

Equation of state of CaTi₂O₄-type MgAl₂O₄

Yuichiro Sueda[1]; Takehiko Yagi[2]; Ken Niwa[3]

[1] Inst.Solid State Phys., Univ. of Tokyo; [2] Inst. Solid State Phys, Univ. Tokyo; [3] ISSP

<http://www.issp.u-tokyo.ac.jp/index.html>

The Al-rich phase is one of the high-pressure phases formed from MORB composition and is regarded to be one of the important host phases of Al in the lower mantle. It is known that Al-rich phase has a complicated solid solution and MgAl₂O₄ is a major end-member of it. MgAl₂O₄ transforms to CaFe₂O₄-type structure (CF phase) at 26 GPa, and then further transforms to CaTi₂O₄-type structure (CT phase) at 42 GPa. However, the elastic property of the CT phase is not well known yet. In this study, we have measured the compressibility and the elastic properties of CT phase up to 25 GPa at room temperature using high-pressure in situ X-ray diffraction technique.

In situ X-ray diffraction measurements were conducted using a laver-type diamond anvil cell at BL-13A and BL-18C, Photon Factory. Starting material was a CaTi₂O₄-type MgAl₂O₄, which was synthesized at 43 GPa and 2373 K using Kawai-type multi-anvil apparatus. This starting material was put in the sample chamber of the diamond anvil cell with the cullet size of 0.45 mm together with gold powder and ruby chips for pressure measurements. The chamber was filled with the helium which works as a hydrostatic pressure medium. Pressure was calculated on the basis of the equation of state of Au reported by Shim et al. (2002) and ruby fluorescence measurements by Mao et al. (1989). The bulk modulus and its pressure derivative were determined by fitting the obtained P-V data of CT phase to the third-order Birch Murnaghan equation of state.

Based on the X-ray diffraction measurements up to 25 GPa at room temperature, we obtained $K_0=204(5)$ GPa, $K_0' = 3.6(6)$, and $V_0=239.9(2)$ Å³. The elastic parameters of CF phase were reported as $K_0=211(5)$ GPa, $K_0' = 3.7(4)$, and $V_0=240.1(3)$ Å³ based on similar measurements (Sueda et al., joint meeting in 2005). These results indicate that the increase of density associated with the CF-CT phase transition at 42 GPa and room temperature is only 0.8 %. The axial compressibility became more isotropic.