Modeling Emissivity Spectra of Airless Bodies

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Mid-infrared (MIR), 2.5-100 μm or 100-4000 cm^{-1}, spectroscopy is useful for understanding regolith properties of airless bodies. However, MIR emissivity is controlled by many factors such as: composition; grain size distribution, shape, and packing; as well as atmospheric pressure and the thermal environment. Accurately modeling spectral changes due to these factors is particularly challenging for the very fine-grained regolith (d~<60μm) typical of airless solar system bodies.

We present the results of a model which calculates near-surface thermal gradients for a layered regolith as a function various environmental conditions including: pressure, temperature, and illumination [1,2]. This model accounts for particle size distribution, regolith porosity, and composition. Individual layers may have different properties and layers may be composed of mineral mixtures. As a test, we compare modeled emissivity spectra with laboratory measurements of two different size separates of the mineral olivine under both ambient earth and simulated lunar conditions.

The low gravitational acceleration on asteroids, the Moon, and other small, airless solar system bodies allows for the formation of high porosity regolith [3,4]. These conditions, in particular the gravity environment, are not easily replicated in a laboratory setting. To gain a better understanding of the effects of porosity on emissivity we collected spectra of mono-disperse smooth, spherical SiO_2 grains of known packing density profiles. Both measurements and models show that porosity has a significant impact on the transparancy features.

We also look at a few methods for modeling the impact of space weathing on MIR spectra. Space weathered materials have reduced visible albedo and this causes a shift in the Christiansen feature, an emissivity maximum that is can be used to infer silicate composition.

[1] Arnold *et al.* (2015) *TherMoPS II* meeting. [2] Milan *et al.* (2011) *JGR,* 116, E12003. [3] Hapke B. (1993) *Theory of Reflectance and Emittance Spectroscopy,* p. 224. [4] Carrier W.D. *et al*. (1991) In *Lunar Sourcebook* (Heiken G.H., Vaniman D.T., and French B.M., Eds.), pp. 475–594.