EPSC Abstracts
Vol. 11, EPSC2017-811, 2017
European Planetary Science Congress 2017

Basic design of sample container for transport of extraterrestrial samples

F. Dirri (1), A. Longobardo (1), E. Palomba (1), A. Hutzler (2), L. Ferrière (2) and the EURO-CARES Consortium

(1) Institute for Space Astrophysics and Planetology (IAPS-INAF), Via del Fosso del Cavaliere 100, 00133, Rome, Italy (fabrizio.dirri@iaps.inaf.it), (2) Natural History Museum, Burgring 7, A-1010 Vienna, Austria

Abstract

The aim of this work is to provide, in the framework of the EURO-CARES (European Curation of Astromaterials Returned from Exploration of Space) project [1], a technical overview based on the sample container used in previous sample return missions (e.g., Hayabusa1, Stardust, etc.) and to define a basic design of a sample container aimed at transporting the extraterrestrial returned samples within a Sample Curation Facility (SCF) or from a SCF to another laboratory (and vice versa). The sample container structure and the transportation criticalities (such as contamination and mechanical stress) are discussed in detail in each scenario.

1. Introduction and guidelines

In order to ensure safe storage conditions and to avoid terrestrial contamination of extraterrestrial samples returned from future missions, it is necessary to define requirements for sample containers and their transport, inside an SCF and from an SCF to other laboratories (and vice versa). Based on the experience of previous sample return missions, we defined a basic design of a sample container which can be used for the storage and transportation of extraterrestrial samples. The sample container design and optional components depends on mission scenario: restricted, i.e. samples having a significant role to understand the origin of life (e.g. from Mars and Europa); unrestricted, i.e. samples from undifferentiated, metamorphosed asteroids and from the Moon. Samples from Mars and Europa should be treated as Category "A" [2], i.e. potentially causing fatal diseases whereas Lunar and asteroid samples should be treated as not hazardous sample.

Different sample containers have been already produced in the framework of previous missions to guarantee the integrity of returned samples by avoiding the external contamination [3,4]. For example, in the case of Hayabusa and Hayabusa2 missions (Fig. 1), the containers in which the returned samples were packaged, mainly consisted of an outer lid equipped with latches, an inner lid, a frame for latches, a non-explosive actuator, and a sample catcher. The sample container is sealed with double Viton O-rings and maintained in an ultra pure nitrogen atmosphere [5,6].

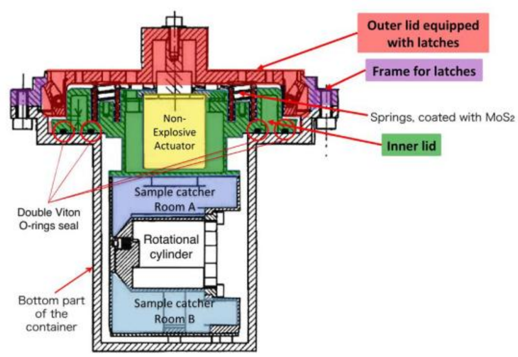

Figure 1. Schematic view of a cross-section of the sample container of Hayabusa and Hayabusa2.

Basically, in order to transfer extraterrestrial samples inside an SCF and from an SCF to laboratories, the following sample container requirements have to be met: 1) samples should be kept under the same storage conditions of temperature, pressure, cleanliness, and humidity; 2) minimization of forward contamination (i.e., from terrestrial environment); 3) in case of restricted samples, it should prevent backward contamination (i.e., no release of potential biologically active contamination into the ambient environment is accepted).

2. Transportation scenarios and sample container basic design

After the landing of a sample return mission, three types of transportation are foreseen to move samples: 1) from landing site to SCF [7]; 2) within the SCF; 3) from SCF to other laboratories (and vice versa). In the 2nd and 3rd scenarios (unrestricted case) the sample container should be composed of: 1) a sample collector (Fig. 2, left), which should include (single) samples, 2) a metallic collector protection (that should include a window with a teflon substrate), which aimed at insulating the samples and reduce their motion, 3) a cover with latch mechanism and seals (which may be in Viton, due to its properties, especially its low outgassing rate). Other optional component, i.e., a pressure system (to keep the samples under an inert gas atmosphere) and a plastic material encapsulation should also be considered for restricted samples (e.g., from Mars).

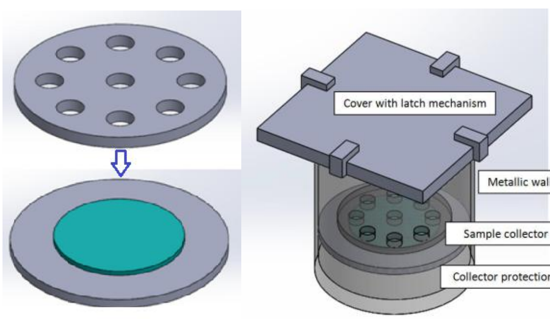

Figure 2. *Left:* Sample collector ("racket" model). *Right:* Basic design of a sample container (unrestricted case).

Otherwise, when the sample is transported from SCF to other laboratories (and vice versa), the samples should be placed in a double or triple package: the sample container (Fig. 2, *right*) will be the internal layer while the other two additional layers will aim at protecting the sample(s) from forward contamination and from vibrations/shocks during transportation [5].
The best material to be used for the sample containers mechanical structure should be stainless steel due to the lower outgassing rate (e.g., two orders of magnitude less than Titanium) and the cost (e.g., 10 times less than Titanium). On the other hand, the most indicated material for the plastic bag is Neoflon (KEL-F) due to its lower permeability to water, nitrogen, and CO_2 [8]. Otherwise, for covering the internal walls of the sample container, Teflon [9] would be preferred since it is cheaper (three times less than Neoflon KEL-F).

3. Conclusions

Guidelines, requirements, basic design, and materials which should be used for a sample container were determined for transportation of extraterrestrial samples inside the SCF or from the SCF to other laboratories (and vice versa). In particular, two different configurations have been defined, i.e., the sample container (sample collector, collector protection, and metallic walls) and the triple packaging (sample container, plastic bag, metallic box) for the transportation between laboratories (unrestricted case). In the latter case, additional precaution has been identified to prevent the risk of fluid leakage and to minimize the shocks.
The criticalities about the material have been defined on the basis of outgassing rates (which should be very low), cost and permeability to water, nitrogen, and CO_2. For restricted samples, slightly different requirements have to be take into account for the two sample container configuration.

References

[1] http://www.euro-cares.eu/

[2] WHO (2012), , WHO/HSE/GCR/2012.2

[3] Fujimura, A. et al. (2011), JAXA Special Publication JAXA-SP-12-012E

[4] Fellows, M. et al. (2006), Stardust Sample Return, NASA Report

[5] Abe, M. et al. (2011), 42nd LPSC Abstract

[6] Yada, T. et al. (2014), M&PS 49, 2, 135–153. doi: 10.1111/maps.12027.

[7] Longobardo, A. et al. (2017), EPSC Abstract

[8] Patrick, T.J. (1973), Vacuum 23(11), 411–413. doi: 10.1016/0042-207X(73)92531-1

[9] Peacock R.N. (1980), J. Vac. Sci. Technol. 17(1), 330–336. doi: 10.1116/1.570380