HANDLING AND DESCRIPTION OF C-TYPE ASTEROID RYUGU SAMPLES RETURNED BY HAYABUSA2. T. Yada[1], M. Abe[1], A, Nakato[1], K. Yogata[1], A. Miyazaki[1], K. Kumagai[2], K. Hatakeda[2], T. Okada[1], M. Nishimura[1], S. Furuya[1], M. Yoshitake[1], A. Iwamae[2], S. Tachibana[3], T. Sawada[1], K. Sakamoto[1], T. Hayashi[1], D. Yamamoto[1], R. Fukai[1], H. Sugahara[1], H. Yurimoto[4], T. Usui[1], S. Watanabe[5], Y. Tsuda[1], and Hayabusa2 Project Team, [1]Inst. Space Astronaut. Sci., Japan Aerosp. Explor. Agency (JAXA), Kanagawa 252-5210, Japan (yada@planeta.sci.isas.jaxa.jp), [2]Marine Works Japan Ltd., Yokosuka 237-0063 Japan, [3]UTOPS, Grad. Sch. Sci., Univ. Tokyo, Tokyo 113-0033, Japan, [4]Dept. Earth Planet. Sci., Grad. Sch. Sci., Hokkaido Univ., Hokkaido 060-0808, Japan, [5]Dept Earth Planet. Sci., Grad. Sch. Sci., Nagoya Univ., Nagoya 464-8601, Japan.

Introduction: Hayabusa2 spacecraft, which was launched in Dec. 2014 and successfully accomplished a series of proximity operations at C-type near-Earth asteroid (162173) Ryugu. The spacecraft left the asteroid in Nov. 2019 [1] and succeeded in returning its reentry capsule to the Woomera Prohibited Area (WPA), South Australia on 6 Dec. 2020 [2]. The reentry capsule was retrieved 3.5 hours after its landing by the Recovery Operation team and was transported to the Quick Look Facility (QLF) in the WPA. After the safety operation of the capsule, the sample container was carefully taken out of the capsule. Then the container was set into the gas sampling system installed in the clean booth at the QLF. Volatile components, released inside the sealed container, were extracted from the container on 7 Dec. 2020. The extracted gas was stored into several tanks at room temperature and at liquid nitrogen temperature [2]. The container was put into the transportation box purged with nitrogen and was safely transported to the Extraterrestrial Sample Curation Center (ESCuC) of JAXA on 8 Dec. 2020 [2].

Here, we report a series of processes done for the Hayabusa2 sample container and the samples inside clean chambers [3] in vacuum and in nitrogen gas.

Opening the sample container: The Hayabusa2 sample container was set to the milling machine first to remove the backside heat shield [2]. Then the container was set to the container opening system to take the outer container lid apart. The container with the opening system was installed into the Clean Chamber (CC) 3-1 on 11 Dec. The CC3-1 was evacuated to reach high vacuum ($<10^{-5}$Pa) for ~2.5 days. On 14 Dec., the container was firstly opened inside the CC3-1 under the static vacuum condition with monitoring the chamber atmosphere with a quadrupole mass spectrometer. The chamber was re-evacuated after the container opening, and the sample catcher, where samples are supposed to be stored, was taken out of the container using the opening system. Black powdery materials were observed at the bottom of the container (Fig. 1). They are most likely to be particles from the sampler catcher.

Handling the container and samples in vacuum: The extracted sample catcher was rotated in the CC3-1 to make chamber A upward and transferred to the CC3-2, which is kept vacuum. The CC3-2 was isolated by closing a gate valve between the CC3-1 and CC3-2. The chamber A cover was cleaned with a Teflon spatula. Screw bolts of the cover were removed with a hex key rotation system, and the cover was taken apart with an electrostatic chuck system. Black particles were found inside chamber A, which are expected to be those obtained during the 1st touchdown on Ryugu (Fig. 2) [1].

Fig. 1. A photograph of the bottom of the Hayabusa2 sample container. Black powders are observed. The inner diameter of the container bottom is 54 mm.

Fig. 2. A photograph of samples inside chamber A of the sample catcher. Black pebbles and powders are observed. The inner diameter of chamber A of the catcher is 46 mm.

Two particles inside chamber A (a few mm in size) were picked up from those samples with a sample picking tool in vacuum and put into a quartz glass dish for further storage under a vacuum condition in the CC3-2.

After picking a couple of particles, the chamber A was covered with a quartz glass to transport to the CC3-3.

Handling and preliminary description of samples in nitrogen: After the transfer of the catcher to the CC3-3, the CC3-3 was isolated by a gate valve and purged slowly with purified nitrogen. Further handling of the sample catcher and samples were performed in pure nitrogen gas using Viton-coated butyl gloves.

The catcher was then transferred to CC4-2 through CC4-1 to measure the weight with a microbalance. Based on the design weight of the catcher and a tare weight of an attached jig, the total weight of samples inside the catcher is calculated to be ~5.4g. The catcher was then transferred back to the CC4-1, where the catcher was dismantled to recover samples from chambers A, B and C (Fig. 3). There were particles in chamber C, including cm-sized pebbles and a metal-like particle. Particles smaller than 1 mm were also observed in chamber B as well. The samples in each chamber were separated into sapphire glass dishes.

The samples in each dish will be weighed and photographed, followed by non-destructive spectroscopic observation in the visible to near-infrared wavelength range. The MicrOmega, which is a non-contact version of the spectroscopic imager onboard the MASCOT lander [4, 5], will also be used for this observation. After the initial descriptions of the samples in the dishes, individual pebbles and particles will be picked up from the bulk samples with a vacuum tweezer for further description.

Future plan for sample distributions: The initial description of the Ryugu samples will last for 6 months after the return of the samples [6]. The samples will be distributed to the initial analysis team of Hayabusa2 [7] the phase2 curation teams that will make detailed analysis with a collaboration with ESCuC [8]. One year later after the return, 10% of the samples will be delivered to NASA based on the Memorandum of Understanding between JAXA and NASA. Simultaneously, some fraction of samples will be distributed to overseas phase2 curation teams. JAXA will release the announcement of opportunity for the Hayabusa2 samples to the community with the sample catalog after 18 months from the return.

Acknowledgements: We appreciate so much for the phase2 Kochi curation team led by Dr. Motoo Ito for their great contribution in developing containers, tools and jigs used for the initial descriptions of Hayabusa2 samples.

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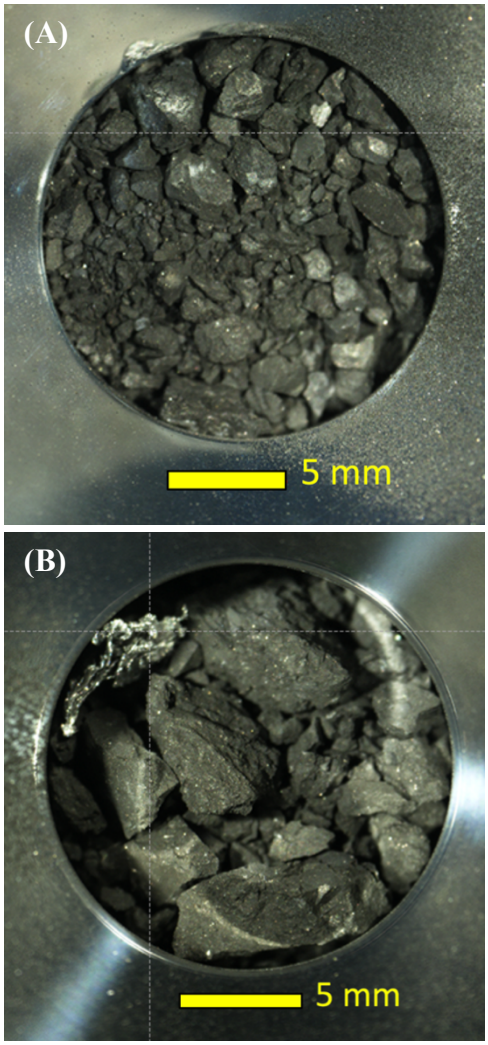

Fig.3. Micrographs of samples from (A) chamber A and (B) chamber C of the sample catcher. Black particles of several millimeter in size are observed in both chambers, and even centimeter-sized grains are found in chamber C. A metallic material in chamber C samples is likely to be an artificial object from the sampler.