffraction experiment.

In the monochromatic beam hutch

A κ-type multi-axis diffractometer

- An additional function for the surface structural study : axis ν for azimuth rotation of the detector slit