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CaIrO3ペロフスカイトとポストペロフカイト間の相転移における結晶方位関係とその結果の解釈・応用
Relationship of crystallographic orientation between perovskite and post-perovskite in CaIrO3 and its implication

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After discovery of post-perovskite phase in MgSiO3 by Murakami et al. (2004), main constituting material in the D" layer is considered to be post-perovskite phase. Therefore, transformation mechanism from perovskite to post-perovskite is a key factor to understand the rheology of subducted slab in this region because transformation mechanism often controls the relationship of crystallographic orientation and grain size contrast before and after transformation.

In this study, we focused on the relationship of crystallographic orientation between perovskite and post-perovskite caused by the phase transformation from perovskite to post-perovskite. To access this topic, we used analogue material of CaIrO3, which has a same crystal structure as MgSiO3, becasue MgSiO3 post-perovskite is only stable over ~120 GPa and unquenchable to ambient conditions, meaning the experimental difficulty.

We first prepared the starting materials of large-grained polycrystalline CaIrO3 perovskite at 2 GPa and 1430-1450 C for 12-15 h in piston cylinder apparatus. By using these starting materials, we conducted transformation experiment at 2 GPa and 1100-1400 C for less than 1 min. After experiments, samples were investigated by XRD, SEM and EBSD for phase identification and microstructural observations.

Two important results were obtained in this study: 1) significant grain-size reduction occurs due to phase transformation from perovskite to post-perovskite. 2) topotactic relations, such as a-axis of perovskite accordance with the a-axis of post-perovskite, b-axis of perovskite accordance with the c-axis of post-perovskite, c-axis of perovskite accordance with the b-axis of post-perovskite, were observed on partially transformed sample.

Our results can explain the strong seismic anisotropy in the D" layer of VSH>VSV in circum Pacific region (Panning and Romanowicz, 2006). If perovskite forms lattice preferred orientation by dislocation creep with slip system of [100](010) (Karato et al., 1995) in the subducting slab, phase transformation also yields lattice preferred orientation of post-perovskite due to topotactic relation even if diffusion creep is dominant for post-perovskite due to grain size reduction. As a result, the expected lattice preferred orientation of post-perovskite of c-axis normal to flow plane and a-axis parallel to flow direction suggests that strong seismic anisotropy of VSH>VSV is immediately formed after phase transformation corresponding to the circum Pacific region.