Relationship between Raman spectral pattern and crystallographic orientation of Fo89Fa11 olivine

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Relationship between Raman spectra and crystallographic orientation was examined for single crystals of $Fo_{89}Fa_{11}$ olivine [$(Mg_{0.89}Fe_{0.11})_2SiO_4$], which is representative composition of mantle-derived olivine. Raman spectra were obtained for chemically homogeneous olivine grains with various orientations on a thin section of a mantle-derived rock (dunite) using micro-Raman equipment and unpolarized exciting laser. Crystallographic orientations of each olivine grains were determined by an electron backscattered diffraction (EBSD) method. Five apparent peaks at 822, 854, 881, 914, and 955 cm^{-1}, denoted respectively as p1, p2, p3, p4, and p5, were observed in the spectral range from 700 to 1050 cm^{-1}. Although peak positions are constant, intensity patterns vary with crystallographic orientation.

Intensity ratios of p1, p4, and p5 to p2 vary in the range of 0.6-1.5, 0-0.3, and 0.065-0.155, respectively. The maximum is near the [100] axis, near the [001] axis, and near the [001] axis for p1, p4, and -p5, respectively. The minimum is near the [010] axis, near the [100] axis, and near the [101] axis for p1, p4, and p5, respectively. Intensity ratios of p1, p4, and p5 to that of p2 were empirically formulated as functions of crystallographic orientations. The equations represent measured intensity ratios within a standard deviation of 0.06, 0.03, and 0.01 for p1, p4, and p5, respectively. The obtained empirical equations enable us the Raman spectroscopic determination of crystallographic orientation of olivine.