Organic Material Archive

Planetary Protection Organic Inventory Workshop

Wayne Schubert

Jet Propulsion Laboratory, California Institute of Technology

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Driving Organic Materials Requirements

- **The Project System (including Science) shall identify, quantify, document, and archive potential pre-launch terrestrial contamination sources, both organic compounds and organisms.**

- ***"shall document the bulk organics materials inventory for landed or impacted hardware that are present in quantities of 1kg or more"***

- ***"shall collect and provide organic samples of at least 50 grams of each organic material type for which more than 25 kg is transported to the Martian surface"***

The Intent of these Requirements

- **These requirements were in place for the Viking Landers and orbiters of the late 1970's.**
- **The Viking Biology Instrument was on the landers with the intention of gathering evidence of biological life.**
- **While the intent of these requirements is not explicitly written, it has been our interpretation that the reasons include:**
  - A means of cross checking life detection signatures against organic materials from the spacecraft that could have contributed.
  - A means of checking false positive results.
  - Physical samples of the largest organic masses for testing
  - A list of other organic materials on the spacecraft, that could contribute to an organic signature.

Traceability of Organics Inventory and Archive

- **"Preventing the Forward Contamination of Mars" (2005)**
  Space Studies Board (SSB), National Research Council, National Academies Press
  - "… NASA should also require the systematic archiving of environmental samples for ATLO environments and for all spacecraft to be sent to Mars." --page 3
  - "Finally, as part of the forward contamination control requirements for Category IV landers, the flight program office must provide for collection and storage of the bulk (>1kg) organics constituents of all launched hardware which is intended to directly contact Mars or might accidentally do so. Parts and materials lists, actual samples, and information on landing and impact point must be maintained for at least 20 years from the launch of the spacecraft." "… this requirement may be insufficient for archiving sufficiently important information." --page 37
- **NPR 8020.12C "*4. An organics archive is required of the bulk (>1kg) organic constituents of all launched hardware which is intended to directly contact the target planet or which might accidentally do so. Each flight program office will provide for the collection and storage, for at least 20 years from the launch of the spacecraft, of a 50 g sample of each organic compound whose total amount in a planetary landing system exceeds 25 kg.*"**
- **NPR 8020.12D – dropped this language, but InSight and Mars 2020 have baselined this approach.**
- **The current approach aligns with the earliest known versions of this requirement.**
- **This policy has continued without amendment (Nearly 50 years)**
- **This policy is captured in the new PP Standard NASA STD-8719.27**

Collection Highlights

- **435 Line items**
- **Typically, less than 12 materials exceed the 25 kg threshold per mission.**
  - Parachutes, heat shields, structures and aeroshells
- **All materials greater that 1 kg are listed in Post Launch Reports**
- **Most of the materials are given and accepted as examples**
- **Many material variations of parachute fabrics**
- **It is difficult to get accurate masses on many organics**
  - We are depending on each project to produce a “Project Materials Identification Usage List” (MIUL)
  - Adhesives and Epoxies are used in small quantities but in many locations
  - Materials information is provided by managers for subsystems

Materials Archive High Level Process

- **Organic Spacecraft Materials can be repackaged**
  - 2 layers of ultraclean aluminum foil
  - 2 heat sealed bags of ultraclean polyethylene, purged with nitrogen
  - Add the sample fact sheet between the inner and outer polyethylene bags
  - Samples are organized into bins (handling containers)
  - Materials are stored at ambient temperature, in the dark
- **Many materials are delivered in sealed ESD protective bags**
  - To avoid additional handling, these objects are often stored as received
- **Material surfaces are not considered aseptic**
  - Typically, considerable handling occurs before delivery to the PP Archive
- **Use of archived materials should require justification.**
  - An allocation committee should be established to evaluate use requests.

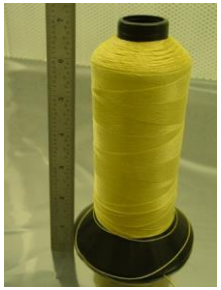
Organic & Microbial Archive

Storage Location

Location Organization

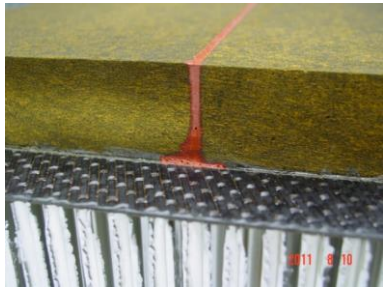
Materials Archive

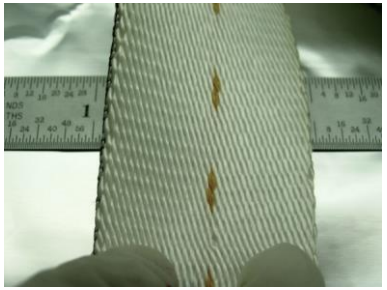
Storage at Room Temperature



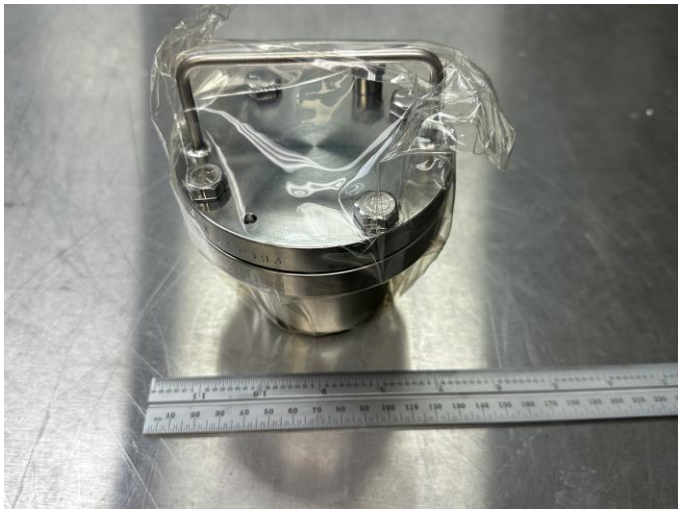
Materials are repackaged according to CC procedure, double wrapped in UHV "clean" aluminum foil, and heat sealed in low out-gassing polyethylene bags.

However some materials can be stored "as received" in sealed ESD bags



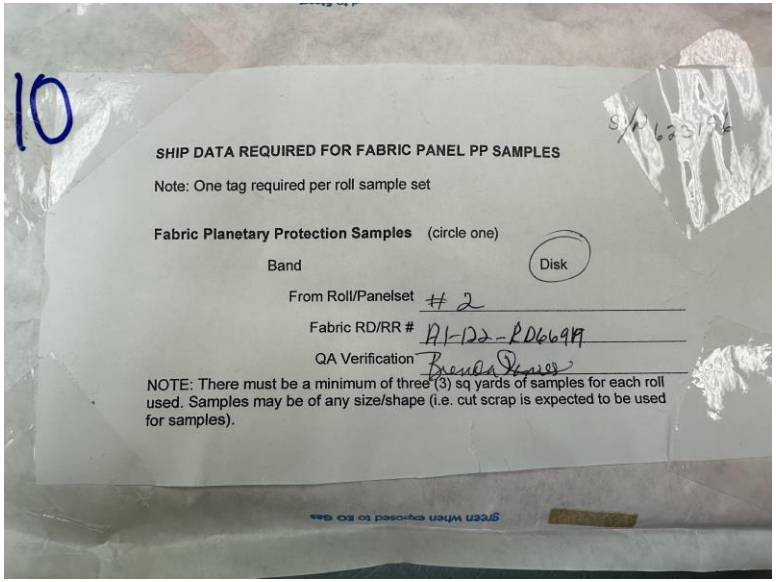


Viking Organic Materials

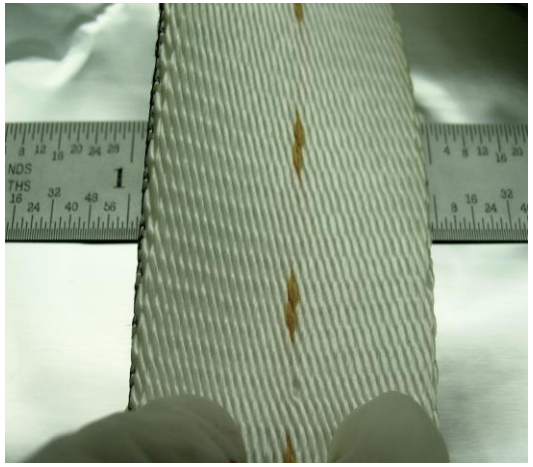


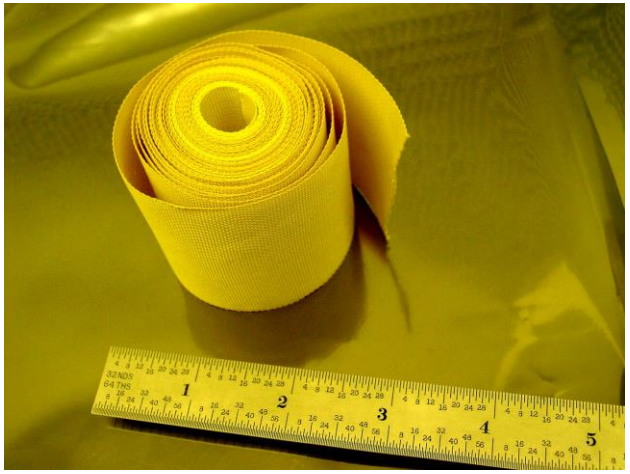
RTV 511
Pigments
Parachute Shroud
Ablators

Parachute Fabric

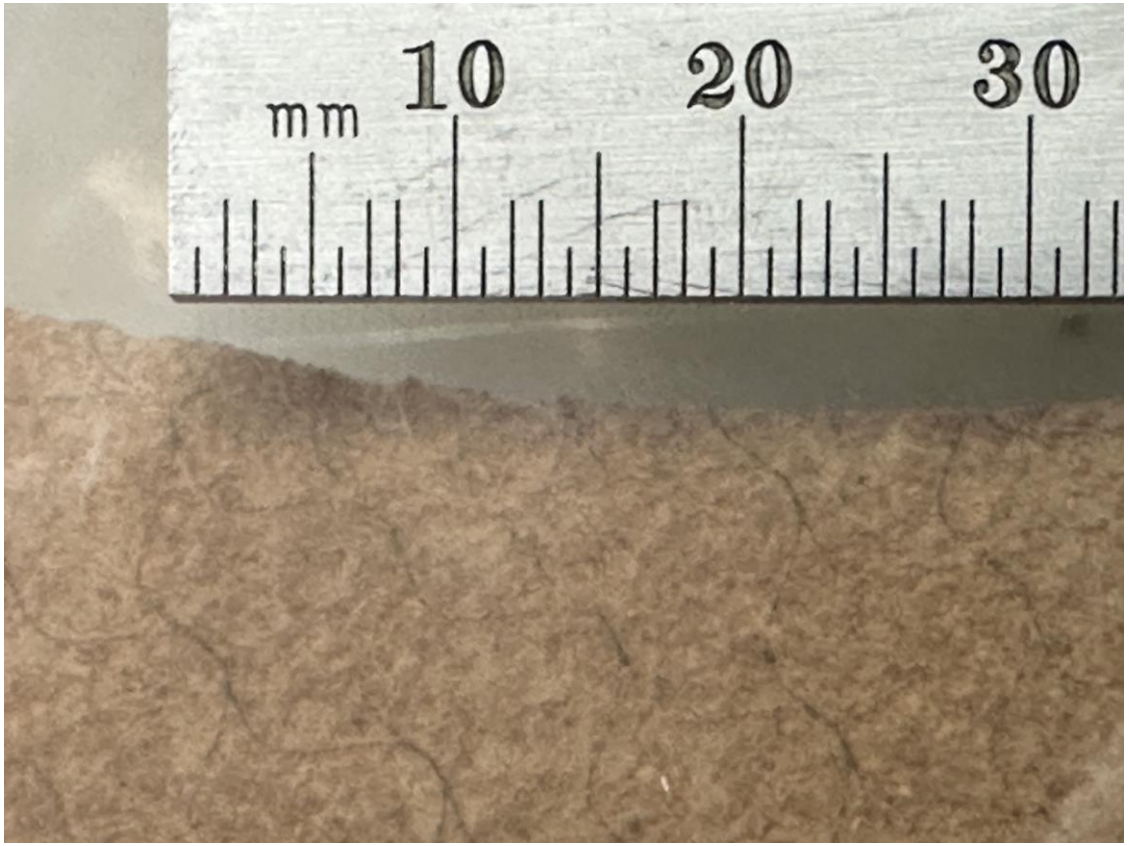


Parachute Materials



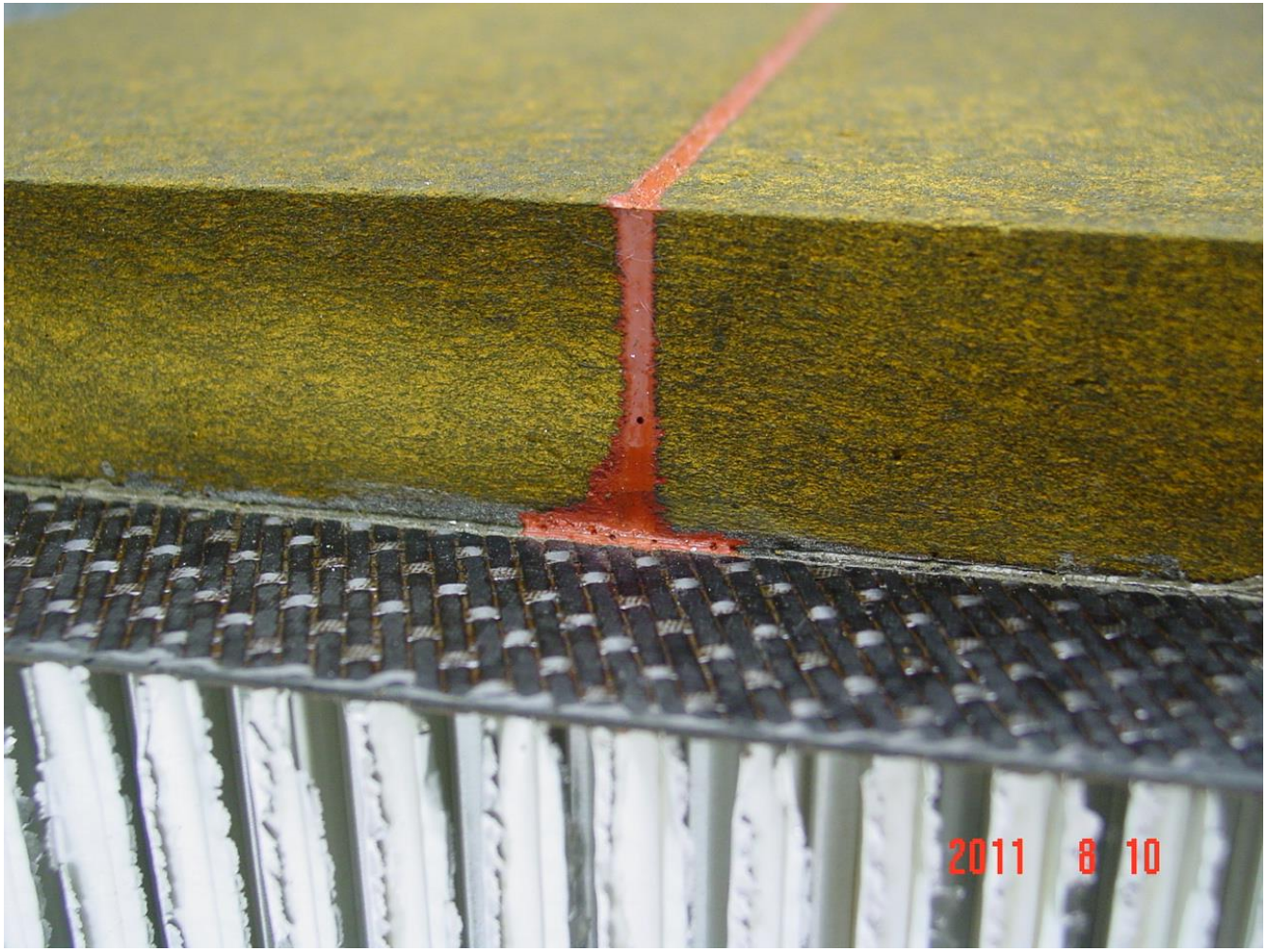


M98 Backshell Thermal Protection System

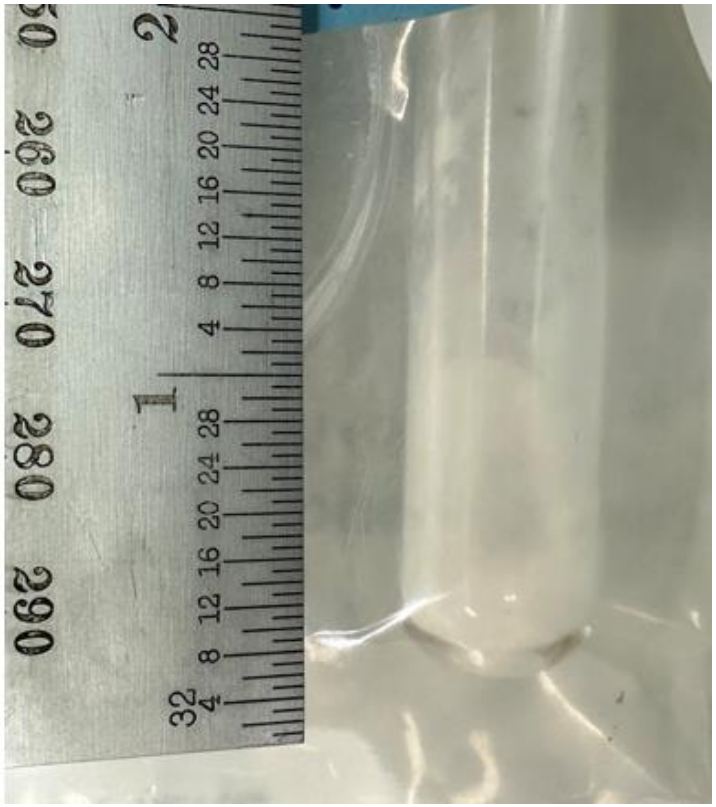


Composition is proprietary: But is cork in the material (cellular structures)?

Heat Shield with Phenolic Impregnated Carbon Ablator



Talc, Airbags



Airbag anti-friction Mineral. (Non-organic)

- Sample of Opportunity

Epoxies & Polymers

Auxiliary items collected

Fabian's Fall-out Cloths

Deployed in the cleanroom during MER assembly
Purpose: Cleanroom Fallout bioburden estimates. Never analyzed.

M2020 Witness Coupons

A “Day” in the Life …

- **Early in the S/C assembly process, the PP Project lead communicates the need for physical samples to the cognizant engineers**
- **Samples are given to the PP Project lead**
- **Samples are then given to the Organic Archive**
- **Samples are assigned a number & the packaging is labeled**
  - If packaged in ESD protective bags, the material is stored as is
  - Ideally, the material is double wrapped in ultra clean aluminum foil, packaged & sealed in nitrogen purged polyethylene, a fact sheet and material are sealed in a second nitrogen purged polyethylene bag.
- **Samples are stored in numbered open bins.**
- **Samples stored in locked cabinets. Building access also controlled.**
  - Controlled laboratory temperatures, 20-22 C
  - Stored in the dark
- **Information provided about the material is entered into an excel-based database & uploaded to a cloud-based database called Airtable**

MSL Material Submission Form

Submitting Organization	Name		Phone/e-mail
352L	Douglas S. Adams		818-363-6387 Douglas.S.Adams@jpl.nas
Material Name/Part Number (include primers/catalysts)	Material Manufacturer	Lot/Date Code	Mix Ratio (if applicat
1" Kevlar Tape E.I. 4052/1999	Bally Ribbon Mills	RR 22586 0209	N/A
Cure Schedule for Flight Hardware	Bakeout Parameters for Flight Hardware	Parameters for Other Thermal Tests (Planetary Protection, Thermal Cycling,etc)	
Time: Temperature: Pressure: Other (explain) N/A	Time: Temperature: Pressure: Other (explain) *No CC bake-out was done.* Has this sample been baked out? Yes (No)	Time: 10.8 h Temperature: 120C Pressure: 1 atm Other (explain) *PP bake-out was performed at 1 atm a no separate CC bake-out was done.* Has this sample been tested per the above? Yes (No)	
Location of Each Use of Material / Qty in grams in each location Feel free to attach photo showing locations if that is easier		Maximum Operating AND Non Opera Temperatures (mission or ground test) each location	
Parachute Single Riser and Sabot Capture Net		Max Operating C 45C	Max Non-Operating (70C

Primary function/application of the material (thermal, structural adhesive, electrical, etc.) and any other information that should be known about the material or its use

Structural
Lot information is available on Pioneer Aerospace Corporation, Receiving Report (RR) 22586 0209
Item Code K1-B5049

Date of Submission:	Date of fabrication	
07/29/11	05/31/09 (DHMR)	

JPL D-37702 MSL Materials Archive
Sample Data Sheet
Brian Blackholb

Organic Materials Archive History – Current Holdings

Collection	Number Required	Additional	Total Number
Viking (Landers & Orbiters)			6
Mars Pathfinder			13
Mars 98			1
Mars Exploration Rovers			176
MRO			36
Phoenix			24
Mars Science Laboratory	12	61	73
Maven	5	7	12
InSight	10	35	45
M2020 (witness coupon packages: ~60 not included)	~12	~20	32
Flight Certified Electronic parts (grouped)	0	45	45
Subtotal of Spacecraft-Related Materials			**461**

Organics Documentation and Curation

	Description of Process	Deliverable

Documentation	• Impacts in-situ analysis - passes selection criterion (e.g. has a credible mechanism to transfer to sensitive system); cross references MIUL.
	• Impacts SCS sample analysis - passes selection criterion (e.g. has a credible mechanism to transfer to sensitive system); cross references MIUL.
	• Bulk organics materials inventory for landed or impacted hardware that are present in quantities of 1kg or more.
		• Customer = Science, RSS
		  • MIUL, PSE memo detailing list and repository for analytical chemistry data
		• Customer = NASA HQ PPO
		  • PSE memo of bulk organics materials inventory >1kg
		• Beneficiary = Engineering. Engineering value added.

Curation	• Impacts in-situ analysis - passes selection criterion (e.g. has a credible mechanism to transfer to sensitive system); cross references MIUL.
	• Impacts SCS sample analysis - passes selection criterion (e.g. has a credible mechanism to transfer to sensitive system); cross references MIUL.
	• Collect organic samples from the entire spacecraft of at least 50 grams of each organic material type for which more than 25 kg is transported to the Martian surface
		• Customer = Science
		  • Organic samples
		• Customer = NASA HQ PPO
		  • 50 grams of each organic material type for which more than 25 kg
		• Beneficiary = Engineering. Engineering value added.

Organics Used in Significant Mass

* = 25 kg threshold

Material	Use
BTCY-1 Polycyanate Resin *	Used as the matrix resin for carbon fiber and glass fiber reinforced panels
Polyester*	Parachute
Vectran*	BUD/ Bridal Spool
Kevlar Tape/Webbing*	Parachute
SLA-561V*	Thermal Protection System on Backshell
Toray 1000 Graphite Fibers	Pressurant Tank ~11 lbs.
Phenolic-Impregnated Carbon Ablator (PICA) *	Thermal Protection on Heat Shield
RTV-566/560*	Backshell TPS Repair
Teflon*	Wire Insulation
Flamemaster S1023 Silicone Paint*	Backshell Paint
Nylon 3, Nylon 5, Cord	Parachute material
Kapton Polyimide Film	Thermal Blankets for Cruise Stage Various Tapes Wire Insulation

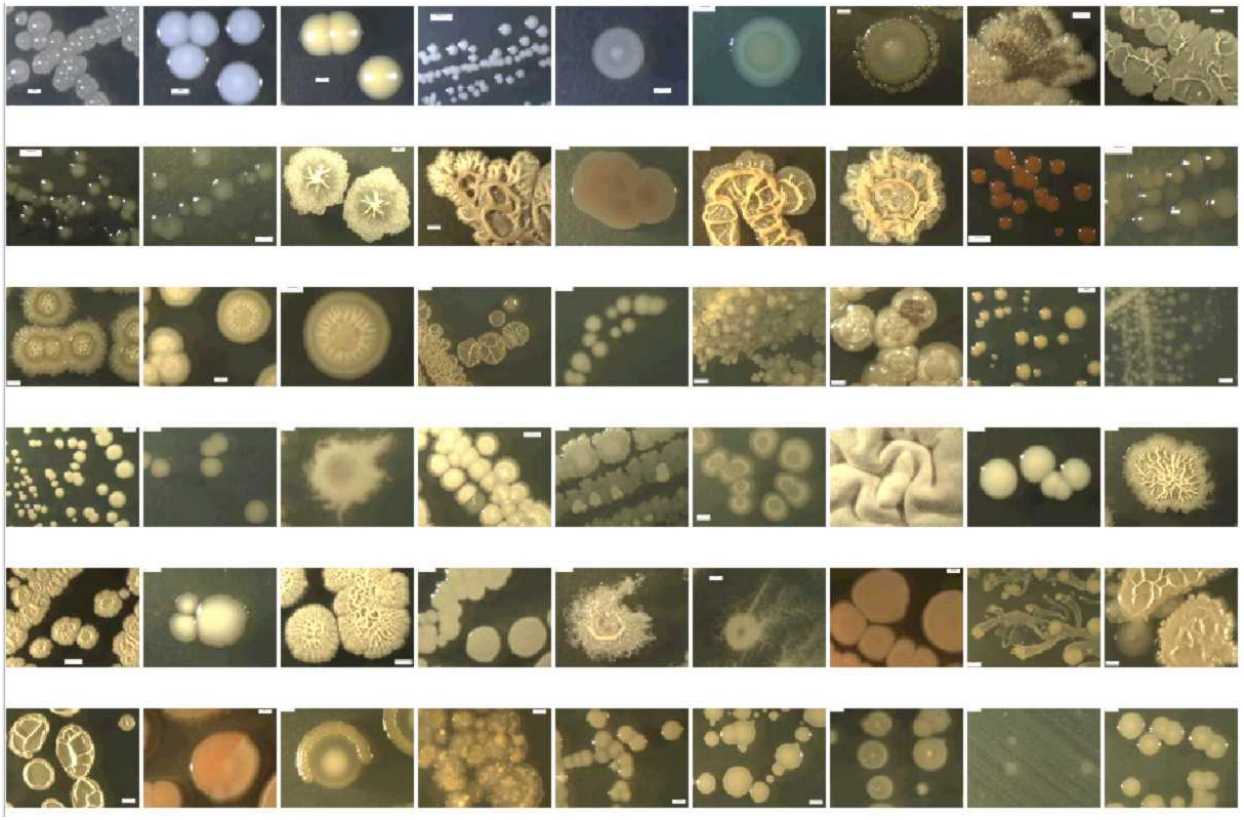
Organics Used in Significant Mass

Material	Use
FM 73 Epoxy Film Adhesive	Pressurant Tanks
EA 9394 Epoxy Paste Adhesive	Structural Bonding
CV-2566 Silicone Adhesive	Silicone Adhesive/Potting Rover, Descent Stage
Arathane 5750 Polyurethane Resin	Potting and Conformal Coating for Lander, Rover
G-10 fiberglass epoxy	Standoffs, Insulators, PWBs for DS, Rover
Mylar polyethylene terephthalate film	Thermal Blankets
M55J Graphite Fibers	Fiber reinforcement for composites Rover/Descent Stage
Bryte Tech EX1541 11+/-1 PCF Polycyanate Corefill	Aeroshell

Most organics fall below the 25 kg threshold

Material	Subsystem	Part Name/Location	Mass (kg)	Notes
PICA	Heatshield	PICA	212.36	
Unknown	Backshell	TPS	67.514	likely PICA
Unknown	Parachute	Suspension Lines	35.01	
Unknown	Parachute	Disk	16.5	
Unknown	Parachute	Band	10.88	
Unknown	Descent Stage	MLI Blankets	10.52	
Unknown	Parachute	Riser	10.5	
Unknown	Heatshield	MLI Blankets	9	
Unknown	Cruise Stage	MLI Blankets	8.84	
Unknown	Backshell	Paint	7.15	
Unknown	Parachute	Nylon Bridle Assembly	6.98	
Paint	Rover	Rover Chassis	4	
Unknown	Cruise Stage	Paint	3.75	very old estimate
Unknown	Cruise Stage	Silver Teflon Tape	1.78	
Unknown	Parachute	Deployment Bag	1.56	
G-10	Rover	Harness Standoffs	1.39	
Unknown	Descent Stage	Bridle cord	0.56	
Unknown	Rover	Purge Tubing	0.34	likely Teflon
Unknown	Cruise Stage	DM105 Aluminized Kapton Tape	0.24	
Unknown	Backshell	Purge Tubing	0.19	likely Teflon
Unknown	Rover	MMRTG Windbreaker	0.17	
Unknown	Descent Stage	Purge Tubing	0.09	likely Teflon
Unknown	Cruise Stage	Purge Tubing	0.08	likely Teflon
Unknown	Parachute	MLI Blanket	0.08	

Rogues Gallery
Some of the 8,000+ Microbial Isolates



Meeting Info

- **Planetary Protection Organic Inventory Workshop**
- **Teams Meeting February 27-28, 2024**

Success! URS323530 has been submitted.