EPSC Abstracts
Vol. 11, EPSC2017-166-1, 2017
European Planetary Science Congress 2017

On the impact of particle size on the characteristics of specular and diffuse reflectance spectra

U. Mall (1), B. Schmidt (2), B. Dabrowski (1), L. Hoenicke (1,2), D. Kloskowski (1,2),

(1) Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany. (2) Institut für Mineralogie, GZG, Universität Göttingen, Goldschmidtstr. 1, Göttingen, Germany

Abstract

Reflectance spectra measurements of materials for studies related to their composition are routinely being made. The remote identification of minerals or rocks by reflectance measurements makes use of the fact that reflectance spectra in the UV-VIS-NIR and thermal infrared (TIR) wavelength regions of minerals contain a number of diagnostic features. These features arise by two different processes which can lead to either maxima or minima in the observed reflectance spectra: Surface scattering, which results from light that has been reflected from the surface without penetration and usually generate upward-going peaks in the reflectance spectrum and volume scattering which generates rays that have penetrated into the sample where the photons have been either scattered and absorbed thus leading to absorption minima. The detailed shape of these features depends on the various chemical and physical parameters of the illuminated sample material. A quantitative composition analysis of a mineral sample depends critically on how accurately one knows these dependencies and the effects of the parameters on the spectral characteristics (e.g. [3]). With the improved instrumentation flown on many recent space missions –resulting in spectra with higher spectral resolution – a better knowledge of the influence of the physical parameters become more important. Among the various physical parameters shaping a reflectance spectrum particle size has been known early on to play an important role (e.g., [1]) and to have a strong effect on albedo and absorption strength ([2]). For studies related to the mineral composition of planetary surfaces where one deals often with soils the analysis of these spectra turns out to be difficult. The analysis of regolith samples is particular complex because such samples are mixtures of different constituents, which can vary in all their characterizing parameters (see e.g. [6]). As regolith on exosphere bound surfaces is principally produced by meteoritic bombardment of the surface, its properties are products of several complex processes (see eg. [5]). Regolith soils such as those collected from the lunar surface contain a distribution of particle sizes that vary largely as a function of surface maturity (e.g. [6]). Many laboratory studies have been made to simulate regolith samples by mixing components of known minerals using specific grain size fractions. Often fraction as <45, 45–250, and 250–1000 µm are chosen. Some fractions have originally been chosen specifically to maximize the overall spectral contrast so that variations in absorption characteristics are well expressed (e.g. [2]). We are reporting on the characteristics of NIR measurements of pure minerals of well-defined grain sizes relevant for remote sensing studies of soils in specular and diffuse reflectance.

References

[1] Aronson, J.,R., Emslie, A.G. and Mc Linden, H.G., Infrared Spectra from Fine Particulate Surfaces, Science, 152, pp. 345-346, 1966.

[2] Crown, D. A., and C. M. Pieters, Spectral properties of plagioclase and pyroxene mixtures and the interpretation of lunar soil spectra, Icarus, 72, 492-506, 1987.

[3] Mall, U. et al., Towards A Quantitative Determination Of The Modal Mineralogy Of Planetary Surfaces Using Near-Infrared Spectroscopic Data From The Moon. LPSC XXXXIII, abstract #1893, 2012.

[4] McKay D.S, Fruland, R.M., and Heiken, G.H, Grain size and the evolution of lunar soils, LPSC, 5th, p. 887-906, 1974.

[5] McKay D.S, et al., The lunar regolith. In: Heiken GH, Vaniman DT, French BM (eds) Lunar sourcebook, pp. 284–356, Cambridge University Press, Cambridge, New York, Melbourne, 1991.

[6] Rommel, D. et al., Automatic Endmember Selection and Nonlinear Spectral Unmixing of Lunar Analog Minerals. ICARUS, 284, pp. 126-149, 2017.