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高周波共振法によるガーネット単結晶弾性定数の測定
Measurements of Elastic Constants of Single-crystal Garnet by High Frequency Resonant Ultrasound Spectroscopy

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Garnet is a major constituent mineral in the lower continental crust, upper mantle, and subducted slab. Gabbroic rock in slab transforms to denser elcogitic rock along with subduction. This larger density, which gives a negative buoyancy to slab, is attributed to the existence of garnet. The abundance of garnet is thus a key to understand the dynamics of subduction. Elastic property of garnet is critical to constrain its abundance in subducted slab from seismic observations. We thus have studied elastic constants of a single-crystal garnet using a resonance method.

We used a natural single-crystal garnet of composition Alm80Py16Sps4 (source unknown). It was selected in terms of the uniformity of crystallographic orientation examined by SEM-EBSD. The orientation of the single crystal was determined by the X-ray precession method. The crystal was shaped into a rectangular parallelepiped (0.890x0.690x0.440 mm^3). Each face was polished flat ($<$ 1 micrometer) in an orientation parallel or perpendicular to $\{100\}$. The density, which is calculated from the chemical composition analyzed with EPMA and the lattice parameter (a= 1.154(1) nm) measured by XRD, is 4.091(8) x 10^3 kg/m^3.

The resonance spectrum was obtained from 3 to 11 MHz by using a measurement system specially designed for such a small sample (Yoneda et al., 2007, JJAP). Elastic constants were determined by repeatedly comparing the obtained resonance spectrum with a theoretical one, which was calculated for trial values of elastic constants. C_{11}, C_{12}, and C_{44} are determined to be 296.0, 111.2, and 94.4 (GPa), respectively. These are quite close to values previously reported for garnet single crystals with similar compositions. We will also report the temperature dependence of elastic constants in this presentation.

キーワード: 弾性定数, 共振法, ザクロ石, 電子線後方散乱回折, 走査型電子顕微鏡
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