BL02B2 Powder Diffraction

This beamline is designed for the research on accurate structure analysis by powder specimens in the area of materials science. The beamline makes it possible to collect a high counting statistics and high angular resolution powder diffraction data, which must contribute to increase the accuracy of structure analysis of crystalline materials.

Area of research

Accurate structure analysis of crystalline materials using powder diffraction data
Structural aspects of phase transition
Ab initio structure determination by powder diffraction
Rietveld refinements

Keywords

Scientific field

Accurate structure for materials science, Powder diffraction under various external fields

Equipment

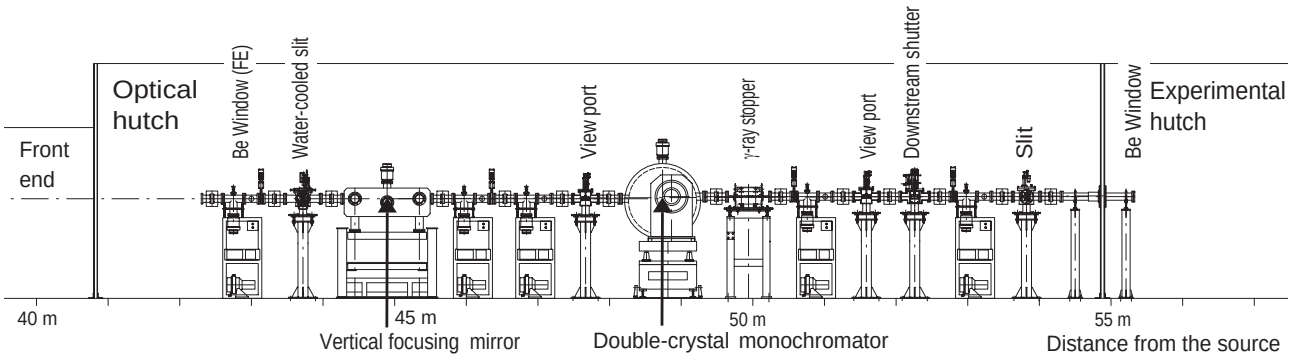
Large Debye-Scherrer camera, Closed-type cryostat, High and low temperature N_2 gas flow system

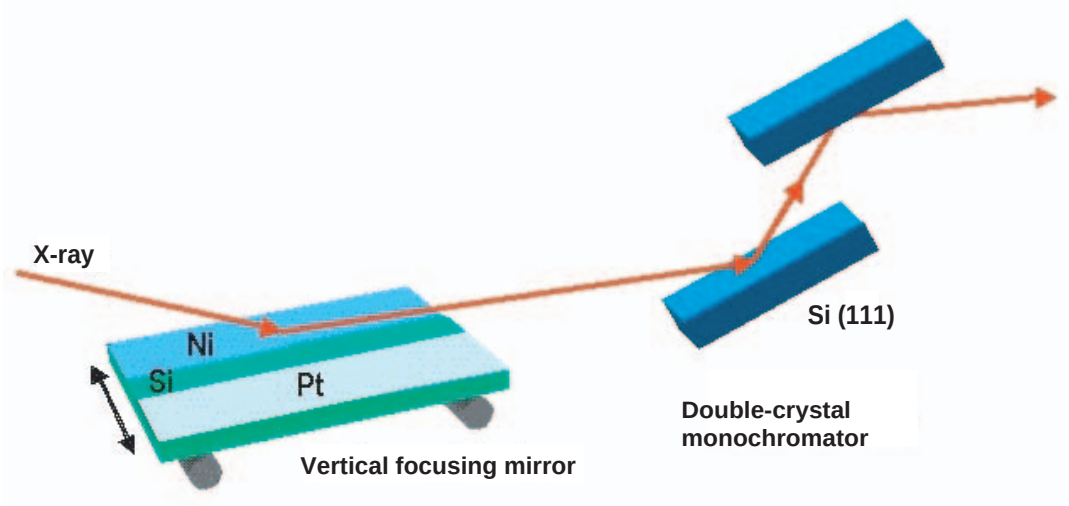
Source and optics

The main optical components are a fixed-exit double-crystal monochromator and a vertical focusing mirror for eliminating high energy harmonics.

X-rays at sample

Energy range	12 ~ 35 keV
Energy resolution	$\Delta E/E \sim 2 \times 10^{-4}$
Photon flux	$\sim 10^{11}$ photons/sec





Schematic view of beamline

Experimental station

A large Debye-Scherrer camera[1, 2] with radius 286.48 mm is installed at the experimental hutch (Table 1 & Fig.1). The camera is available in a wide range of temperature (15 ~ 1000 K). The closed-type cryostat (15 ~ 300 K) can be installed within the ω-stage of the camera. The high and low temperature N_2 gas flow systems are installed for high-temperature (300 ~ 1000 K) and low-temperature (90 ~ 300 K) experiments (Fig.2). As a detector, the camera has an Imaging Plate (IP) on the 2θ-arm. The station is equipped with an off-line IP reader. It is also possible to record several powder patterns (max.18) on one IP using a long vertical slit attached before the IP (Fig.3). The system combined with a control program made by LabVIEW provides one with an automatic collection of temperature dependent powder data.

By taking advantage of third generation synchrotron radiation, the camera enables one a rapid and easy collection of a high counting statistics and high angular resolution powder data even for heavy materials (Fig.4 (a) and (b)[3]). As a result, the beamline has flexibility for many levels of structural studies, for example, from measuring just lattice constants to obtaining accurate electron densities at various temperature.

Table 1. Specifications of diffractometer

Large Debye-Scherrer camera	
Radius of camera	286.48 mm
2θ range	2 ~ 75 degree
Detector	Imaging Plate (IP)
	Size : 400 (V) × 200(H) mm^2
	Reader: Off-line
Collimator size	0.1 (V) × 0.1 (H) mm^2
	~ 0.7 (V) × 3.0 (H) mm^2

Accessories for the large Debye-Scherrer camera	Control range of temperature
Closed-type cryostat	15 ~ 300 K
Low-temperature N_2 gas flow system	90 ~ 300 K
High-temperature N_2 gas flow system	300 ~ 1000 K

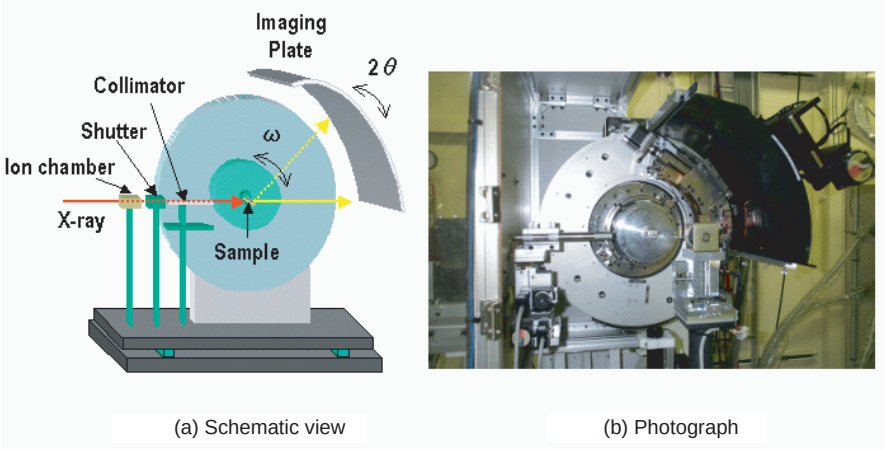


Fig.1. Large Debye-Scherrer camera installed at the experimental hutch

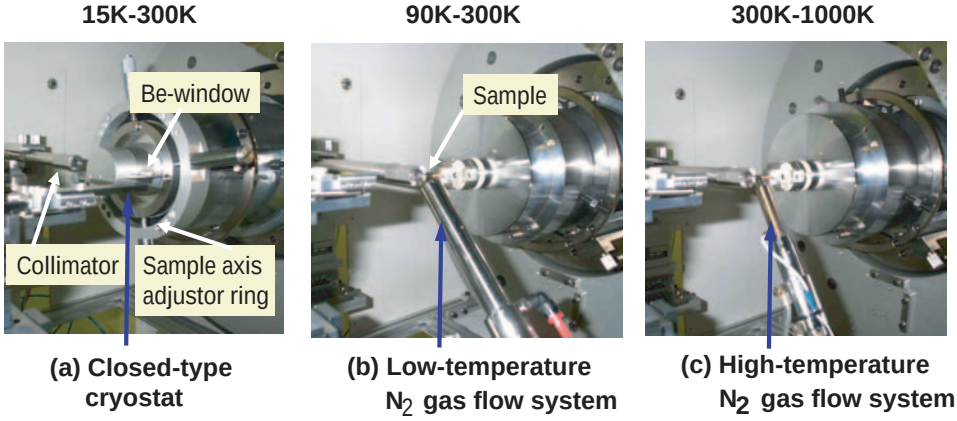


Fig.2. Accessories installed at the large Debye-Scherrer camera

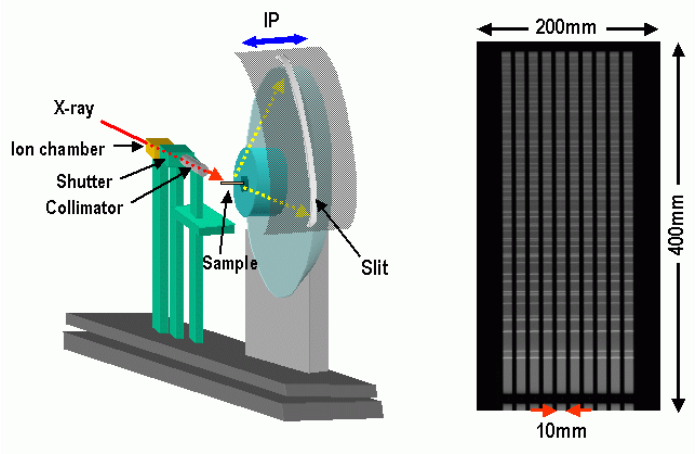


Fig.3. Multi pattern recording system using a long vertical slit

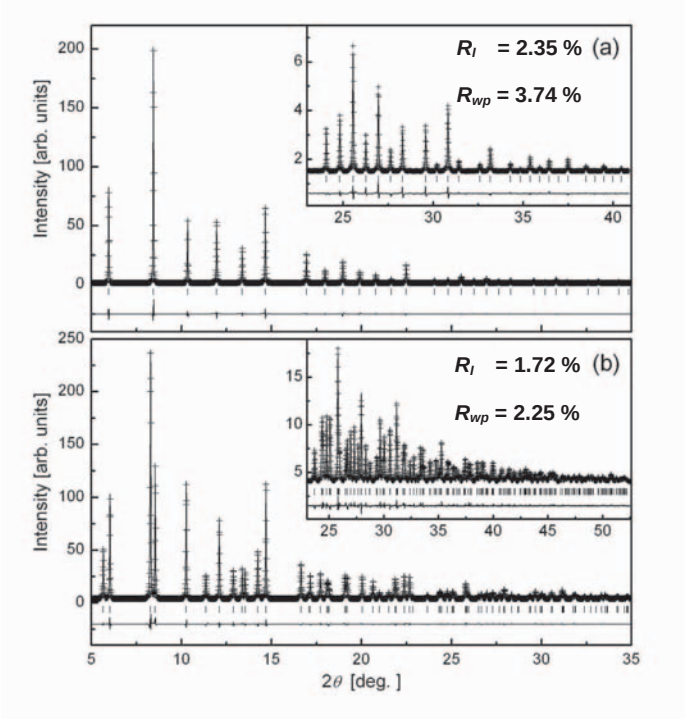


Fig.4. Rietveld fitting for $PbTiO_3$ at (a) 800 K (cubic phase) and (b) 300 K (tetragonal phase)[3]

References

[1] Nuclear Instruments and Methods in Physics Research A467-468 (2001) 1045.

[2] Advance in X-ray Analysis, 45 (2002) 377.

[3] Physical Review Letters, 87 (2001) 217601.

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