

Deformation experiments of (Mg,Fe)SiO₃-Perovskite at the lower mantle conditions

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The Earth's lower mantle is thought to be consisting of ~77 vol% (Mg,Fe)SiO₃-perovskite (Pv), ~16 vol% ferropericlae and ~8 vol% CaSiO₃-perovskite in pyrolite model. In the uppermost and lowermost lower mantle, presence of seismic anisotropy has been reported. The anisotropy may be produced by lattice preferred orientation of the majority phase Pv. Thus, knowledge of slip system of Pv is important for understanding of rheology in the lower mantle.

Shear deformation experiments at the lower mantle conditions were conducted using Kawai-type apparatus triaxial deformation (KATD) at Tokyo Institute of Technology. Dense aggregates of synthetic (Mg,Fe)SiO₃- orthopyroxene (Mg# = 0.97) was prepared as starting material using Kawai-type multi anvil apparatus at 2 GPa and 1273 K. The shear deformation assembly consists of a Cr₂O₃-doped MgO pressure medium with 7 mm edge length and a cylindrical LaCrO₃ furnace. Temperature was estimated from power-temperature relationship in a similar cell assembly. Pt foil is placed at the back of Al₂O₃ piston to assist sideslip of the piston, and Ni foil placed at the center of sample is used as strain marker. Undeformed runs, which were not deliberately deformed by the differential rams, were quenched after phase transitions and relaxation of stress at 25 GPa and 1873 K. In deformation runs, samples were deformed by moving differential rams in the guide blocks each 75 μm (total 150 μm) during 1 h after the annealing process (for 30 min or 1 h).

Lattice preferred orientation (LPO) of sample was determined using 2D-Xray diffraction patterns of sample. The 2D-Xray diffraction patterns were measured using Imaging plate in the SPring-8 (BL04B1). Analysis of LPO was conducted by the software "Recipro".

Strains of undeformed and deformed recovered samples measured from rotation of strain marker were ~0.4 ± 1 and ~1.3 ± 1, respectively. Then total strains of samples during deformation process in deformation runs are calculated to be ~0.9 ± 1. Average strain rates of sample are $3 \times 10^{-4} \text{ s}^{-1}$. LPO of perovskite in shear deformation experiments developed greatly in comparison with that at undeformed experiment. The results suggest that main slip system of Pv at 25 GPa and 1873 K is [100](001).

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