High Temperature Research (BL04B1)

1. Introduction

The BL04B1 is a bending magnet beamline designed for high pressure and high temperature experiments. The beamline uses only an unfocused white beam over the range of 20 to 150 keV, which is suitable for energy dispersive powder X-ray diffraction. This ideal white beam flux density at the sample is 1.0×10^{14} photons/sec/mrad^2 at 28.9 keV. The main high pressure and high temperature experimental facilities are a large multi-anvil apparatus (SPEED-1500) and a high pressure vessel. The beamline has two experimental hutches, each of which is supported by two user subgroups, *i.e.,* the high pressure mineral group and the high temperature group. One is dedicated to the large press (SPEED-1500), used for the high pressure mineral physics group, and the other is dedicated to the high pressure vessel, used for the high temperature group. These hutches have been built in tandem.

2. Experimental Facilities

2.1 High Pressure Mineral Physics Group

The main high pressure facility SPEED-1500 is the double stage type multi-anvil press with 1500 ton ram force. The outside first stage is the DIA type, which consists of six cubic type anvils in the [100] axis direction. The inside second stage consists of eight cubic anvils, each of which has one corner truncated into a triangular face. The eight faces form an octahedral cavity. The eight second stage anvils that are compressed by the six first stage anvils compress an octahedral shaped pressure medium. In the present system, a 26 × 26 × 26 mm WC or a 14 × 14 × 14 mm sintered diamond anvil can be used as the second anvil. 25 GPa over 2,000 °C has been reached with the WC anvils with maximum 1,500 ton ram load. Recently, sintered diamond anvils have been tested at SPEED-1500 (Fig. 1), and 40 GPa has been reached with less than half of the maximum load.

In order to carry out the energy dispersive X-ray diffraction on the double stage system, the first stage anvils are cut holes to pass the X-ray beam. The incident white X-ray beam from the first stage passes through the gaps between the second stage anvils in a horizontal plane. The horizontal diffractometer covers a range of 2θ angles up to 15°. The incident beam can be as low as 50 × 50 μm^2 and the diffracted X-rays are detected by Ge SSD.

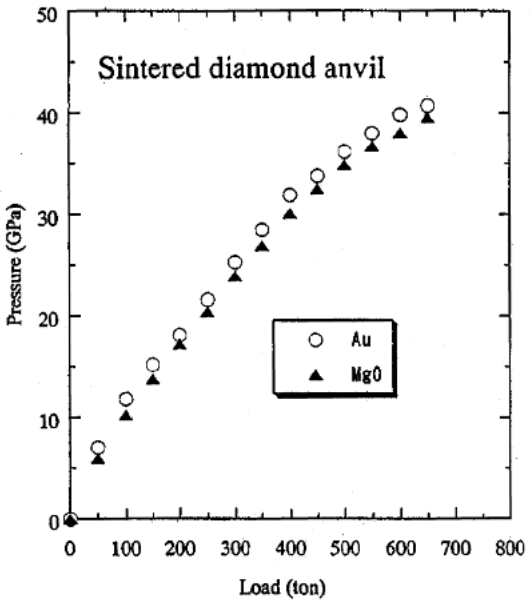

Fig. 1. Pressure (GPa) vs. load (ton) for SPEED-1500 with sintered diamond anvils (TEL = 14 mm) determined by using MgO and Au internal pressure standards.

2.2 High Temperature Group

The tandem downstream hutch is designed for the structural study of high pressure and high temperature expanded fluid over the critical point. The high pressure vessel is equipped with a horizontal energy dispersive X-ray diffractometer. The vessel has Be windows for the incident and scattered X-ray beam (2θ = 5, 10, 20, 33°). High purity He gas is used for the pressure medium, and the fluid sample contained in a single crystal sapphire cell is surrounded by the compressed He gas in the vessel. The pressure is measured by a Heise gauge at an accuracy of ± 3 bar. The system is suitable for high pressure and high temperature X-ray diffraction measurement up to 2,000 kg/cm^2 and 1,650 °C. The latest result of expanded fluid Hg (T_c = 1,478 °C, P_c = 1,673 bar, ρ_c = 5.8 g/cm^3) is shown in Fig. 2. Much important information on the metal – non metal transition of fluid Hg has been obtained from the energy dispersive X-ray diffraction study [1].

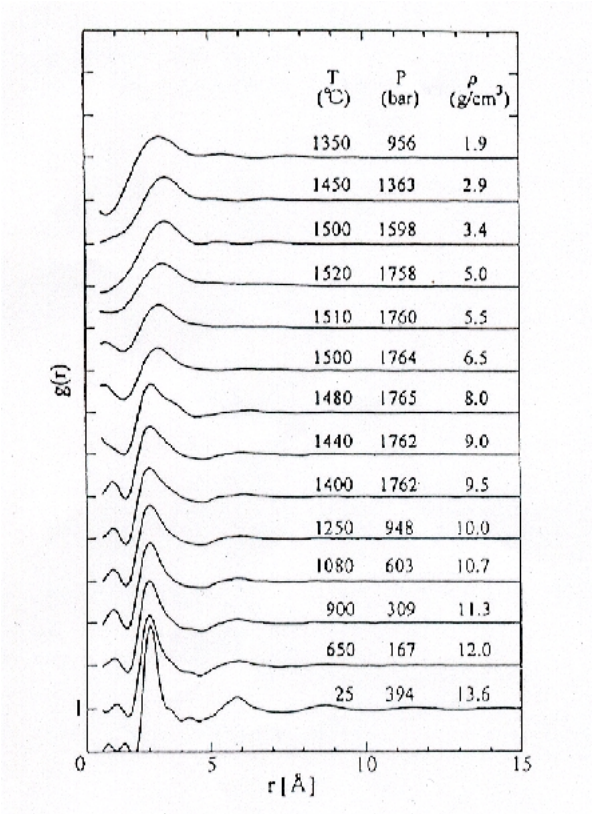

Fig. 2. Pair distribution functions g(r) for expanded fluid Hg [1].

References

[1] K. Tamura *et al.*, J. Phys., **10** (1998) 11405.