# Utilizing Chemical Optical Sensor Technology to Assess Oxygen Permeability of Candidate Asteroid Regolith Sample Containers

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The Astromaterials Acquisition and Curation Office at NASA Johnson Space Center currently curates 500 mg (10%) of carbonaceous asteroid Ryugu regolith collected by the Japan Aerospace and Exploration Agency's Hayabusa II spacecraft and returned to Earth in 2021 [1] In September 2023, NASA's OSIRIS-REx spacecraft is expected to return at least 60 grams of regolith collected from the surface of Carbonaceous Asteroid Bennu [2]. These new astromaterials collections will be stored and handled in gloveboxes and desiccators that are continuously purged with ultrapure nitrogen, in order to minimize contamination and alteration of extraterrestrial samples from terrestrial environments, e.g. reaction with terrestrial oxygen. Ito et al. have previously reported on the development of containers to transport samples between facilities in inert, sealed environments [3]; Hayabusa2 samples allocated to investigators by JAXA's Extraterrestrial Sample Curation Center (ESCuC) are shipped in these Facility-to-Facility Transfer Containers (FFTCs). NASA curation has also been investigating sealed containers for storage, transportation, and allocation of Bennu and Ryugu regolith in sealed anoxic environments. In order to assess the ability of potential sample containers to maintain an inert atmosphere, we have acquired a PreSens Fibox 4 fiber optic oxygen meter and PSt9 chemical optical sensor spots. Oxygen measurements are performed as follows: A calibrated PSt9 sensor spot is fixed either mechanically or with adhesive to an internal transparent container surface (the container must incorporate at least one transparent surface into its design, i.e. the container cannot be completely opaque). The end of the oxygen meter's fiber optic attachment is placed normal to the exterior transparent face (opposite the sensor spot), and a measurement is made. This configuration provides a passive, non-invasive method of measuring an unmodified sample container [4]. The sensor can perform multiple measurements in time intervals as short as one second; by measuring the oxygen concentration of the internal container volume periodically, we can determine a rate of oxygen ingress into candidate sample containers. The PSt9 sensor has a measurement range of 0-200 ppmv; we therefore seal our containers and measure the internal sensor within a nitrogen purged glovebox. We compare the reading for the sealed container with a control sensor spot that is loose in the glovebox. The sealed container is then removed from the glovebox (as well as the fiber optic $O_2$ meter), and measurements are made in periodic intervals of 10 minutes to one hour (depending on ingress rate) to assess changes in the internal oxygen environment. We conducted very preliminary tests on a commercial stainless steel container sealed with a Viton gasket; an internal oxygen concentration of 200 ppmv was measured four days after removal from the ~30ppm glovebox environment. More controlled experiments are required to determine whether the increase in oxygen was due to diffusion through the Viton gasket, or whether outgassing internal contaminants contributed to the increased oxygen concentration; these experiments will be conducted in October 2022.

**References**

[1] Watanabe S. et al. 2017. Space Sciences Reviews, 208, p. 3-16. [2] Lauretta D. S. et al. 2017. Space Sciences Reviews, 212, p. 925-984. [3] Ito M. et al. 2020. Earth, Planets and Space. 72:133. [4] Huber C. et al. 2006. Monatsschrift für Brauwissenschaft, 59, 5-15.