Raman spectroscopy as a method for mineral identification on lunar robotic exploration missions

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Abstract. The sharp, nonoverlapping Raman bands for plagioclase, pyroxene, and olivine would be advantageous for on-surface, active mineralogical analysis of lunar materials.

A robust, light-weight, low-power, rover-based Raman spectrometer with a laser exciting source, entirely transmission-mode holographic optics, and a charge-coupled device (CCD) detector could fit within a <20 cm cube. A sensor head on the end of an optical fiber bundle that carried the laser beam and returned the scattered radiation could be placed against surfaces at any desired angle by a deployment mechanism; otherwise, the instrument would need no moving parts. A modern micro-Raman spectrometer with its beam broadened (to expand the spot to 50-?m diameter) and set for low resolution (7 cm^{-1} in the 100-1400 cm^{-1} region relative to 514.5-nm excitation), was used to simulate the spectra anticipated from a rover instrument. We present spectra for lunar mineral grains, <1 mm soil fines, breccia fragments, and glasses. From frequencies of olivine peaks, we derived sufficiently precise forsterite contents to correlate the analyzed grains to known rock types and we obtained appropriate forsterite contents from weak signals above background in soil fines and breccias. Peak positions of pyroxenes were sufficiently well

determined to distinguish among orthorhombic, monoclinic, and triclinic (pyroxenoid) structures; additional information can be obtained from pyroxene spectra, but requires further laboratory calibration. Plagioclase provided sharp peaks in soil fines and most breccias even when the glass content was high.