FIRST MEASUREMENTS FROM THE PLANETARY AND ASTEROID REGOLITH SPECTROSCOPY ENVIRONMENTAL CHAMBER (PARSEC).

K. A. Shirley[1], T. D. Glotch[1], [1]Department of Geosciences, Stony Brook University, Stony Brook, NY 11794-2100 (katherine.shirley@stonybrook.edu)

Introduction: Remote sensing is an important tool for our understanding of the Moon and other airless Solar System bodies; however, techniques such as remote mineral spectroscopy require detailed laboratory validation that can be difficult to implement. The Planetary and Asteroid Regolith Spectroscopy Environmental Chamber (PARSEC) is a new instrument at Stony Brook University capable of measuring samples at pressures and temperatures comparable to lunar and asteroid conditions. By using PARSEC we can recreate thermal gradients within regolith samples that mimic those found on the Moon and asteroids and allow us to more quantitatively interpret spectral data.

Here we present the first mid-IR (MIR) emissivity measurements obtained using PARSEC for minerals (forsterite, augite, ilmenite, enstatite) and a lunar simulant (JSC1) measured under both ambient and lunar conditions.

Instrumentation: PARSEC was built at the University of Oxford and has recently been installed in the Geosciences Department at Stony Brook University. The chamber is connected to a control box for sample cup position and temperature, a Pfeifer HiCube Vacuum, and a Nicolet 6700 Fourier Transform Infrared spectrometer. The chamber itself contains a rotating wheel with room for six sample cups, and one black body, each of which can be individually heated from below. Additionally, there is an external black body set below the wheel that can also be heated from below. A 75 W solar-like halogen lamp is attached to the outside of the chamber to heat the samples from above, and an LN2 dewar is set within the chamber to cool the chamber and approximate the cold space environment. See Figure 1 for instrument details.

Methods: Each mineral sample was ground and sieved into < 63 μm powders, each of which was placed into a sample cup and set into position within the sample wheel of PARSEC. The chamber was then sealed and spectra were acquired for each mineral under ambient conditions from 400 – 4000 cm^{-1}. The vacuum was activated and the chamber allowed to outgas for several hours under low pressure before filling the dewar with liquid nitrogen and taking spectra under simulated lunar environment (SLE) conditions. SLE conditions for these measurements were defined as 10^{-3} mbar pressure and chamber temperature of < -150 °C. Each sample was heated from below to 120 °C and exposed to heating from above by the solar lamp. Black body

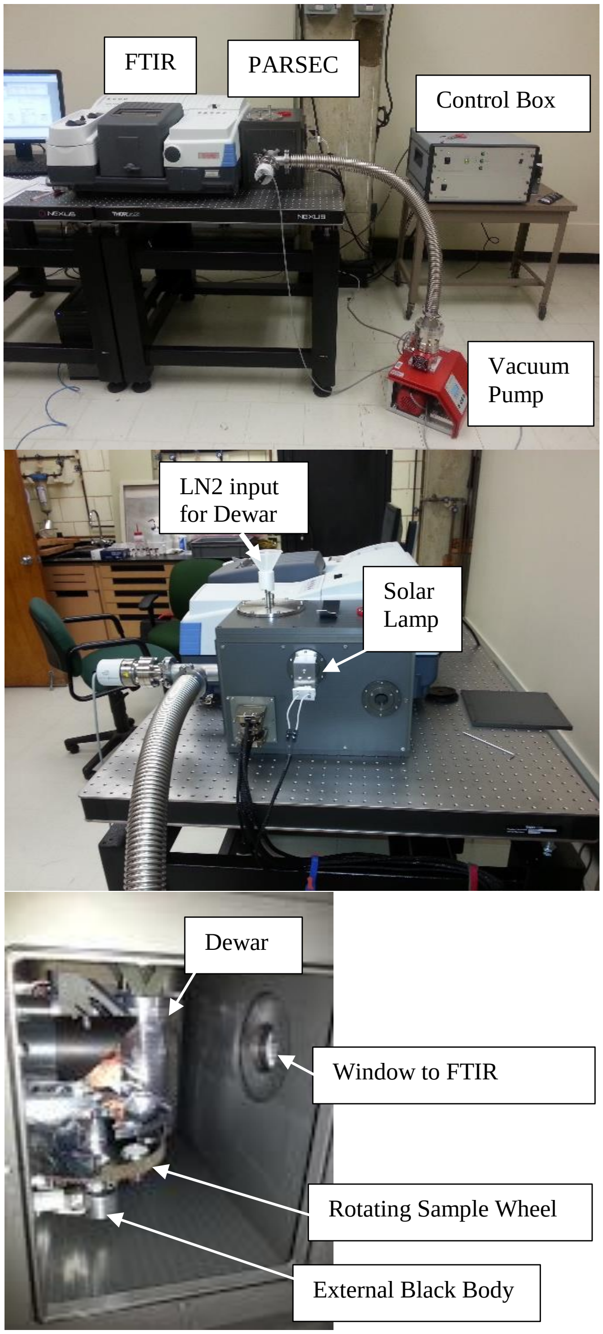

Figure 1. PARSEC laboratory set-up and interior. Parsec od connected to a Nicolet 6700 FTIR, Pfeifer HiCube vacuum, and control box. Liquid nitrogen is input into the dewar, and the solar lamp is attached to the outside of the chamber. Inside, the sample wheel contains six cups for samples, one for the internal black body, and the external black body is located below the wheel.

measurements were taken at 110 °C and 130 °C, first using the external black body, then, half way through measurements, the internal black body set into the sample wheel.

Once all measurements were complete, we calibrated the spectra using the Davinci open source software. Ambient spectra were calibrated following the method of [1] SLE spectra were calibrated following the method of [2].

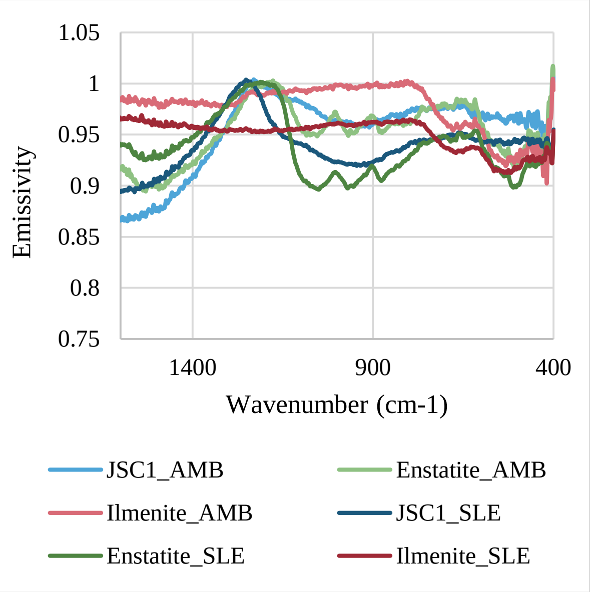

Figure 2. The MIR spectra for JSC1 (blue), enstatite (green), and ilmenite (red) are shown for both ambient and SLE conditions.

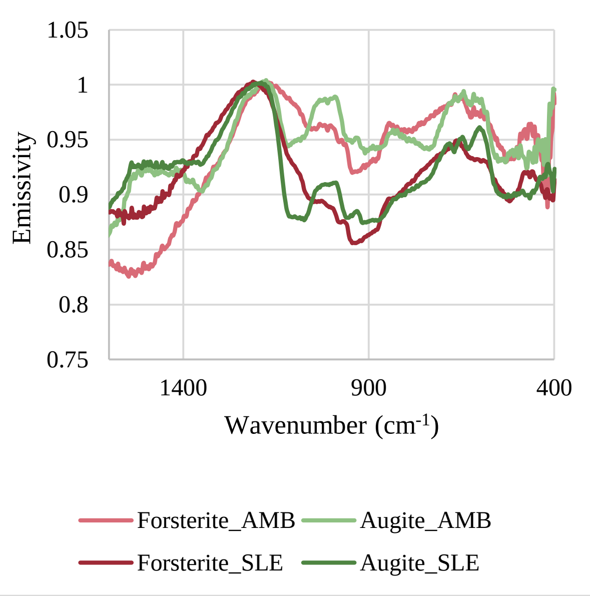

Figure 3. The ambient and SLE spectra for forsterite and augite are shown here. Note the shift in spectra contrast between the ambient and SLE measurements as well as the shift of the CF to longer wavenumbers.

Results: The mineral spectra acquired under ambient and SLE conditions have varied spectral contrast. Forsterite, augite, enstatite, and JSC1 SLE measurements < 1200 cm^{-1} showing greater band depth and > 1200 cm^{-1} having shallower band depths than the ambient measurements (Figures 2 & 3). The ilmenite SLE spectrum is conistently at a shallower band depth than the ambient measurement.

Additionally, the spectral contrast of the Christiansen Feature (CF) is increased under SLE conditions and the location shifts to longer wavenumbers. For example, for forsterite, we see the CF shifting from 1180 cm^{-1} to 1211 cm^{-1} and for augite, it moves from 1176 cm^{-1} to 1190 cm^{-1} (Figure 3).

Discussion: The measurements we have acquired using PARSEC are comparable to those taken using ther SLE instruments (ALEC, SLEC, SABEL) and demonstrate the changes in spectral signal that SLE conditions yield [1-6]. These laboratory experiments are necessary to understand and interpret the spectral information returned from planetary surfaces like the Moon, and directly relate to the data acquired from the Diviner Lunar Radiometer Experiment currently in orbit [5-8].

Future Work: We will continue to acquire the spectra of minerals of different grain sizes and mineral mixtures. PARSEC can also measure within the visible and near-infrared which will allow us to analyze spectra ranging from the visible to mid-infrared. These experiments will give us a better understanding of the environmental conditions in which spectra are acquired on the Moon, as well as better classify the mineral assembleges we can identify from orbit.

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