ULTRAVIOLET TO NEAR-INFRARED SPECTRAL AND PHOTOMETRIC MEASUREMENTS OF 162173 RYUGU POWDERS. C. Jaramillo-Correa[1], D. L. Domingue[2], R. Clark[2], N. Pearson[2], K. Amano[3], T. Hiroi[4], A. Hendrix[2], F. Vilas[2], T. Nakamura[3], H. Yurimoto[5], T. Noguchi[6], R. Okazaki[7], H. Yabuta[8], H. Naraoka[7], K. Sakamoto[9], S. Tachibana[9,10], S.-I. Watanabe[11], and Y. Tsuda[9] [1]Ken and Mary Alice Lindquist Department of Nuclear Engineering, Pennsylvania State University, University Park, PA, U.S.A. (camilo@psu.edu), [2]Planetary Science Institute, 1700 E. Fort Lowell, Tucson AZ, USA 85719, [3]Department of Earth Science, Graduate School of Science, Tohoku University, Aoba, Sendai, Miyagi 980-8578, Japan, [4]Brown University, Providence RI, USA 02912, , [5]Hokkaido University, Sapporo 060-0810, Japan, [6]Kyoto University, Kyoto 606-8502, Japan, [7]Kyushu University, Fukuoka 812-8581, Japan, [8]Hiroshima University, Higashi-Hiroshima 739-8526, Japan, [9]ISAS/JAXA, Sagamihara 252-5210, Japan, [10]The University of Tokyo, Tokyo 113-0033, Japan, [11]Nagoya University, Nagoya 464-8601, Japan.

Introduction: The sample return mission Hayabusa2 delivered samples from C-type asteroid 162173 Ryugu on December 6, 2020. Initial analyses of these samples [1 – 4] have provided insight into Ryugu's composition, evolution, and origins. We present here preliminary spectrophotometric measurements of C0002 powders derived from the mechanical and physical property studies of [2]. Approximately 5mg of powder were provided for examination (Fig 1). Since the powders were exposed to air during the mechanical studies conducted in advance of this examination [2], they were not kept under vacuum while distributed for examination nor for these spectral measurements.

Figure 1. Ryugu powder samples in sample holder. The sample cup (center) is 5mm in diameter.

Measurement Set-up: The measurements were conducted at the University of Illinois Urbana-Champaign using fiber optic probes mounted on a gonionmeter, a compact sample capsule, and two spectrometers: 1) an Avantes AvaSpec-ULS2048XL-EVO spectrometer to measure the ultraviolet (230 - 900nm), and 2) an ASD FieldSpec to measure the visible to near-infrared (900nm – 2350nm). An Avantes AvaLight-DH-S-BAL light source with integrated tungsten and deuterium lamps was used for illumination. Both the deuterium and tungsten lamps were used with the Avantes spectrometer to collect the UV-Vis data, whereas only the tungsten lamp as used with the ASD to illuminate the samples across the visible to near-infrared. The sample was viewed through a UV-grade sapphire window in the capsule holder. Spectralon was used for the reflectance standard across all wavelengths.

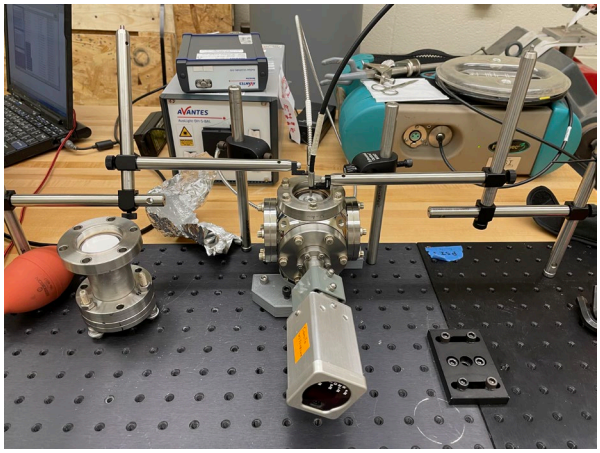

Figure 2. Goniometer setup with fiber optic probes, sample capsule (center), and spectrometers and light source (in the background).

The goniometer setup allowed for spectra to be measured at a variety of different incidence, emission, and phase angle values selected to match the majority of geometries in which the Hayabusa2 NIRS3 spectra were acquired.

Interim Results: Preliminary spectra are displayed in Figure 3. The measurements from the Avantes were corrected to overlap with the ADS over their mutual wavelength range. The increase in reflectance from the visible into the UV is indicative of the presence of fine particles/scattering centers much smaller than 1 micron. Initial comparisons with the NIRS3 data set (Figure 4)

show the laboratory spectra are inherently brighter, but both display featureless spectra with similar slopes. Analyses of these spectra and their corresponding NIRS3 observations are ongoing.

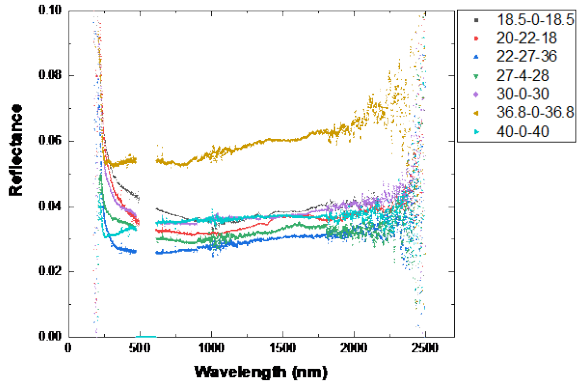

Figure 3. Photometric spectral measurements of Ryugu powders as a function of incidence, emission, and phase angle (as labeled in the legend).

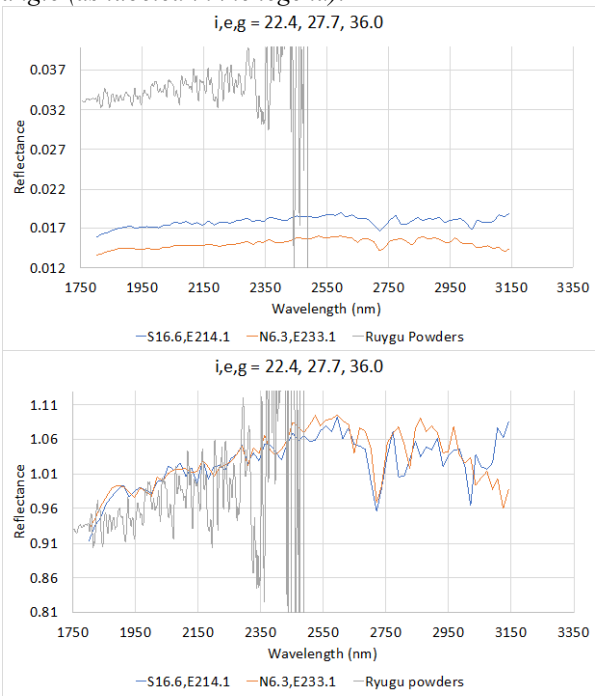

Figure 4. Comparisons of the laboratory spectra of the returned C0002 powder with NIRS3 spectra acquired at near-identical incidence, emission, and phase angle. Grey spectrum is the laboratory spectrum taken at i=22°, e=27°, α=36° (Fig. 3), blue and orange spectra are from the pre-touchdown 1 NIRS3 data archive acquired at similar i, e, and α. (top) absolute reflectance (bottom) reflectance normalized to unity at 2037nm.

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