Fabrication of uni- and tri-axially oriented olivine aggregates using colloidal processing under high magnetic field

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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. Physical properties of olivine such as elasticity, plasticity, thermal conductivity, thermal expansion and electron conductivity are known to be very anisotropic so that geophysical observations that show directional dependence in the mantle are often attributed to the result of crystallographic preferred orientation (CPO) of this material. To understand the CPO effects on bulk rock properties, it is ideal d to prepare a material that reproduces the rock texture and measure its properties directly.
Magnetic field (up to 12 T) was applied to fine-grained (~120 nm) equigranular Fe-free and Fe-bearing olivine particles, which were dispersed in ethanol (solvent) with expectation of alignment of certain crystallographic axis of the particles with respect to the magnetic direction due to the olivine magnetic anisotropy. To align the magnetic easy and hard axes of olivine, we used a vertical static magnetic field and horizontal magnetic field with rotating suspensions of the olivine particles, respectively. For tri-axial alignment, we used a horizontal magnetic field with changing rotation rate of the suspensions. The dispersed and aligned particles in a strong magnetic field were gradually deposited on a solid-liquid separation filter during ethanol drainage. The dried particles were then densified isostatically and sintered under vacuum condition out of magnet. With this technique, we could obtain c-, b-axes uniaxially and triaxially aligned Fe-bearing (Fe : Mg = 1 : 9) olivine aggregates with achievements of high density (≥ 99%) and fine grain size.

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