NH-rich grains detected by MicrOmega in the Ryugu returned samples

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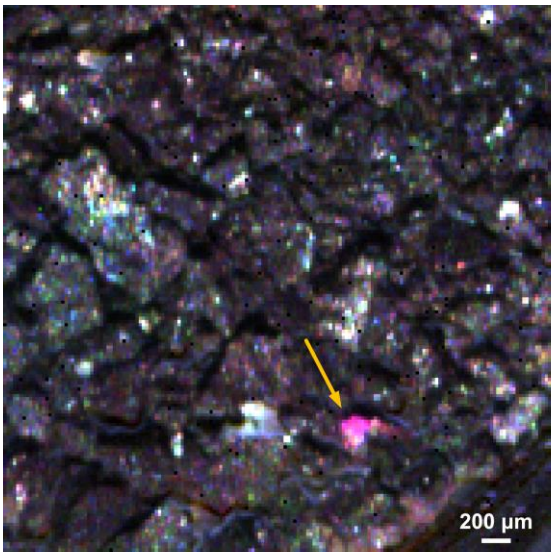
NH-rich compounds have been reported on Ceres [1, 2], Comet 67P [3, 4], and other primitive asteroids [5, 6] thanks to NIR observations. The proposed compositions include ammonium salts, ammoniated phyllosilicates, and ammonia-bearing organics. Investigating their composition and relation with other components can tell us information on how they were formed, what was the environment, and may also indicate the transfer of some volatiles in the Solar System. Similarly, NIR observations of the Ryugu samples obtained at the millimeter scale showed that they exhibit a ~3.06 µm shallow feature that was tentatively attributed to NH-rich compounds that would be present at a small scale and spread over the collection [7, 8]. However, one grain (a few hundred microns in size) exhibited a much stronger ~3.06 µm feature, coupled with additional features such as ~3.24 µm and ~2.72 µm bands [7]. Its reflectance (~10%) was also much higher than that of the typical matrix (2-3%). Here we report on our latest analyses to identify grains/inclusions with similar properties (both showing 2.7 µm and 3.06 µm absorptions).

MicrOmega is an infrared hyperspectral microscope installed inside the Hayabusa2 Curation Facility. It covers the spectral range 0.99-3.65 µm with a pixel size of ~22.5×22.5 µm², and a total field of view covering ~5×5 mm². From 2021 to July 2023, MicrOmega has measured almost half (in weight) of the Ryugu returned samples in the form of aggregates (~50) (small subsets extracted from the bulks, a few tens of mg each) and individual (mm-sized) grains (>500). Here we focus on the aggregate samples, which give access to a large number of grains spread as a thin layer in the sample holders. We use the average spectrum of the grain from the first NH-rich detection in [7] as a reference. After removing the continuum from 2.5 to 3.2 µm, we calculate the similarities between the reference spectrum and spectra from each pixel, then select the enriched regions with high similarity (strong 3.06 µm and 2.7 µm bands) and check for consistency at different orientations to avoid biases.

The detections of such areas are quite rare: among all the aggregate samples, we have detected 10 regions of interest (ROIs). The reflectance of the ROIs is generally higher than that of the surrounding material, mostly ranging from ~5% to ~10% but can be up to 15%. The size of the ROIs varies from ~100 µm to ~400 µm, their shape can be from relatively rounded to elongated. Figure 1 shows an RGB image (R 2.01 µm, G 2.72 µm, B 3.45 µm) of an aggregate sample, the pink color area is the ROI, and its average spectrum shows very strong 2.7 µm absorption (~50%) and 3.06 µm feature (~10%). We will report on the spectral heterogeneity within the ROIs at pixel scale and between different ROIs, in particular their variations in band position, depth, and shape. Since most of the ROI are present as inclusions instead of isolated grains, we will also present their relationship with the surrounding materials.



Such detections highlight the presence of a few particular grains in the Ryugu returned samples that may contribute to understanding the origin and evolution of the N-bearing material in Ryugu's parent body.

Figure 1. RGB image of an aggregate-sample (Sample ID: A0481). R 2.01 µm, G 2.72 µm, B 3.45 µm. The pink region pointed by the yellow arrow is the NH-rich ROI.

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