High-temperature Research (BL04B1)

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1. Introduction

The BL04B1 beamline is designed for high-pressure and high-temperature research using energy-dispersive diffraction techniques. The beamline is built on a bending magnet and uses no monochromatic beam. The main high-pressure and high-temperature experimental facilities are a large-volume press and a high-pressure vessel, each of which is supported by two user subgroups, i.e., the high-pressure mineral physics group and the high-temperature group. This beamline was opened to users in October 1997.

2. Beamline Design

The beamline is designed to have an optics station and two experimental stations. The experimental stations are built in tandem; The large-volume press is installed at the first station and the high-pressure vessel is at the second station. Each station is equipped with a powder diffractometer, and a white beam up to 150 keV energy is available for energy-dispersive diffraction experiments using a Ge-SSD. The energy resolution E/ΔE is over 10000 in the entire energy range.

3. Experimental Facilities

3.1 First experimental station (High-pressure mineral physics)

The newly developed large-volume press in the first station has a 1500 ton ram-force uniaxial press, which is named SPEED-1500 (SPring Eight Energy-dispersive Device-1500 ton, Fig. 1). The press is equipped with two single-axis (vertical and horizontal directions) goniometers. The vertical goniometer covers up to ±25 degrees and the horizontal goniometer covers up to ±10 degrees in the diffraction angles. The press is mounted on the control stage which is moved in the x-, y-, z-axis translation and the z-axis rotation directions. In addition, a divergence slit and a receiving slit are mounted on the control stage independent of the press. All movements can be controlled within an accuracy of 1 micron.

The compression system of SPEED-1500 is of the so-called 6-8 two-stage type (Fig. 2). The first stage is of the DIA-type with six anvils and the second stage is of the MA8-type with eight anvils.

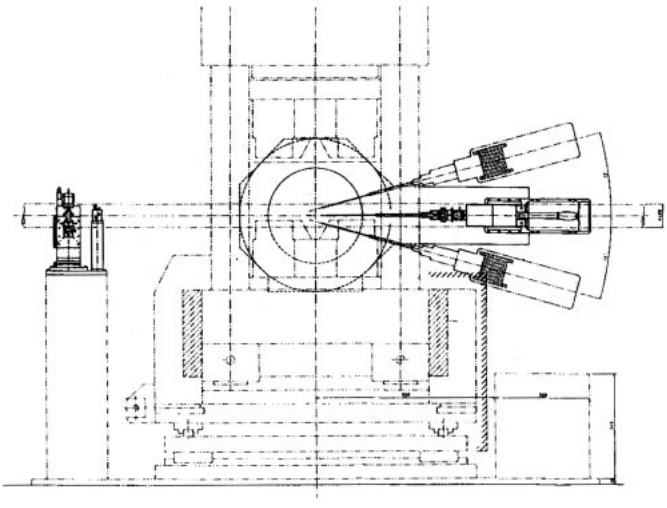

Fig. 1 Large volume press SPEED-1500.

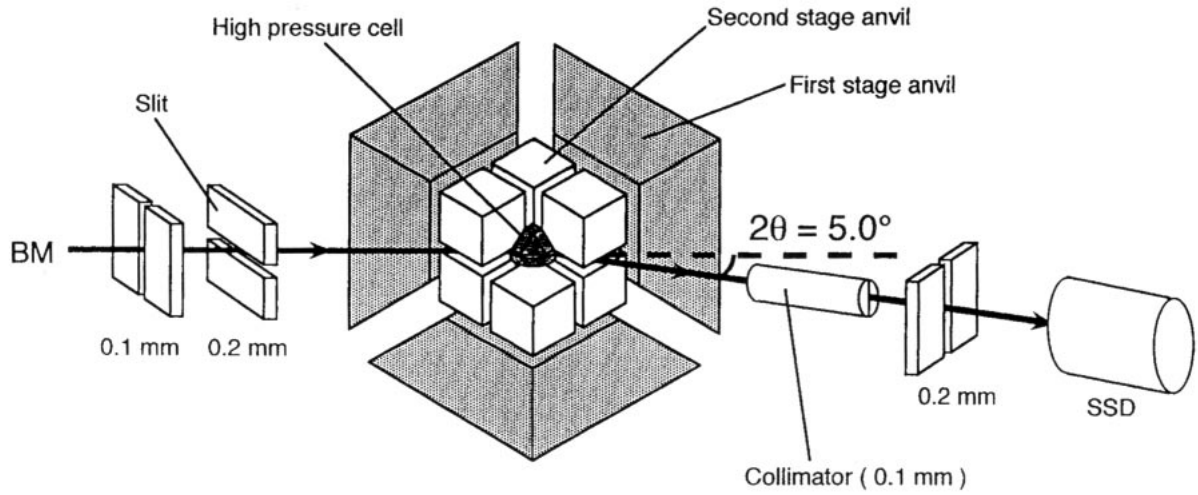

Fig. 2 Schematic drawing of high-pressure and high-temperature measurement using the 6-8 two-stage type.

An octahedral shaped pressure medium is compressed by the eight inner anvils, which are compressed by the outer six anvils. Either tungsten carbide or semi-sintered diamond can be used for the second anvils. This system is available for high-pressure and high-temperature measurements up to 30 GPa and 2000˚ C by using tungsten carbide anvils. A pressure higher than 40 GPa is possible when semi-sintered diamond anvils are used.

3.2 Second experimental station (High-temperature)

This station is designed for diffraction studies on expanded fluid metals and semiconductors at pressure values higher than the critical point. The main facilities are a high-pressure vessel and an energy-dispersive diffractometer using a Ge-SSD (Fig. 3). Helium high-pressure gas is used for the pressure medium and the fluid sample is contained in a single crystal sapphire cell surrounded by the compressed helium gas. The high-pressure vessel has Be windows for incident and scattered x-rays and is equipped with a horizontal goniometer which is mounted on the x-z control stage. The goniometer and the stage can be controlled from a personal PC. This system is available for high-pressure and high-temperature measurements up to 2000 kg/cm2 and 1650˚ C.

Fig. 3 High-pressure vessel and diffractometer.