

Pressure-induced change in the compressional behavior of the O-H bond in chrysotile: A Raman high-pressure study up to 4.5 GPa

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ABSTRACT

A change in the linear pressure behavior of the chrysotile Raman O-H band is revealed by an in-situ high-pressure Raman study using a diamond anvil cell (DAC) at 0.1–0.4 GPa pressure intervals. The peak of 3701 cm⁻¹ can be accurately determined in the pressure range of 0.2–4.5 GPa regardless of peak fitting models. The pressure (P)-wavenumber (ν) relationship for the peak is closely approximated by two linear functions with the slopes ($d\nu/dP$) of 4.3 cm⁻¹/GPa and 1.7 cm⁻¹/GPa at pressures above and below 1.7 GPa, respectively. The spectral resolution given by a peak fitting method (0.5 cm⁻¹) implies that these functions for changes in the positions of the 3701 cm⁻¹ peak provide pressure estimates with resolutions of 0.1–0.2 GPa. This method can be used to estimate remnant pressure in natural samples in the form of thin sections. The pressure shift characterized by the change in slope and the associated decrease of the peak width can be explained by a model where the change in compressibility of the tetrahedral layer affects the interaction between the inner O-H and Si atoms forming a six-membered ring. The high-pressure dependence at pressures lower than 1.7 GPa may be a contribution of a dominant layer-parallel (in-plane) compression that compensates a distortion in the tetrahedral layer of chrysotile. The conclusion that chrysotile changes its compressibility at around 1.7 GPa is significant for understanding of the properties of chrysotile nano-fibers and possibly for thermodynamic consideration on serpentine phase relations.

Keywords: High-pressure Raman spectroscopy, chrysotile, pressure scale, O-H bond, compressional behavior of sheet silicate