High Pressure Mineral Physics

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1. Introduction

High pressure x-ray observation is one of the most important techniques in the mineral physics. A large volume high pressure apparatus combined with synchrotron radiation allows us to investigate the constitution and the dynamics in the deep interior of the Earth and planets.

We constructed the experimental station for high pressure mineral physics study in the up stream hutch of high temperature beamline (BL04B1), in which the bending magnet is a light source. This station has been opened for user since October, 1997.

2. Experimental Facilities

This beamline has no monochromater and polychromatic x-ray up to 200 keV is supplied to the station. X-ray diffraction experiments are carried out by the energy dispersive method using a Ge-SSD.

The high pressure apparatus is so called 6-8 two stage compression type, which is driven by the uniaxial 1500 ton press (Fig.1). The first stage is the DIA-type apparatus with six anvils and the second stage consists of eight anvils of the MA8-type apparatus (Fig.2). The vertical and the horizontal single-axis goniometers are equipped for this apparatus. The press and the goniometers are mounted on the translation stages to align the beam with the sample. We call this high pressure x-ray system SPEED1500.

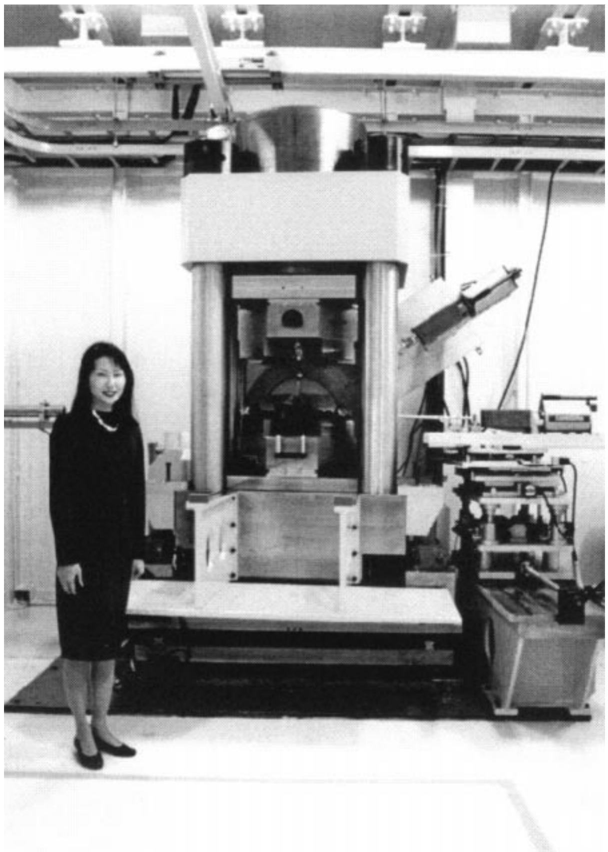

Fig. 1. High pressure x-ray system SPEED 1500 installed at BL04B1.

We have used the tungsten carbide cube as the second stage anvil to successfully generate high pressure up to about 30 GPa. Temperature higher than 2000 K stably generated by the

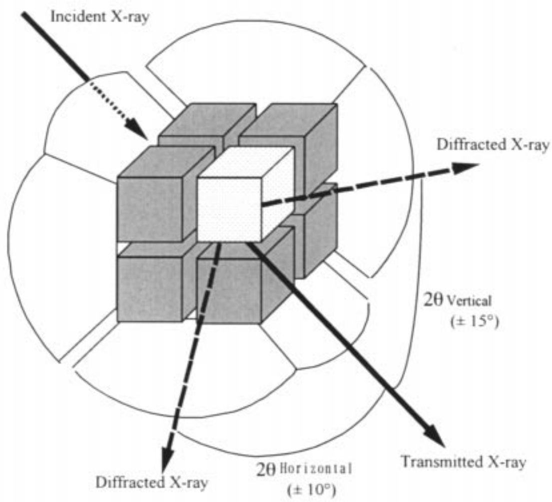

Fig. 2. Schematic drawing of the two-stage high pressure apparatus.

internal resistance heater. It is expected that the semi-sintered diamond anvil has a performance to generate the higher pressure than 30 GPa. This will be tested in coming year. The *P-T* range attainable with SPEED 1500 is shown in Fig. 3.

A brilliant incident x-ray can expose the sample diffraction pattern within several minutes (Fig.4). Intensity of x-ray above 100keV is still high enough to detect the diffraction peak due to the high photon energy of 8 GeV.

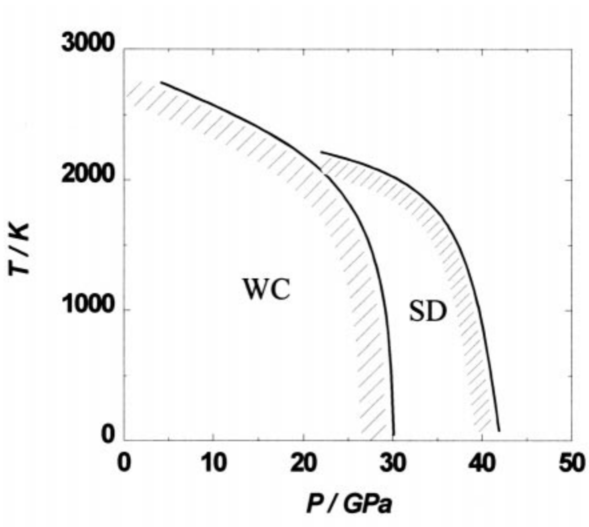

Fig.3. P-T range available in a in-situ x-ray observation with SPEED1500.

3. Research Activity

We have performed the several kinds of study using this experimental station. The phase equilibrium in the system $MgO-SiO_2$ is one of the important theme in the earth sciences, because the Earth's mantle is mainly composed of MgO and SiO_2. The precise phase boundary of postspinel transition of $MgSiO_4$ was determined using the internal pressure standard (Irifune et al.). Ilmenite-perovskite transition of $MgSiO_3$ was also investigated. Kinetics of postspinel transition has been studied for Mg_2SiO_4. These study will elucidate the origin of the 670km seismic discontinuity and the deep focus earthquake in the Earth's mantle.

Study of phase relations is also important in the solid state physics and the material science. Pressure induced phase transition and amorphization of CaI_2-structured PbI_2 was studied to 15 GPa. A trial study on the mechanism of diamond synthesis was conducted using a carbonate catalyst to elucidated the role of carbonate. This study will give the key information on the industrial diamond synthesis and the origin of natural diamond.

Gold is a one of the most plausible pressure standard. In order to establish the equation of state for gold, *P-V-T* relationships of gold was determined up to 20 GPa and 1200K.

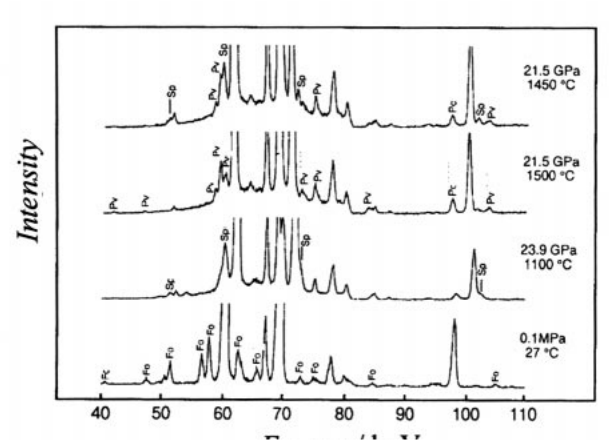

Fig.4. Example of x-ray diffraction pattern acquired by SPEED1500.

Reference

Irifune et al., Postspinel phase boundary in Mg_2SiO_4 determined by in situ x-ray measurement, Science, (in press)