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CaSiO3 ペロフスカイトの状態方程式
Thermal equation of state of CaSiO3 perovskite

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CaSiO3 perovskite (Ca-perovskite) is one of the major constituent minerals in the deep mantle. In the lower mantle conditions, peridotitic mantle and subducted mid-oceanic ridge basalt (MORB) contain ˜5 wt% and ˜23 wt% Ca-Perovskite, respectively (Hirose et al., 1999, Wood, 2000, Hirose et al., 2005). In addition to MORB, recently, subduction of continental crusts is discussed in relation to the continental growth history. Experimental studies demonstrated that subducted continental crust may also contain Ca-perovskite at the pressure-temperature conditions near the 660-km discontinuity (Wu et al., 2009). Therefore, the density and elastic behavior of Ca-perovskite may be a key to understand the distribution of the subducted materials in the deep Earth. In the present study, we constructed a thermal equation of state of Ca-perovskite based on high-temperature diamond anvil cell (DAC) experiments.

The pressure-volume-temperature (P-V-T) relation of Ca-Perovskite was studied in a DAC with in situ X-ray diffraction method. For high-P-T generation, an externally-heated DAC and laser-heated DAC were used. A membrane gas regulating system was attached to both types of the DAC. Diamond anvils with 150 micron

beveled were used. A starting material was pure CaSiO3 glass mixed with platinum powder which served as a laser absorber and pressure standard. The sample mixture was sandwiched by NaCl pressure medium and was loaded into 50 micron sample chamber in a rhenium gasket. Angle-dispersive X-ray diffraction spectra were collected on a charge-coupled device (CCD) at the BL10XU beamline, SPring-8. Exposure times were 10 seconds. A monochromatized X-ray with a wavelength of about 0.41 A was collimated to 20 micron in diameter. Pressure was calculated from the unit-cell volume of Pt, using the thermal equation of state of Pt (Fei et al., 2004).

We conducted three separate compression runs at BL10XU of SPring-8.The sample was compressed to a certain pressure at 300 K and then the temperature was increased by the laser heating to synthesize Ca-perovskite. After the temperature was reached to a desired temperature, we started compression by increasing the gas pressure in the membrane system. During compression, we kept constant temperature so as to make isothermal compression experiments. We collected the XRD pattern at every 3-4 GPa. The maximum pressure we reached was 127 GPa. In one run, we conducted simultaneous heating of laser and external heating systems. First we increased the temperature by the external heating system to 700 K. Then, the laser was turned on to further increase temperature. This technique allowed us to reduce the temperature gradient in the sample and to attain much more stable heating compared to the laser heating alone.

We fitted thus obtained data to a thermal equation of state. We will present new P-V-T data of Ca-perovskite and discuss its density and elastic behavior at the deep lower mantle conditions.

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