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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 $(30-500 \ \mu\text{W})$ 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 Mn³⁺ in the octahedral Mn sites. With the comprehensive Raman database of well-characterized Mn oxide standards provided here (and available online as Online Material¹), 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