# Innovative Sample Handling for Surface Analysis of Ryugu: A Focus on Space Weathering

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The Hayabusa2 mission (JAXA) studied the near-Earth asteroid (NEA) Ryugu from June 2018 to November 2019. As part of its sampling operations, two key touchdown events were carried out. The first touchdown (TD1) collected surface materials, which were stored in Chamber A, while the second touchdown (TD2) retrieved subsurface materials from approximately 1 meter below the surface, stored in Chamber C [1]. On December 6, 2020, a total of 5 grams of samples from the C-type asteroid 162173 Ryugu were successfully returned to Earth.

The samples vary in size, with the largest grains measuring approximately 8 mm, down to fine submillimeter dust. These samples exhibit a diverse array of lithologies, with the predominant mineralogical composition consisting of Mg-rich phyllosilicates, Mg-Ca and Mg-Fe carbonates, Fe sulfides, and Fe oxides. Overall, the primary lithology is consistent with that of a CI chondrite [2,3,4].

In this work, a threefold comparative analysis is in progress, involving the characterization of three mm-sized samples (two samples from site A and one from site C): A0226-1, A0226-2, and C0242 [5]. During the mounting process, sample A0226-2 was inadvertently separated from A0226-1.

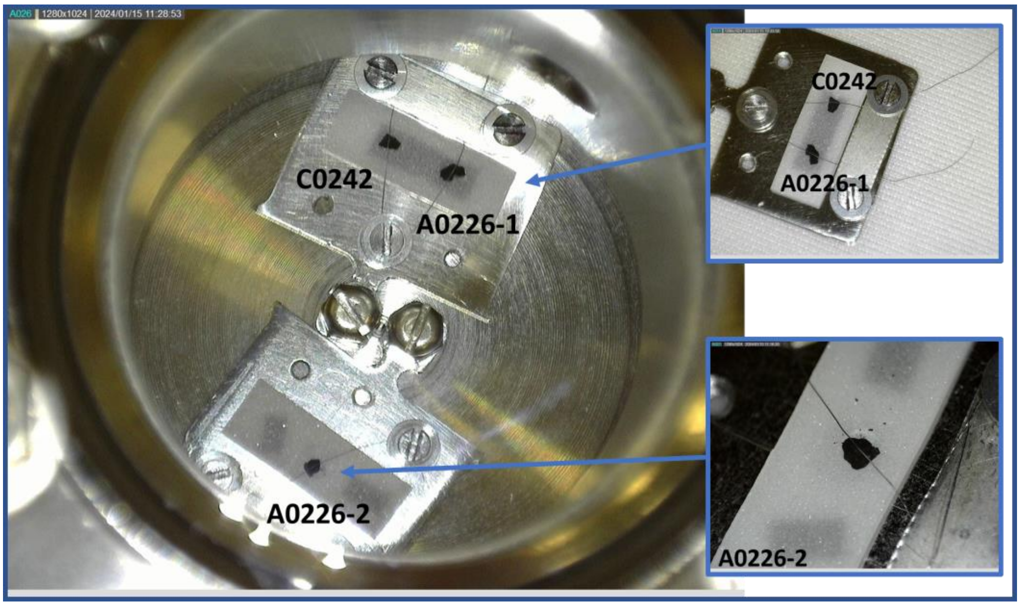


Figure 1. *Ryugu grains A0226-1, A0226-2, C0242*

The extensive surface characterization of our samples are using:

- Micro-FT-IR spectroscopy and imaging for assessing the hydration state, the organic components, the mineralogy and for comparison between laboratory data and remote-sensing data from the Hayabusa2 mission;
- X-ray photoelectron spectroscopy (XPS) for surface and near surface elemental analysis;
- Scanning Electron Microscope – Energy dispersive spectroscopy (SEM-EDS) for morphological studies and elemental mapping of the samples;
- Micro-RAMAN for determining the complexity of organics.

To protect the samples from terrestrial alteration and preserve them during transportation among the different facilities, where each analysis are performed, we developed an innovative sample-holder [6].

We propose a new sample holder (SH) designed to maintain stability for millimetre-sized (1.5–10 mm) and highly friable grains, such as those from Ryugu and CI-type carbonaceous chondrites (CC), during coordinated surface analyses. This sample holder has been developed to preserve the integrity of friable grains for non-destructive and non-invasive surface analytical techniques, including X-ray photoelectron spectroscopy (XPS), micro-infrared (micro-IR) spectroscopy, and micro-Raman spectroscopy.

Additionally, a sample holder container (SHC) has been implemented to ensure secure transport of the SH, protecting the samples from exposure to the terrestrial atmosphere. This container was developed to keep the samples under low pressure or inert gas environments (e.g., pure $N_2$) to allow transport in security safe from facility to facility, minimizing terrestrial contamination.

In this study, we examine the variations across the surfaces of individual grains to evaluate mineralogical and morphological differences and identify potential effects of space weathering avoiding terrestrial contamination. The investigation is currently ongoing, revealing that a predominant hydrated silicate phase characterizes the surface matrix, which is interspersed with carbonates. They exhibit early signs of micro-impacts, including clear ejecta and glassy structures, alongside with evidence of solar wind processing.

**References**

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