Fabrication of highly-dense and fine-grained olivine aggregates with various crystallographic preferred orientation patterns in natural peridotite rocks

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Olivine is the most abundant mineral in the Earth’ s upper mantle and it is considered to orient crystallographically in response to the mantle flow. Six types of fabrics have been identified in mantle peridotite: A, B, C, D, E and AG type. Physical properties of olivine such as elasticity, plasticity, thermal conductivity, thermal expansion and electron conductivity are known to be anisotropic so that geophysical observations showing directional dependence in the mantle are often attributed to the result of crystallographic preferred orientation (CPO) of the mineral. However, most of our current understanding of the effects of CPO on physical properties of bulk rocks is essentially based on the properties of single crystals.
To measure CPO effect on the bulk rock properties directly by room experiments, it is required to prepare polycrystalline materials with ideally controlled CPO
Olivine particles synthesized from source oxide powders and natural mineral particles prepared from milling natural olivine crystals were used in this study. To fabricate olivine aggregates with CPO, an external strong magnetic field (12 T) was applied to the olivine fine particles which were dispersed in the solvent. The alignment of certain crystallographic axes of the particles with respect to the magnetic direction was anticipated due to magnetic anisotropy of olivine. The dispersed particles were gradually consolidated on a porous alumina mold, which was covered with a solid-liquid separation filter, during drainage of the solvent. The consolidated aggregate was then isostatically pressed and vacuum sintered.
Uni-axially aligned *c*-axes and *b*-axes olivine aggregates that correspond BC-type and AC-type peridotite were obtained from the aggregates aligned under static and rotated magnetic field, respectively.
Tri-axially aligned olivine aggregates corresponding to A-, B-, C- and E-type peridotite were obtained from a modulated rotation magnetic field.

Keywords: crystallographic preferred orientation, olivine, mineral aggregate

