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Lattice preferred orientation of stishovite in deformation experiment
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Seismic observations reveal strong negative anisotropy ($V_{SV}>V_{SH}$) at around 550 km depth in the lower part of mantle transition zone (Visser et al., 2008). The mantle tomography indicates the obvious association of this negative anisotropy with the subduction zones (Panning and Romanowicz., 2006). The observed anisotropy can be caused by lattice preferred orientation (LPO) of constituting material when the material is elastically anisotropic. Majorite and ringwoodite, which are the dominant minerals in this region, are nearly isotropic (Chai et al., 1997; Weidner et al., 1984). On the other hand, stishovite, which may occur in significant amounts in this region derived from the delaminated subducting basaltic layer (Karato et al., 1997) and continental crust (Kawai et al., 2012), shows strong elastic anisotropy (V_{SV}/V_{SH} is as large as 150%) indicated by the acoustic velocities study (Yoneda et al., 2012) on single crystal of stishovite. Therefore, the LPO of stishovite has a high potential to interpret the seismic anisotropy in the lower part of the transition zone and indicate the geometry of mantle flow.

To investigate the LPO of stishovite, deformation experiments on stishovite were conducted in both simple shear and uni-axial geometry. We prepared starting material of polycrystalline stishovite with grain size of ˜10 μm at 12 GPa and 1450 ℃ in a Kawai-type high-pressure apparatus. Then deformation experiments were carried out at 12 GPa and 1600 ℃ by Kawai-type apparatus for tri-axial deformation (KATD installed at Tokyo Institute of Technology) and deformation-DIA apparatus (SPEED-Mk. II installed at SPring-8). Sintered diamond piston was used in the uni-axial deformation experiment. Shear strain was ˜1.0 estimated from the rotation of platinum strain maker after deformation. From the change of sample length, uni-axial tension and compression strain were 0.4 and 0.1 respectively. The microstructure and crystallographic orientation of the deformed samples were investigated by SEM with EBSD.

The EBSD results reveal that the [001] direction of stishovite tends to be parallel to the shear direction. (100) plane, though not so obvious, tends to parallel to the shear plane. The slip system is consistent with rutile TiO_2 (Blanchin and Faisant., 1979), which has the same structure with stishovite. The calculated seismic anisotropy indicates a fast shear wave along shear direction. Polarization anisotropy reported by Visser et al. (2008) can be attributed by a vertical flow and LPO of stishovite in the transition zone. The negative anisotropy along subduction zones in Panning and Romanowicz. (2006) indicates the type A slabs (slabs which penetrate directly into the lower mantle without much deflection in the transition zone) (Karato et al., 2001).

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