

Simultaneous determination of Mg# and residual pressure in olivine using micro-Raman spectroscopy

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The origin of diamonds is one of the most important issues of Earth and planetary science. Diamonds often capture mineral grains as inclusions during their growth. Fe-Mg olivine is one of the most common minerals observed in mantle-derived diamonds. The olivine inclusions give us essential information on the origin of the host diamonds; Mg# [$=100\text{Mg}/(\text{Mg}+\text{Fe})$] of olivine reflects chemical characteristics of their provenance, and residual pressures in inclusions indicate the depth of their formation.

Raman spectroscopy presents information about structure, phase, composition, and state of minerals. In addition, micro-Raman spectroscopy has several advantages: (1) non-destructive, (2) high spatial resolution which enables measurement of minute parts embedded at a certain depth from surface by adjusting the focal point of laser beam. These enable non-destructive analysis of unexposed tiny inclusions. Therefore, Raman spectroscopy is a powerful and convenient analytical method in petrological and mineralogical investigations. Raman peak positions of olivine depend on composition and residual pressure. By understanding relationship among peak positions, Mg#, and residual pressure, simultaneous determination of both Mg# and residual pressure will be possible. So far, relations between the peak positions and Mg# of olivine have been examined under 1 atm (eg., Kuebler et al., 2006; Mouri & Enami, 2008). On the other hand, systematic studies on pressure-dependence of Raman spectra of olivine have not been reported. In this study, Mg# dependence and pressure dependence of Raman spectra of olivine was systematically studied.

Raman spectra of olivine samples with Mg# of 70-100 were measured under pressure from 0 to 8 GPa using a diamond anvil cell (DAC). *In situ* analysis of Raman spectra was performed by a micro-Raman spectral analyzing system. Samples were excited with Ar ion laser (514.5 nm). Peak position was determined with precision of 0.05 cm^{-1} using the simultaneous calibration and curve fitting procedure (Otake et al., 2008).

Five apparent Raman peaks were observed at around 824, 857, 882, 920, and 966 cm^{-1} in the spectral range of 700-1050 cm^{-1} . These peaks were denoted as p1, p2, p3, p4, and p5, respectively. Peak position of each peak shifted upward as pressure increased. Linear correlations were observed between pressure and peak position for the five peaks. For example, the pressure derivative of peak position, k , for p1, p2, p3, p4, and p5 were ca. 3.30, 3.28, 3.07, 2.99, 5.37 $\text{cm}^{-1}/\text{GPa}$, respectively. Mg# and k showed positive correlation for p2, negative correlation for p3, p4, and p5. No systematic correlation was found for p1. We will formulate Raman peak positions as functions of both Mg# and pressure. The formulae will enable simultaneous, non-destructive determination of both Mg# and residual pressure of olivine inclusions in diamonds.