DEVELOPMENT OF SAMPLE TRANSFER AND ANALYTICAL METHODS FOR THE HAYABUSA2 RETURNED SAMPLES.

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Introduction: Hayabusa2 spacecraft was successfully launched at December 2014 toward asteroid Ryugu. The target asteroid is classified as C-type, which shows similar features to the carbonaceous chondrites in the reflectance spectrum (REF). Thus, the samples to be obtained and returned to the Earth by the spacecraft will include organic materials and volatile species such as noble gases and water.

Previously, analyses of such returned samples were performed under the collaboration of several analytical methods [1-3], in order to integrate the result and establish a comprehensive knowledge of the sample, and to minimize the consumption of samples. However, the samples have to be transferred between facilities, even between countries, and moved from holder to holder for each analysis. Those transfer could cause severe problems; the contamination of terrestrial materials, sample damages such as fragmentation, breaking and even sample lost. Since organics and volatile materials to be included in the Hayabusa2 returned samples are abundant in terrestrial surface, we should protect the samples from the contamination of those materials as well as damages during the transfer and analyses.

Extraterrestrial sample curation center (ESCuC) of Japan Aerospace Exploration Agency (JAXA) organized a special team constitutes of members of Japan Agency for Marine-Earth Science and technology (JAMSTEC) Kochi Institute for Core Sample Research, National Institute of Polar Research (NIPR) Antarctic Meteorite Research Center, Japan Synchrotron Radiation Research Institute (JASRI), Institute for Molecular Science (IMS) and JAXA ESCuC under a collaboration agreement, and started developments of devices and techniques for the sample transfer and analysis of Hayabusa2 returned samples from March, 2015. The team was organized facilities which have *state-of-the-art* analytical instruments and experiences of curatorial works of precious natural samples, but beyond the specialists of the extraterrestrial materials, in order to introduce latest specialties and knowledge from diverse scientific and technological fields.

Final goals of the team are to accumulate comprehensive knowledge of the sample transfer for inter-instruments, inter-institutes, to create special sample holder for multi-instrument, and to construct analytical protocols of Hayabusa2 returned samples. In addition, our attempt will make gain of the Hayabusa2 sample return mission more fruitfully, by sharing experiences of this challenging development and enhancing cross collaboration between facilities, across the field boundary.

In this paper, we report the current status of the development and introduce the future works.

Current status: Currently we are developing a sample transfer container between facilities, and sample holders applicable multiple analytical instruments, such as SEM, TEM, STXM, and NanoSIMS etc. It is noted that a sample holder for a specific analytical device has been well developed already. However, a sample holder which is applicable to multiple analytical devices of different principles was rarely and hardly developed, because it often reduces the accuracy of acquired data and simplicity of the analysis.

Development of the new sample transfer container between facilities, named as Facility to Facility Transfer Container (FFTC) was almost finished, and is under the stage of the examination of suitability for the requirements. FFTC consists only of SUS, Qz glass for a viewport and viton for O-rings which can be used inside the clean chambers for the returned samples equipped at JAXA ESCuC, and can be ultrasonically cleaned by ultrapure-water and organic solvent. We confirmed that it can hold positive pressure (~70 kPa) for a month with undetectable pressure loss.

Several materials, such as Nitto Denko Gecko tape and polyimide film, are under the examination for the sample holders of multiple analytical devices. Those materials are planned to use for the sample holding during the analysis such as SEM and X-ray computed tomography (CT) instead of glues and resins which are used in previous studies. We are also developing methods for the evaluation of the cleanness of those materials. New sample holders for ultrathin sections are also under the development. For the protection of samples from contamination of terrestrial atmosphere, most sample preparation processes will be performed inside gloveboxes with purified gas species. Those new holders of ultrathin sections are developed for easy handling in the gloveboxes.

Future works: We plan to perform a series of rehearsals of the sample analysis with the developed devices through the member's facilities, in order to evaluate the sample damages, contaminations and analytical protocols. Details and results of the examination will be reported at the next Hayabusa symposium.

References: [1] Nakamura T. et al. (2011) Science, 333,1121-1125. [2] Nakamura T. et al. (2008) Science, 321, 1664-1667. [3] Uesugi M. et al. (2014) Earth Planet. Space, 66,102.