

## Relationship between polarized Raman spectra and crystallographic orientations of olivine

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Crystallographic orientation distribution of olivine grains, a major constituent mineral of terrestrial upper mantle, has essential implication on mantle dynamics because it depends on the conditions of plastic deformation. Determination of crystallographic orientation of olivine is, therefore, important for petrological investigations on mantle deformation. Polarized Raman spectrum of olivine varies significantly with its crystallographic orientation, implying that Raman spectroscopic determination of crystallographic orientation is feasible by understanding the crystallographic orientation-dependence of olivine Raman spectrum. For this purpose, the relationship between polarized Raman spectral patterns and crystallographic orientations of a single crystal of euhedral olivine was quantitatively examined.

Raman spectra were obtained by a micro-Raman spectral analyzing system with a 514.5nm Ar ion laser at Geochemical Laboratory, The University of Tokyo. Raman scattering light was polarized by a polarized filter. This apparatus enables us to analyze polarized Raman spectra with backscattered configuration. Direction of the polarized filter was adjusted to be parallel or perpendicular to polarized direction of the incident laser by using CCl<sub>4</sub>. The former and the latter are denoted as the parallel mode and the cross mode, respectively. Raman spectra of the both modes were measured in the spectral range of 400-1000 cm<sup>-1</sup>. The obtained Raman peaks were fitted to a Lorentz curve and the peak position and intensity were precisely determined using the GRAMS program (Thermo electron Co. Ltd.).

In the spectral range, ten Raman peaks were observed at 440, 552, 584, 609, 823, 837, 855, 865, 881, 919, and 964 cm<sup>-1</sup>. Wavenumbers of these peaks do not vary with crystallographic orientation. The constant peak positions regardless of analyzed positions suggest that the olivine has an identical composition on its surface. Mg# [=100 Mg/(Mg+Fe)] is estimated from the peak positions of the doublet at 823 and 855 cm<sup>-1</sup> to be ca. 90, which is representative composition of olivine in terrestrial upper mantle. Peaks at 552, 609, 823, 855, 964 cm<sup>-1</sup> are observed under the parallel mode and those at 440, 584, 837, 865, 881, and 919 cm<sup>-1</sup> are observed under the cross mode, respectively, when polarization directions and a laser-incident direction coincide with each of the a-, b-, and c-axes. The former group and the latter corresponds to A<sub>g</sub> and B<sub>xg</sub> (x=1, 2, 3) symmetries, respectively. Under the parallel mode, the three peaks at 823, 855, 964 cm<sup>-1</sup> are always observed, however either of the peaks at 552 or 609 cm<sup>-1</sup> appears dependently on both the directions of a laser-incidence and polarization. Combinations of observed peaks significantly change with a laser incident direction under the cross mode. The two peaks at 837 and 865 cm<sup>-1</sup> appear when a laser-incident direction is parallel to the a-axis. The peak at 881 cm<sup>-1</sup> and that at 919 cm<sup>-1</sup> respectively appears when a laser incident direction is parallel to the b- and c-axis. The peak at 440 cm<sup>-1</sup> is not observed when a laser-incident direction is parallel to the a-axis, and the peak at 584 cm<sup>-1</sup> is always observed. On the other hands, both peaks of A<sub>g</sub> and B<sub>xg</sub> symmetries simultaneously appear when either of the polarized directions does not coincide with the crystallographic axes. The relative intensities of these peaks vary significantly with crystallographic orientations. This change of the peak intensities is caused by crystallographic orientation-dependent change of polarizability. We will discuss on the relationship between relative intensities among the Raman peaks and crystallographic orientation in terms of polarizability tensor.