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Raman spectroscopy study of manganese oxides: Layer structures

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Abstract

Raman spectra were collected for an extensive set of well-characterized layer-structure Mn oxide mineral species (phyllomanganates) employing a range of data collection conditions. We show that the application of various laser wavelengths, such as 785, 633, and 532 nm, at low power levels (30–500 μW) in conjunction with the comprehensive database of standard spectra presented here, makes it possible to distinguish and identify the various phyllomanganate 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 incident 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. The position of the highest frequency Raman mode near 630–665 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 Online Material[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, as well as for laboratory and industrial materials.

Keywords: Manganese oxide, Raman spectroscopy, phyllomanganates, birnessite