Initial description of Ryugu returned samples: characteristics of individual grains by FT-IR analysis

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A total of ~5.4 g of sample was collected at the surface of the C-type asteroid 162173 Ryugu and successfully returned to Earth [1] [2]. The collected samples were transported to the curation facility in ISAS, Sagamihara, Japan, and stored in purified nitrogen condition, except for a few grains picked up under vacuum condition, to keep the samples as physically and chemically pristine as possible. Approximately 100 grains have been picked up from each of those in Chamber A, uppermost centimeter-scale layer of Ryugu collected during the first touch-down sampling (TD1), and in Chamber C, surface to subsurface layer (~1 m) of Ryugu collected close to the artificial crater during the second touch-down sampling (TD2). Then, initial descriptions, such as weighing, optical imaging, FT-IR spectroscopy in 1-5 μm range, MicrOmega as a hyperspectral NIR microscope, and visual multispectral imaging, have been performed for characterization of these samples. Here we present the preliminary result of FT-IR spectral analysis for individual grains.

The measurement system consists of the spectrometric unit outside the clean chamber and the sample chamber connected to the clean chamber (Figure 1). Although purified nitrogen gas flowed inside the spectrometric unit, absorption bands of O-H (e.g., H_2O) and that of C-O (CO_2) appeared in the reflectance spectra of reference material (Infragold) measured after the sample analysis, indicating the influence of spectral absorption in the atmosphere. In addition, the spot size of the incident beam, approx. 1 mm in diameter at the focal position, was slightly larger than the sizes of individual grains in many cases, and these data were contaminated by the reflectance from the sapphire dish at the bottom of the sample holder. The reflection from the sapphire dish increased the albedo, changed the spectral slope between 1 and 2.5 μm from positive to negative, and decreased the absorption band depth (Figure 2).

Except for the samples with significant effect of sapphire dish, reflectance spectra of individual grains generally show a similar trend to those of bulk samples [3] in the wavelength range between 2.5 and 4 μm. The depth of absorption bands varied between grains, and the band-depth variation is observed not only between the individual grains but also within the single grain. We also found grains with unique spectral profiles, of which abundance is ~1% or less. These grains basically contain relatively large inclusions, which are apparently different from the surrounding matrix.

We are now planning to modify the FT-IR system to extend to the mid to far-infrared wavelength range, and expect to get further information on the collected Ryugu samples.

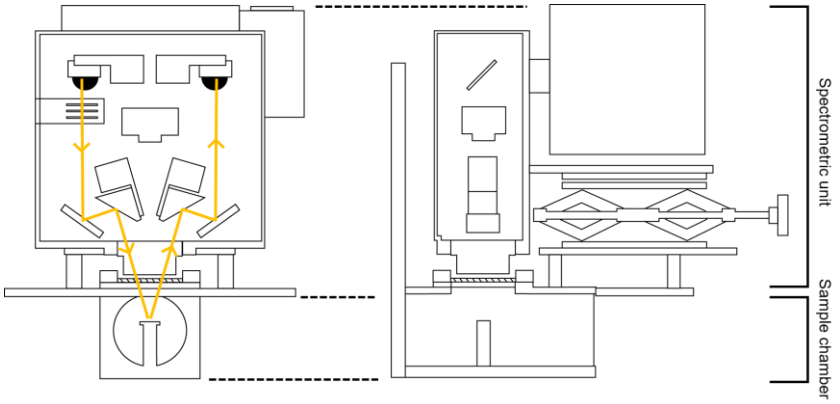

Figure 1. Overview of the FT-IR measurement system

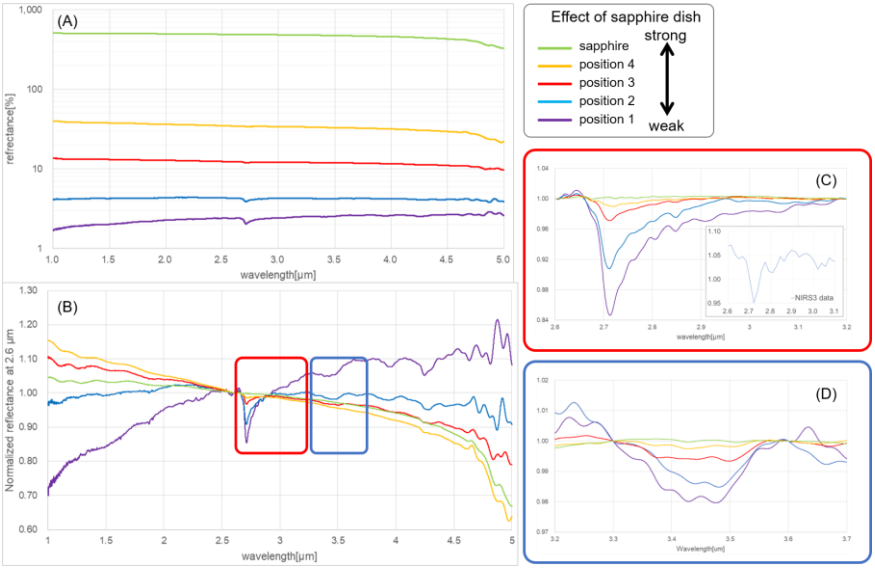

Figure 2. The mixing effect of the sapphire dish reflectance. The larger effect was observed with increasing the area where incident beam illuminated the sapphire dish; A) Reflectance spectra (%), B) Normalized reflectance at 2.6 μm, C) Normalized reflectance with continuum at 2.6-3.2 μm and NIRS3 spectral data [4], D) Normalized reflectance with continuum at 3.3-3.6 μm.

References

[1] Tachibana S. et al. (2021) LPS, XXXXXII, Abstract #1289. [2] Yada T. et al. (2021) LPS, XXXXXII, Abstract #2008. [3] Yada T. et al. in press. Nature Astronomy. [4] Kitazato et al. (2019) Science **364**: 272.