Potential Contaminant particles generated in Ryugu Clean Chamber

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Introduction

At the JAXA curation facility, samples from Itokawa, Ryugu, and Bennu are stored and initially characterized in nitrogen-purged clean chambers (CCs) to avoid exposure to the terrestrial environment. These samples have remained extremely primitive and unaltered, offering a rare opportunity to study extraterrestrial materials in their original state. To preserve this condition, gaseous species (H_2O, CO_2, O_2, CH_4) in the CCs are continuously monitored by API-MS, and trace organics molecules and metallic elements are periodically evaluated by impinger/wafer methods with ICP-MS and GC-MS [e.g., 1]. In addition to these environmental evaluations, the occurrence and behavior of solid particles (> a few μm) inside the CCs have not yet been characterized in detail. The present study provides the first systematic assessment of such particles, adding a new dimension to ongoing efforts to comprehensively understand the CC environment. The CCs are mainly composed of Stainless steel (SUS304), glass windows, Viton-coated butyl gloves, aluminum alloy (A6061) tools, and Teflon, all of which can generate particles through abrasion or degradation [2]. Because samples stored in these CCs are distributed to the broader scientific community through the announcement of opportunity (AO), understanding the origin and behavior of such solid particles is essential not only for JAXA but also for all researchers who analyze these materials.

Methods

Microparticles on the Ryugu-CC floor (i.e., CC4-1 and 4-2) were collected using vacuum tweezers and initially examined by FE-SEM (SU6600, Hitachi High-Tech) equipped with an EDS detector [3]. Selected particles were then analyzed by EPMA-WDS (JXA-iHP-200f, JEOL). In addition, major materials considered as potential sources of these particles were analyzed by LA-ICP-MS (Element XR, Thermo Fisher Scientific; LSX-213 G2+, Teledyne Cetac Technologies) at NIPR to determine their trace-element compositions and to evaluate the possible chemical impact on the returned samples.

Results and discussion

EDS analyses revealed that most particles collected from the Ryugu-CC floor are Fe–Cr–Ni alloys, Al alloys, and Teflon-like materials. WDS analyses showed that Fe–Cr–Ni particles contain ~16 wt% Cr and ~7 wt% Ni, consistent with SUS304, whereas Al-alloy particles contain ~0.4 wt% Si and ~0.8 wt% Mg, corresponding to A6061. These results indicate that solid particles in the CC are generated by mechanical actions such as abrasion of handling tools, scuffing and scratching of the chamber floor during sample transport, and wear of structural components during routine operations. Trace-element analyses revealed that SUS304 contains Nb, Mo, and W at concentrations more than 100 times higher than the bulk composition of Ryugu [4], whereas A6061 contains Cu and Hf at concentrations more than 10 times higher. Some curated samples also have documented histories of contact with the CC floor and are classified in the database as Class-2 (e.g., samples accidentally dropped onto the CC floor) [5]. For such samples, trace-element analyses require particular caution, as potential contamination from CC-derived particles cannot be excluded. In this study, we systematically characterize the types and chemical compositions of potential contaminant particles and establish a framework for evaluating their possible contributions to trace-element signatures in returned samples, should such particles adhere to the sample surfaces.

References:

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