Stability and P-V-T equation of state of MgAl2O4 calcium ferrite-type structure

Yuichiro Sueda[1]; Tetsuo Irifune[2]; Takeshi Sanehira[2]; takehiro kunimoto[3]; Toru Shinmei[1]; Daisuke Yamazaki[2]; Toru Inoue[2]; Ken-ichi Funakoshi[4]; Akifumi Nozawa[4]

[1] GRC, Ehime Univ; [2] GRC, Ehime Univ.; [3] GRC,Ehime Univ.; [4] JASRI

Al-rich phase with MgAl2O4 calcium ferrite (CaFe2O4) type structure is one of the major minerals in mid-ocean ridge basalt (MORB), and taken to lower mantle with subducting oceanic crust. Thus, it is important to determine the stability and the equation of state of MgAl2O4 calcium ferrite type structure for understanding the geodynamics. In this study, we conducted in situ X-ray observations to determine the phase relations and the thermoelastic parameters in MgAl2O4 up to 45 GPa and 2500 K.

The experiments were conducted using Kawai type apparatus combined with synchrotron radiation, installed at the BL04 beamline, SPring-8. We used sintered diamond and c-BN as second anvils (L=14mm), and conducted the experiments up to 45 GPa and 2500 K. The starting material was used MgAl2O4 spinel mixed with gold powder (10:1 wt%) for pressure measurement. Pressure was estimated from the equation of state of gold reported by Anderson et al. (1989). P-V-T data were collected after synthesized at 1800 K and the stability field in CaFe2O4 type structure, and acquired at every 200 K upon decreasing temperature to the room temperature.

The experiments were conducted at 25-45 GPa and to 2500 K. CaFe2O4 type structure was observed up to 45 GPa and at 1800 K. However, we could observe the phase transition to the unknown phase at 2100 K and 42 GPa. Furthermore, CaTi2O4 type structure was observed at 43.5 GPa and 2373 K. Thus, we expect to be the triple point at 43 GPa and 2000 K in MgAl2O4. The crystal structure of unknown phase was under analyzing.

The obtained P-V-T data at the room temperature were fitted by Birch-Murnaghan equation of state, and the bulk modulus and it""s pressure derivative were determined as K0=211 GPa, dK0dP=3.7. We also analyzed the P-V-T data at high temperature to 1800 K under pressure, and determined thermal expansion coefficient at the ambient condition and the temperature derivative of the bulk modulus, a0=2.3*10-5 K-1, b0=1.9*10-8 K-2, and (dK0/dT)P=-0.034 GPa/K.