Thermoelastic properties of CaMg2Al6O12 hexagonal phase determined by in situ X-ray observations up to 19GPa and 1273K

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Density difference of the subducted mid oceanic ridge basalt (MORB) relative to the ambient peridotitic mantle is very important to understand the geodynamics and chemical evolution of the Earth (e.g., Irifune and Ringwood. 1987). In the lower mantle conditions, Al-phase appears in the MORB (Irifune and Ringwood 1993). This Al-phase has the same structure as CaMg2Al6O12 hexagonal phase (Akaogi et al. 1999). The CaMg2Al6O12 phase is the important end-member of the Al-phase in MORB. In order to study the dynamics of subducted oceanic crust, we have measured lattice parameters of at wide range of P-T conditions, and determined its thermal equation of state.

The CaMg2Al6O12 hexagonal phase was synthesized from reagents by using a multi-anvil apparatus SPI-1000 installed at Tokyo Institute of Technology at 17 GPa and 1973 K for 2 h. The reagents of MgO, Al2O3 and CaCO3 were mixed to possess desired ratio, decarbonated, heated at 1273 K for one night and used for synthesis experiment. In situ X-ray observation experiments were conducted using the MAX-3 multi-anvil apparatus installed at the synchrotron beam line (BL14C2) in the Photon Factory at National Laboratory for High Energy Accelerator Research Organization, Tsukuba, Japan. Double-stage compression was made with seven WC and one ADC (for X-ray window) cubic anvils (10 x 10 x 10 mm3). Sample assembly with LaCrO3 pressure transmitting medium, Re sheet heater, W-Re thermocouple and WC cubic anvil (TEL = 2 mm) were used. Careful attention was made to achieve hydrostatic sample environment even at high pressures. A sintered chip (not powder) of sample was used. The sample and pressure marker (mixture of Au and MgO) were packed into NaCl sample chamber separately. The data collected after heating above 1273 K were used for subsequent calculation. Pressures were calculated by the EOS of Au (Anderson et al. 1989).

The lattice parameters were calculated from 5 isolated diffraction lines of CaMg2Al6O12 hexagonal phase. Datasets of P-V-T were collected at 13 conditions up to 19 GPa and 1273 K. Derived P-V-T data were fitted to high-temperature Birch–Murnaghan EOS. Derived thermoelastic parameters are isothermal bulk modulus KT = 201 GPa, pressure derivative of bulk modulus K` = 4.9, with temperature derivative of bulk modulus dK/dT = -0.055 GPa/K, and volumic thermal expansivity with alpha = a + bT with values of a = 2.4 x 10^(-5) K^(-1) and b = 2.7 x 10^(-8) K^(-2).