**GLOVEBOX DESIGN CONSIDERATIONS FOR THE CURATION OF ASTROMATERIALS COLLECTIONS.** C. J. Snead[1], S. Martinez III[2], W.D. Connelly[3], N. G. Lunning[1], J. Davidson[1]. [1]NASA Johnson Space Center, Houston, TX 77058, USA. (christopher.j.snead@nasa.gov) [2]Amentum JETS II, NASA Johnson Space Center, Houston, TX 77058, USA. [3]Innovex International, Houston, TX 77338, USA.

**Introduction:** The Astromaterials Acquisition and Curation office at the NASA Johnson Space Center (JSC) is responsible for the preservation, documentation, preparation and distribution of NASA's extraterrestrial samples [1]. Astromaterials collections are stored and processed in gloveboxes and desiccators that are purged with pure (<1 ppm trace impurities) nitrogen gas. These gloveboxes and desiccators provide a primary layer of protection against sample contamination (e.g. alteration from terrestrial $H_2O$ and $O_2$, elemental/isotopic contamination, contamination from organic compounds, microbial alteration). JSC recently procured four gloveboxes for the preparation and documentation of ~500 mg of Asteroid Ryugu regolith that was returned by the Japan Aerospace and Exploration Agency (JAXA) Hayabusa2 Mission [2] and ~120 grams of Asteroid Bennu regolith that was returned by NASA's OSIRIS-REx mission [3]. These gloveboxes had to be designed to support hardware disassembly of spacecraft components, high-resolution imaging, as well as sample processing, subdivision, characterization of small scale (typically < 1cm) stones and particles. The types of materials used for the construction of the gloveboxes were limited in order to minimize potential elemental and organic contamination of the returned samples. Here we briefly describe our experience with the design and procurement of gloveboxes for astromaterials curation.

**Physical Characteristics:** The American Glovebox Society has published a guideline that details various aspects of glovebox construction [4]; here we describe considerations that are specific to extraterrestrial sample curation.

*Shell:* The preferred material for the construction of the glovebox shell is 316 stainless steel due to its excellent corrosion resistance, durability, and compatibility with curation materials restrictions. The shell should be constructed of 7-11 stainless steel, and the shell corners should be radiused for ease of cleaning.

*Surface Finish:* During the initial procurement phases of the OSIRIS-REx gloveboxes, an interior surface finish of No. 4 or better was specified. The gloveboxes were delivered with a mirror (2B) finish. The high mirror finish provided challenges for high resolution sample imaging, and can increase eye strain; in some instances, sample processors found the mirror finish useful for locating tools in areas that were otherwise visually obscured. Gloveboxes for future collections that expect to have critical imaging requirements should specify a No. 4 interior, mechanically ground and polished surface finish, or a non-reflective EFS-4 electropolished finish.

*Airlock/antechamber:* Airlocks, or Antechambers, enable the transfer of samples, tools and equipment between the glovebox interior and the external environment without compromising the internal nitrogen atmosphere of the glovebox chamber. OSIRIS-REx antechambers are purged with nitrogen and have integrated oxygen, humidity and pressure sensors that prevent the simultaneous opening of the internal and external glovebox doors. In practice, procedural protocols are also effective in preventing interior and exterior antechamber doors from being opened at the same time.

*Windows:* We prefer laminated safety glass of at least 3/8" thickness for use in curation gloveboxes due to its scratch resistance (when compared to polycarbonate or acrylic windows). Laminated glass can maybe antireflection coated via pyrolytic or sol-gel process [5]. Windows are fastened to the glovebox shell via Viton/FKM gaskets and stainless steel window retainers. We prohibit the use of adhesive-backed window gaskets due to the potential for organic contamination of the samples.

*Imaging Appurtenances:* Many of JSC curation's Apollo-era gloveboxes include appurtenances to accommodate the detailed observation of samples via binocular microscope. These sample observation ports consist of top-mounted pane of safety glass, a smaller auxiliary vertically mounted window, and two glove ports that are welded into the stainless steel bumpout. One of the OSIRIS-REx processing gloveboxes incorporates a modified observation and imaging appurtenance that includes two additional anti-reflective panes of glass mounted at 45 degree angles; this configuration enabled detailed nadir and oblique imaging of the Bennu samples.

*Service Penetrations:* Numerous service penetrations should be incorporated into the glovebox shell, including: a drain located at the bottom of the shell for ease of cleaning, port for coupling $N_2$ inlet and exhaust connections, and electrical feedthroughs to supply power to analytical balances. Additional ConFlat or KF-style service penetrations can provide support for future instrument and tool installation.

*Gloves:* NASA curation has examined the offgassing, permeability and particle shedding of glovebox gloves fabricated from neoprene, Hypalon/CSM, Viton/FKM, and butyl rubber [6]. Hypalon and Viton gloves shed very few particles relative to other gloves, and butyl rubber and Hypalon gloves were found to be the least permeable. Based on the results of this study, we have chosen Hypalon for use in our OSIRIS-REx and Hayabusa2 gloveboxes.

**Glovebox Mockups:** Initial design concepts for a curation glovebox optimized for small-scale extraterrestrial samples diverged from the design of our existing Apollo-era gloveboxes. In order to understand how the altered glovebox morphology might affect human factors such as work envelope, accessibility and ergonomics, we constructed mockups of protype designs. These full-scale models were initially fabricated from foam-core sheets that were cut to size. We quickly recognized the value of practicing activities such as disassembling a model OSIRIS-REx Touch-And-Go Sample Acquisition Mechanism (TAGSAM) inside the mockup (fig. 1). Subsequent rehearsal increased in complexity and required the construction of more robust full-scale mockups from plywood and aluminum extrusion.



Figure 1. OSIRIS-REx sample processing rehearsals in a foam-core mock-up, and in actual finished TAGSAM processing glovebox.

**References:** [1] Allen C. et al. (2011) *Geochemistry, 71*, 1-20. [2] Yada T. et al. (2021) *Nature Astronomy 6*, 214-220. [3] Lauretta D. S. et al. (2024) *Meteoritics & Planetary Science* 1-34 [4] American Glovebox Society (2007) AGS-G001-2007. [5] Mackenzie E. & Bescher E. (200) *Journal of Sol-Gel Science and Technology, 19*, 23-29. [6] Calaway M. J. et al. (2014) No. JSC-CN-31060.