低温条件におけるリングウッダイトの変形実験

Deformation experiments of ringwoodite at low temperature conditions

*今村 公裕[1]、久保 友明[1]、加藤 工[1]、亀卦川 卓美[2]、肥後 祐司[3]、丹下 慶範[3]
*Masahiro Imamura[1], Tomoaki Kubo[1], Takumi Kato[1], Takumi Kikegawa[2], Yuji Higo[3], Yoshinori Tange[3]

1.九州大学、2.高エネルギー加速器研究機構、3.高輝度光科学研究センター
1.Kyushu University, 2.Photon Factory, High Energy Accelerator Research Organization, 3.Japan Synchrotron Radiation Institute

Seismic tomography images that some subducting slabs horizontally stagnate near 660km discontinuity (e.g., Fukao and Obayashi, 2013). However, it has been difficult to explain the large deformation of deep slabs in mantle transition zone because the flow law of constituent minerals such as ringwoodite has not been determined yet. Low temperature plasticity (Peierls mechanism) could be a dominant deformation mechanism in cold subducting slab. In order to construct the flow law of ringwoodite in this deformation mechanism, we conducted deformation experiments of $(Mg_{0.9},Fe_{0.1})SiO_4$ ringwoodite at low temperature conditons. Here, we report its preliminary results.

High-pressure deformation experiments were conducted at 9-13 GPa and 500°C in constant-strain rate mode by Deformation-DIA apparatus installed at NE7 and BL04B1 beamlines in synchrotron facilities of PF-AR and SPring-8, respectively. We synthesized a polycrystalline ringwoodite with height of 1.2 mm and diameter of 0.9 mm at 22 GPa and 1400°C for 180 min from a single crystalline San Carlos olivine using a Kawai-type multi-anvil apparatus in Kyushu University. This was recovered and used as a starting material for the deformation experiment. Differential stress and axial strain of ringwoodite samples were estimated from the distortion of Debye ring and radiography image using 50 keV monochromatic X-ray.

Although deformation experiments were performed outside the ringwoodite stability field, we did not observe the back transformation up to at least 500°C. The sample stress almost reached steady state at the strain of about 3%, and then slightly increased under strain up to ~20%, suggesting the strain hardening. The effect of pressure was negligible in our experimental condition. The flow stresses of ringwoodite obtained at 500°C were 2.6-5.1 GPa at the constant strain rates of $1.2\text{-}5.9\times10^{-5}\ s^{-1}$, which is smaller than those obtained at room temperature in the previous study (Nishiyama et al., 2005). Preliminary analysis of the creep data indicates that the stress exponent is about 6. The relatively large stress exponent may suggest that ringwoodite was deformed in low-temperature plasticity regime although further experiments are needed to construct the quantitative flow law.