PREPARATION FOR THE ANALYSIS OF HAYABUSA2 RETURNED SAMPLES.

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Extraterrestrial Sample Curation Center at JAXA (ESCuC/JAXA) organized a team for development of techniques and devices for the handling, transfer and analysis of the Hayabusa2-returned samples from 2015, with the members of the ESCuC/JAXA, Kochi Institute for Core Sample Research, JAMSTEC (Kochi), JASRI/SPring-8, UVSOR Synchrotron/ Institute for Molecular Science, National Institute of Polar Research (NIPR) and Tokyo Metropolitan University. The team consists of specialists of analytical methods of diverse scientific fields, to gather the knowledge and experience of the state-of-art analytical methods. The team was authorized as the Phase 2 curation team KOCHI at 2017, which is one of the activities of ESCuC for describing the Hayabusa2-returned samples in detail, using even destructive methods [1]. Thus, major purpose of the team is to construct comprehensive methods for the handling and analysis of the returned samples of future missions, and to describe Hayabusa2-returned samples in detail.

In the activities of the team, Facility to Facility Transfer Container (FFTC) was developed for the inter-facility and inter-instruments transfer of samples [2]. The container includes several options, according to sample size and conditions, such as a quartz (Qz) glass holder for the unprocessed grains from 10 μm to several milli-meters, a rod holder for samples fixed on a tip of fiber or rods, and processed sample holders such for ultra-thin sections of Transmission Electron Microscopy (TEM). It is confirmed that the FFTC can keep positive pressure as well as vacuumed condition (lower than) more than 1 month. Thus it can also be used for temporary storage of samples. An universal sample holder using Vertically-Aligned Carbon NanoTube (VACNT) was developed for the holder of unprocessed samples for the non-destructive analyses such as Synchrotron Radiation (SR) Computed Tomography (CT), X-ray Diffraction (XRD), and Field Emission Scanning Electron Microscopy (FE-SEM) [3]. During the SR experiments, the holder was sealed by polyimide tube. The VACNT holder is also applicable to the Secondary Ion Mass Spectrometry (SIMS) and fabrication of samples by Focused Ion Beam (FIB). Because the Qz glass holder of FFTC, VACNT and polyimide tube will contact unprocessed samples directly, cleanness of them should be examined before application. The cleanness of the Qz glass, VACNT holder and polyimide tube was evaluated using Instrumental Photon Activation Analysis (IPAA) and Instrumental Neutron Activation Analysis (INAA) [4]. It is confirmed that elemental contamination transferred from those materials are considerably small. An universal holder for ultra-thin sections, called KOCHI grid is also developed, for the safe handling of ultra-thin sections in the glovebox, and linkage of high spatial resolution analysis using ultra-thin section. [5] The grid can be installed into TEM, Scanning Transmition X-ray Microscopy with using Near Edge X-ray Absorption Fine Structure analysis (STXM-NEXAFS) and NanoSIMS. When installing the KOCHI grid into STXM-NEXAFS system, the grid was fixed into new sample cell, OKAZAKI cell. The OKAZAKI cell can be installed into FFTC as the option for ultra-thin section transfer. We are also developing sample handling tools, such as a tool for pressing sample onto metal film for the analysis of organic matters, glovebox system for the sample handling, atmosphere shielded loading system of samples to instruments, and cutting method for the samples with low sample damage, as well as techniques for the curatorial works and sequential analysis.

Using those devices and systems, Antarctic micrometeorites (AMMs) showing similar characteristics to carbonaceous chondrites and four Antarctic meteorites, Y-791198 (CM2.4), Y-980115 (CI1), Y-793495 (CR2.8) and A-881595 (CR2), were investigated as the rehearsals of the analysis of Hayabusa2-returned samples. They were investigated by SR-CT, XRD and FE-SEM to characterize their internal structure and mineral compositions, and to select region of interest (ROI). After that, ultra-thin sections were extracted using FIB from ROI. The section was investigated by STXM-NEXAFS, TEM and NanoSIMS, focusing mainly on characteristics of organic materials. For the case of Antarctic meteorites, Field-Emission Electron Probe MicroAnalyzer (FE-EPMA) and Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) will be applied for the detailed analysis of chemical compositions of each hydrous and un-hydrous phase. Through the rehearsals, sample damage and problems of analytical flow are evaluated, along with constructing database for the comparison of returned samples. Analytical flow of the sample will be improved based on the result of a series of rehearsals. In the actual analysis of Hayabusa2 returned samples, the flow will be modified according to the characteristics of the samples flexibly.

References: [1] Ito et al. (2019) *MAPS* abstract, submitted. [2] Uesugi K. et al. (2019) *in prep.* [3] Uesugi M. et al. (2019) *in prep.* [4] Shirai N. et al. (2019) *in prep.* [5] Ohigashi T. et al. (2019) *in prep.*