EARTH & PLANETARY SCIENCE

Some technically important progress has been made in beamlines related to high-pressure Earth sciences. A combination of a laser-heated diamond anvil cell (LHDAC) and monochromatic X-rays at BL10XU has made it possible to conduct *in situ* diffraction measurements under P/T conditions equivalent to the mantle-core boundary (a depth of ~3000 km) of Earth. On the other hand, a newly installed large-volume multianvil apparatus press (LVMAP or Kawai-type apparatus), referred to as "SPEED-MkII," at BL04B1 has been used for the precise determination of phase boundaries and higher pressure generation with sintered diamond anvils utilizing its improved guide block and new oscillation systems.

Isshiki *et al.* first made an *in situ* X-ray diffraction measurement of $MgCO_3$ magnesite, the major carbonate in the deep mantle, under entire mantle conditions using the LHDAC at BL10XU to address long-term carbon recycling in the solid Earth-ocean-atmosphere system. They found that magnesite is stable at depths down to ~ 2600 km in the mantle, where it is transformed into a new structure, which is unquenchable under ambient conditions. Parts of this study have been published in *Nature*, and have drown the attention of researchers from a wide range of specialties.

Using a DAC with an external heating system at BL04B2, Kawamoto *et al.* suggested the occurrence of a drastic compositional change in an aqueous fluid at approximately 3 GPa, based on *in situ* X-ray observations for the coexisting solid phases under precisely controlled pressure and temperature. They concluded that the aqueous fluid and the hydrous partial melt may unite to form a single phase under a certain P/T condition in the upper mantle, as these phases should have similar compositions possessing high Mg/Si ratios.

The determination of this "second critical endpoint" has been challenged with a different approach by Mibe *et al.* using the LVMAP (SPEED-1500) at BL04B1. They directly observed morphological changes in the coexisting phases in a synthetic hydrous sample using an X-ray radiographic imaging technique at high pressure and high temperature. They claim that the second critical endpoint exists at a pressure in the range of 4 - 4.3 GPa for the specific composition they used, on the basis of the observed changes in the sample under pressure and those in the quenched sample.

Katsura *et al.* reported detailed specifications and characteristics of the newly designed LVMAP installed at BL04B1 in 2002. This system uses a new guide block, which equally pressurizes the second-stage anvil assemblage for the safer operation of second-stage anvils made of expensive polycrystalline diamond sintered material. The other major improvement in SPEED-MkII is the adoption of a mechanism to oscillate the entire press system while *in situ* X-ray diffraction data are being acquired, so that the effect of crystal growth on diffraction profiles can be minimized during high-pressure and high-temperature runs. Initial tests on these improved points in SPEED-MkII are reported to be quite satisfactory.

Nishiyama *et al.* then used SPEED-MkII for the determination of the B1-B2 transition in NaCl by an *in situ* X-ray diffraction method at pressures up to ~ 25 GPa and temperatures up to 2100 K. They found that the new oscillation system of SPEED-MkII works remarkably well, and were able to define the boundary very precisely under these conditions despite of the observed significant crystal growth of NaCl. They concluded that NaCl cannot be used as the pressure scale for the P/T conditions equivalent to the base of the mantle transition region (~ 600 km in depth) due to the transition to the B2 phase.

Developments in the new technology in both the LHDAC and LVMAP combined with the bright light source at SPring-8 thus provide opportunities for observing the detailed structures, physical properties, and dynamic processes in deeper parts of Earth's and planetary interiors with much improved accuracy.

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