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Raman spectroscopy study of manganese oxides: Tunnel structures

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Abstract

Raman spectra were collected for an extensive set of well-characterized tunnel-structure Mn oxide mineral species employing a range of data collection conditions. Using various laser wavelengths, such as 785, 633, and 532 nm at low power levels (30–500 μW), as well as the comprehensive database of standard spectra presented here, it is generally possible to distinguish and identify the various tunnel structure Mn oxide minerals. The Raman mode relative intensities can vary significantly as a function of crystal orientation relative to the incident laser light polarization direction as well as laser light wavelength. Consequently, phase identification success is enhanced when using a standards database that includes multiple spectra collected for different crystal orientations and with different laser light wavelengths. For the hollandite-group minerals, the frequency of the Raman mode near 630 cm^{-1} shows a strong linear correlation with the fraction of Mn^{3+} in the octahedral Mn sites. With the comprehensive Raman database of well-characterized Mn oxide standards provided here (and available online as Supplemental Materials[1]), and use of appropriate data collection conditions, micro-Raman is a powerful tool for identification and characterization of biotic and abiotic Mn oxide phases from diverse natural settings, including on other planets.

Keywords: Manganese oxide, Raman spectroscopy, todorokite, hollandite