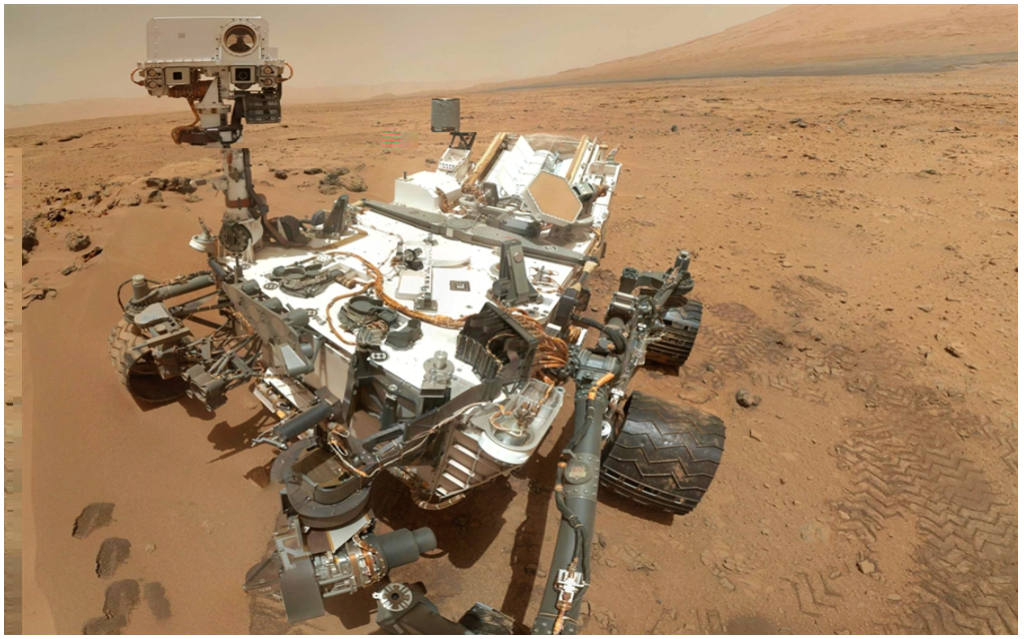
Preservation of Biosignature Molecules in Potential Sample Return Container of the Mars 2020 Mission



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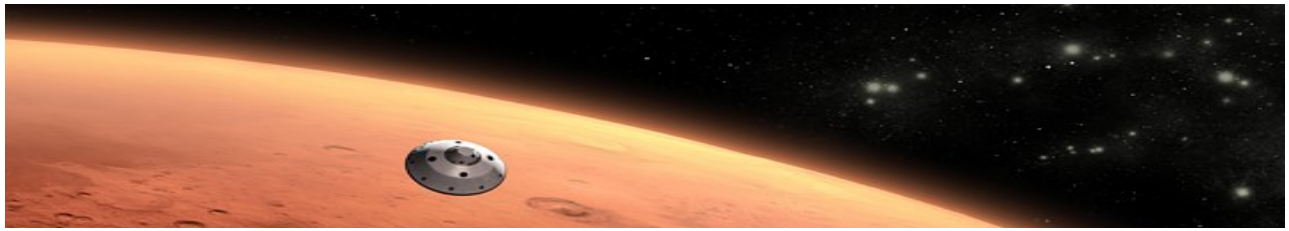
Jet Propulsion Laboratory
Planetary Protection Group
STAR Program
Summer 2013

Presentation Outline

Mars Sample-Return Mission
Sample Collection and Storage
Potential Container Metals
Representative Organic Molecules
Methods and Procedure
Results



Mars Sample-Return
Mars 2020 Mission

"Holy grail of space missions"

Mission Objectives:

- *In situ* search for Biosignatures
- Rock and dust samples and return them to Earth
- Improvement in landing technology
- Potential human mission
- Maximize engineering

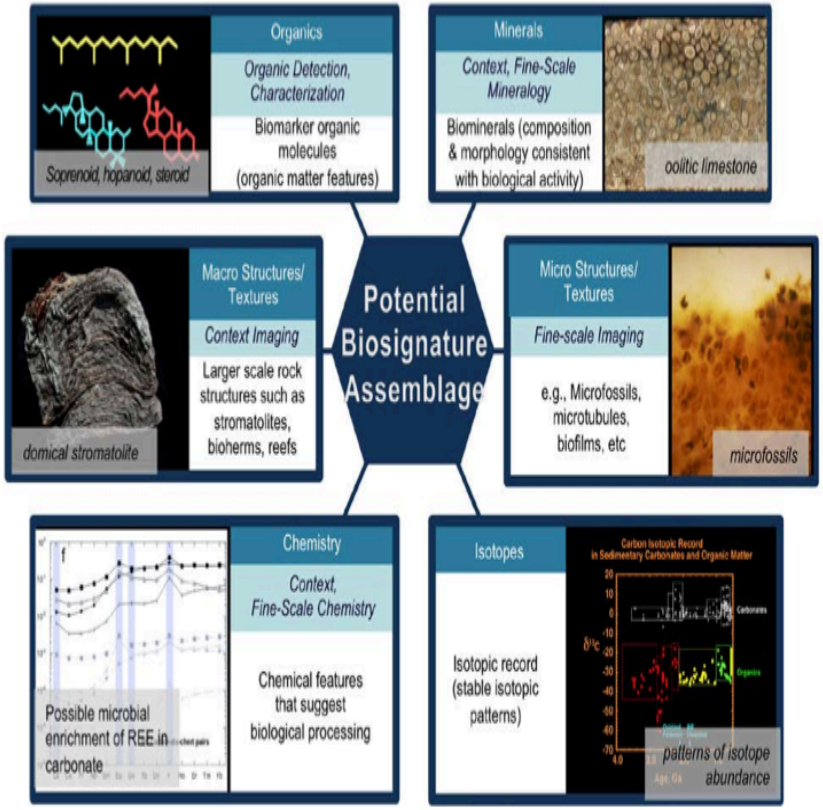


Figure 1. 5 of the 6 Potential Biosignatures will be detectable by the rover in Mars 2020 mission. Isotopes will not be detectable with current technology.

Sample Collection and Storage

Purpose

- Removes time and budgetary limitation
- Spacecraft sensors limitations no longer a factor
- All major laboratories could conduct studies at own pace

Essential Questions

- How will the container metal chemically interact with Martian sample?
- Will corrosion impact the integrity of the sample upon return?
- Ultimately, will biosignautre molecules react with the metal container over time?

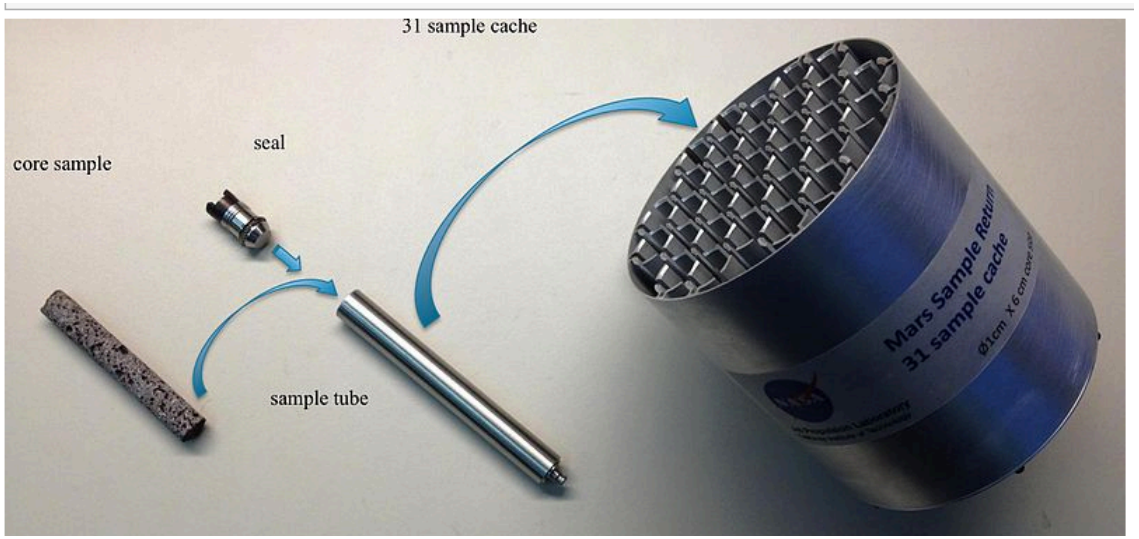


Figure 2. Prototype of returnable container and cache for the Sample Return Mission 2020.

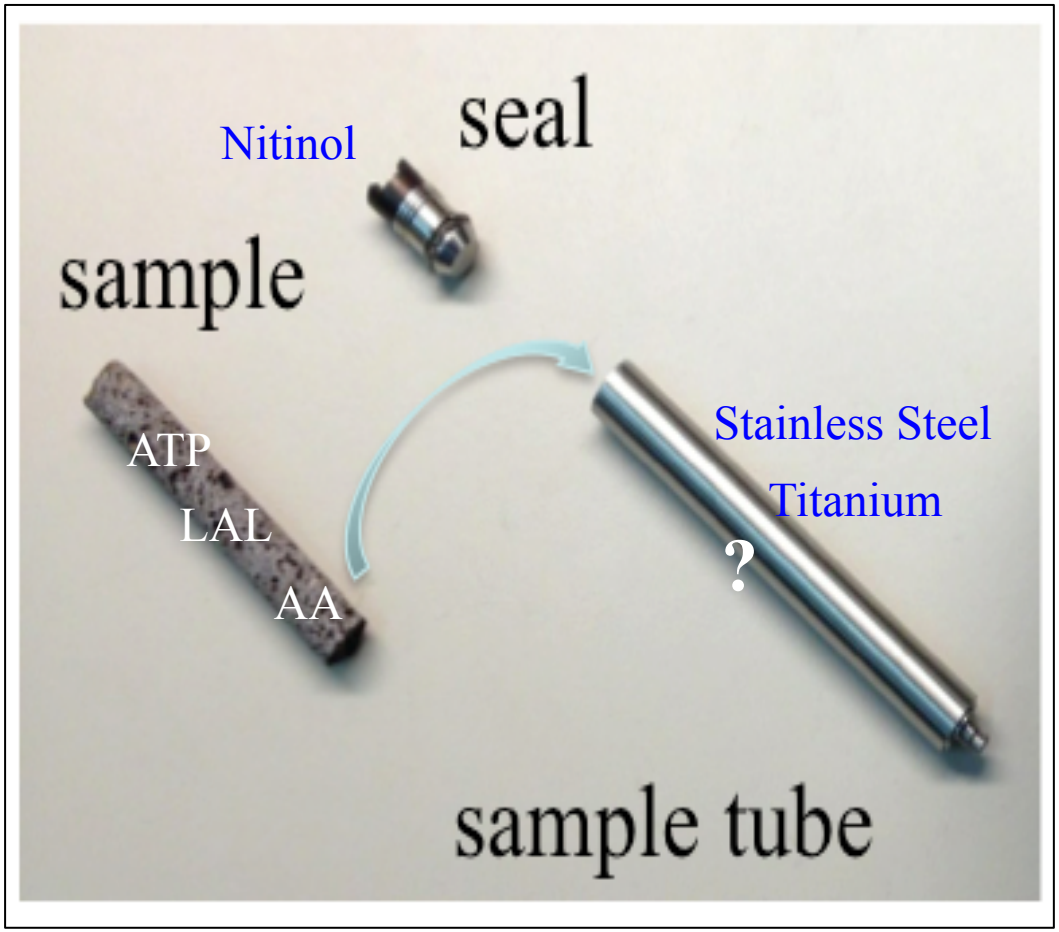
Possible Container Metals

Possible Metals

Stainless Steel

Titanium

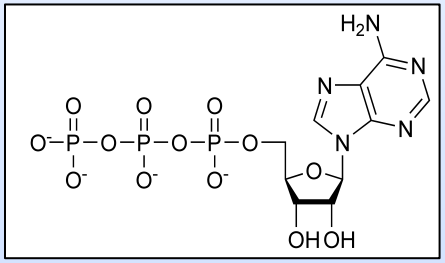
Nitinol
(Shape-memory)



Representative Organic Molecules

Representative organic molecules for follow-up assay procedures upon different metal samples

Adenosine triphosphate (ATP)



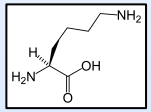
Detection

Total ATP Bioluminescence Assay

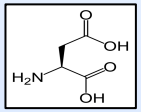
Reason for Test Selection

Found in all metabolically active organisms

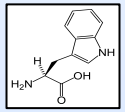
Amino Acids



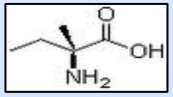
Lysine



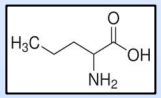
Aspartic Acid



Tryptophan



Isovaline



Norvaline

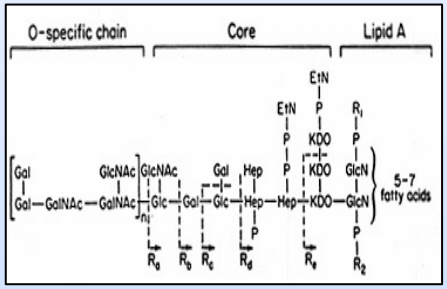
Detection

Fluorescamine Assay

Reason for Test Selection

Representative amino acid

Limulus Amebocyte Lysate (LAL)



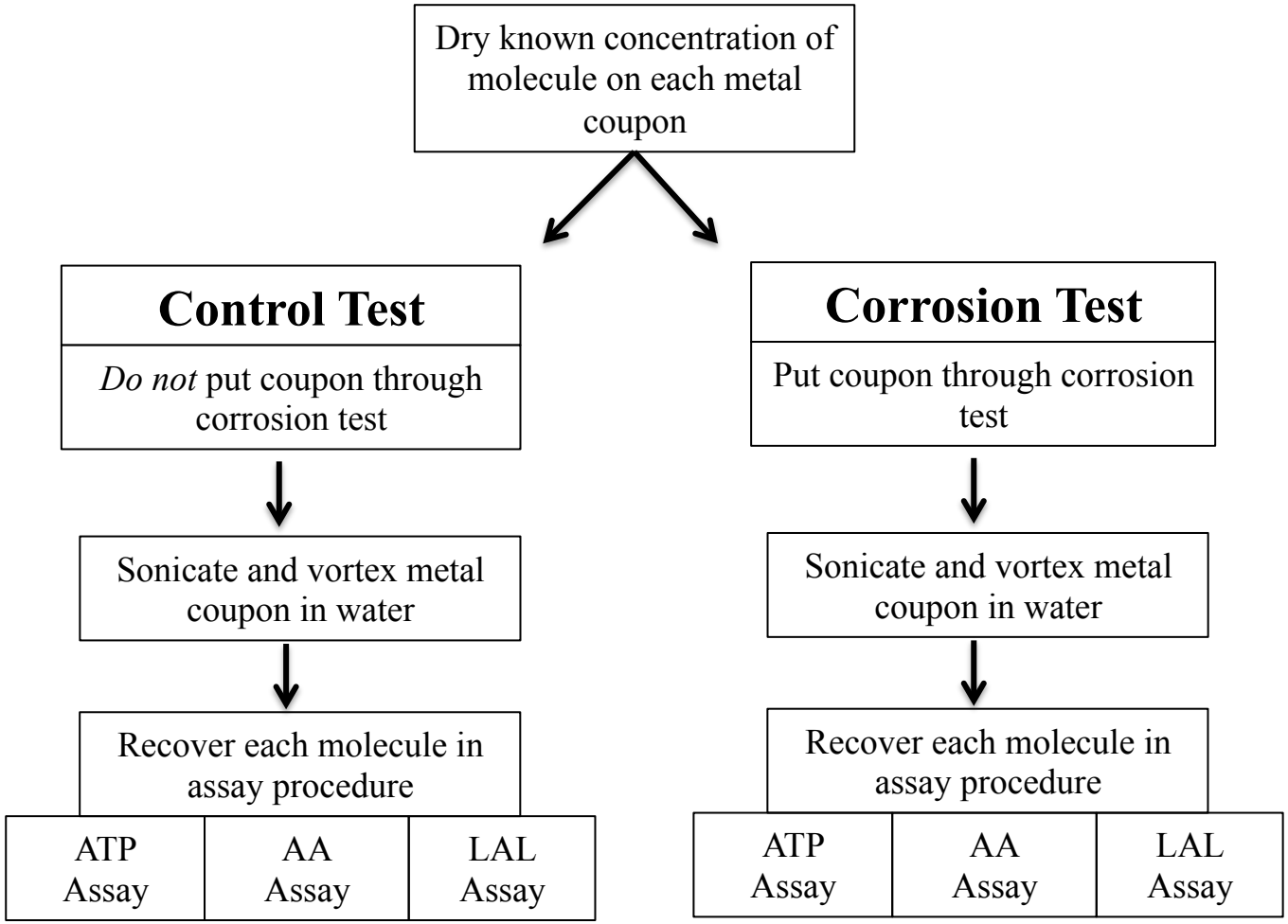
Detection

LAL Assay

Reason for Test Selection

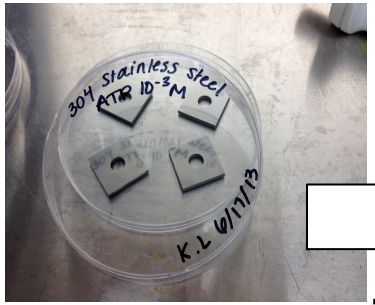
Membrane lipid found in Gram Negative Bacterial Cell Walls

Experimental Overview



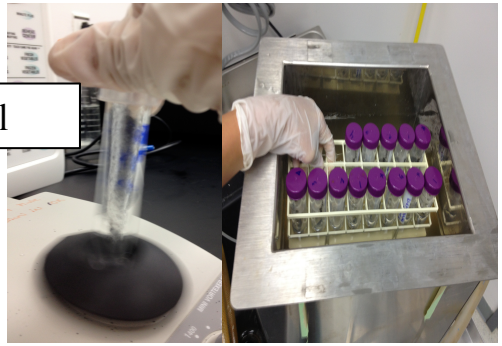
Experimental Procedure

Corrosion Test

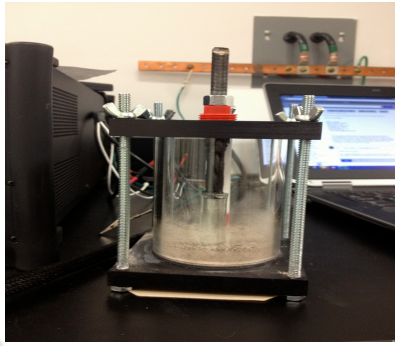


Dry molecule on coupon

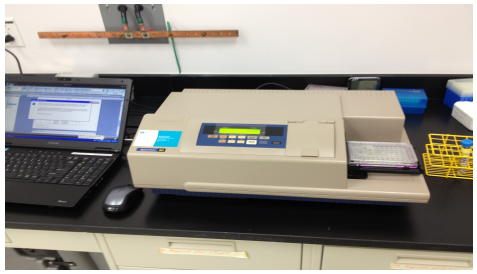
Control



Vortex and sonicate the coupons in water

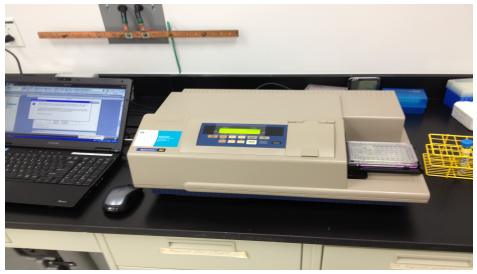


Corrosion test on metal coupon in Martian simiulant



Flourescamine Assay

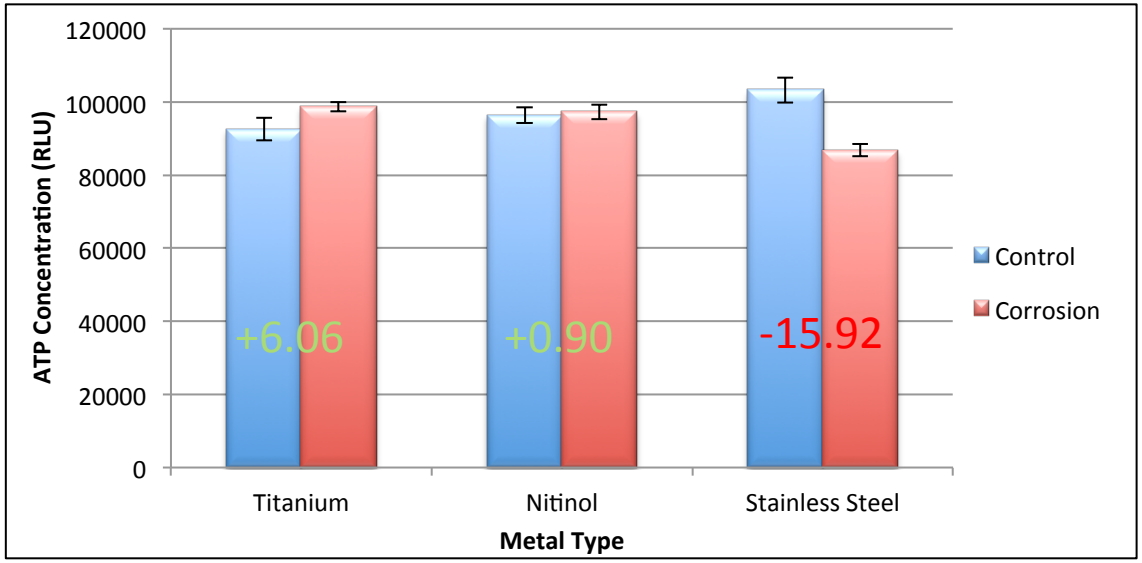
Bioluminescence Assay



LAL Assay

ATP Assay Results

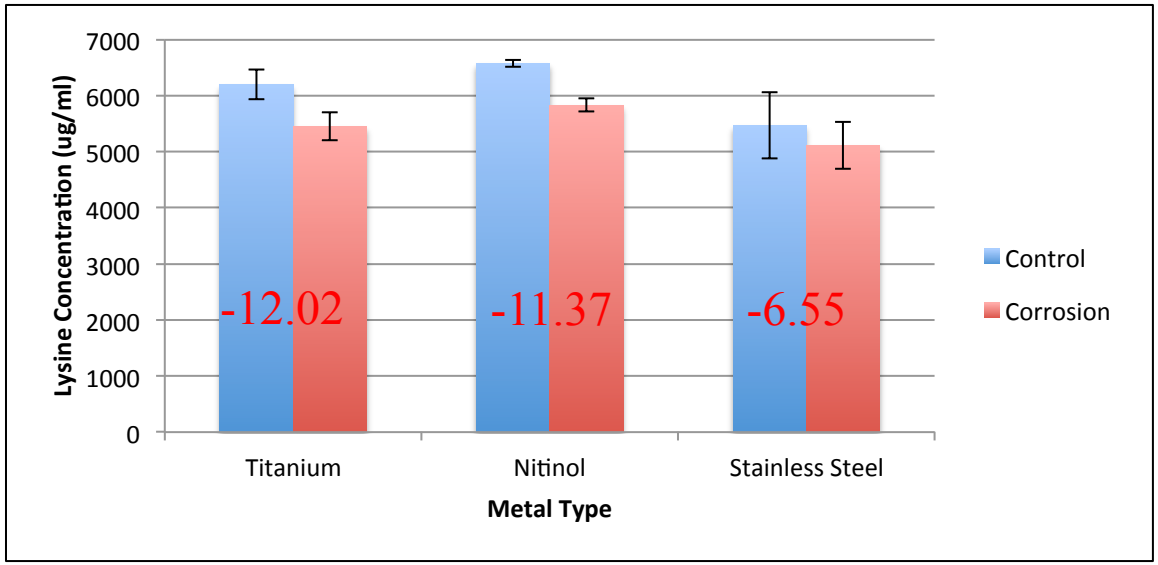
ATP Recovery in Control vs Corrosion Test



Metal	Control	Corrosion	Percent Change
Titanium	92541.4	98658.12	6.61
Nitinol	96379.7	97242.6	0.90
Stainless Steel	103170.5	86745.75	-15.92

Amino Acid Assay Results

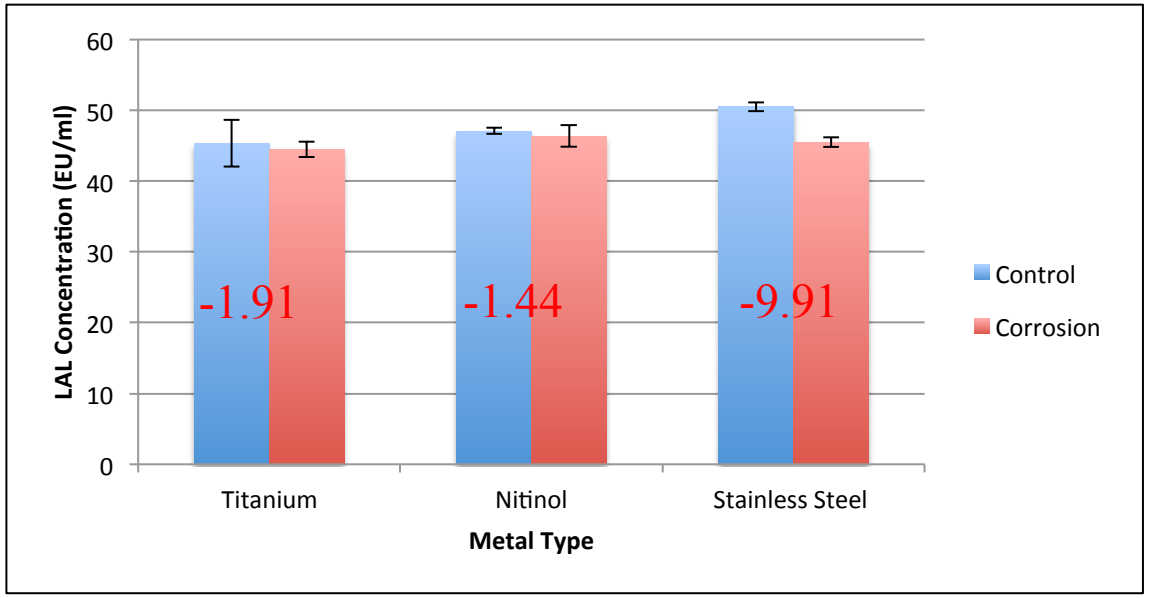
Lysine Recovery in Control vs Corrosion Test



Metal Type	Control	Corrosion	Percent Change
Titanium	6199.35	5454.36	-12.02
Nitinol	6577.91	5830.20	-11.37
Stainless Steel	5470.31	5111.87	-6.55

LAL Assay Results

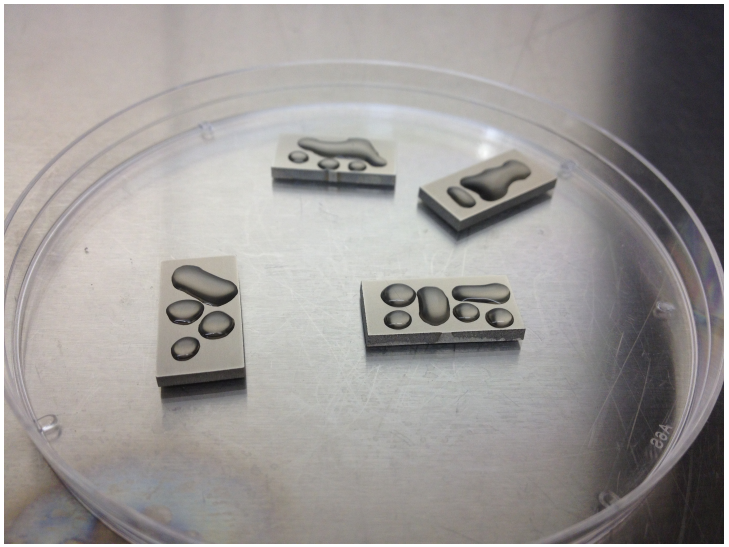
LAL Concentration in Control vs Corrosion Test

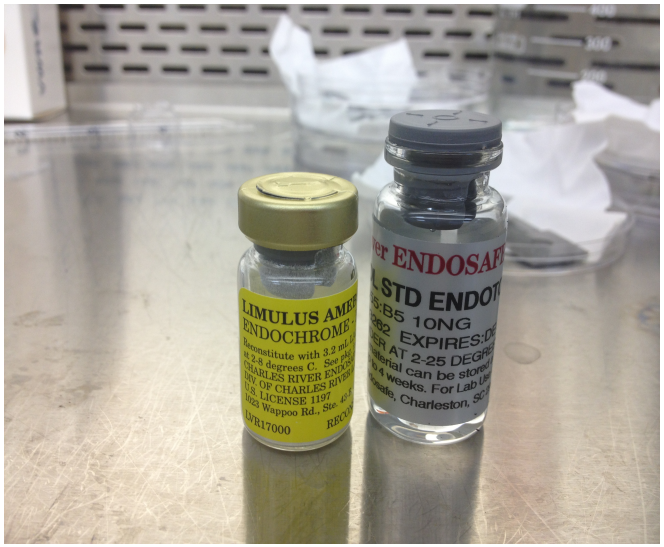


Metal Type	Control	Corrosion	Percent Change
Titanium	45.36	44.49	-1.9
Nitinol	47.03	46.35	-1.44
Stainless Steel	50.48	45.48	-9.91

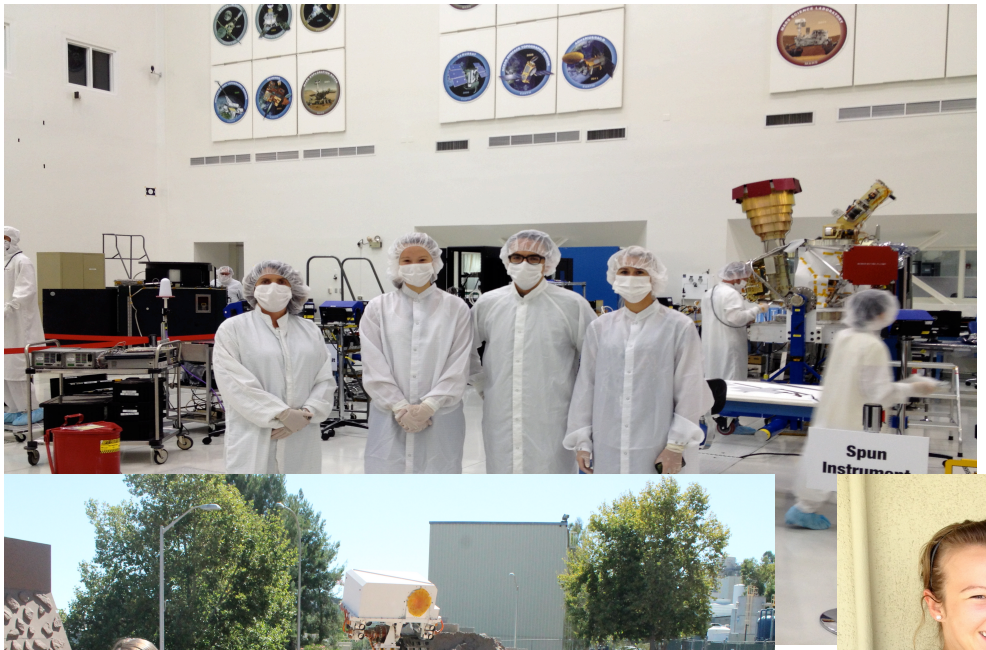
Assay Conclusions

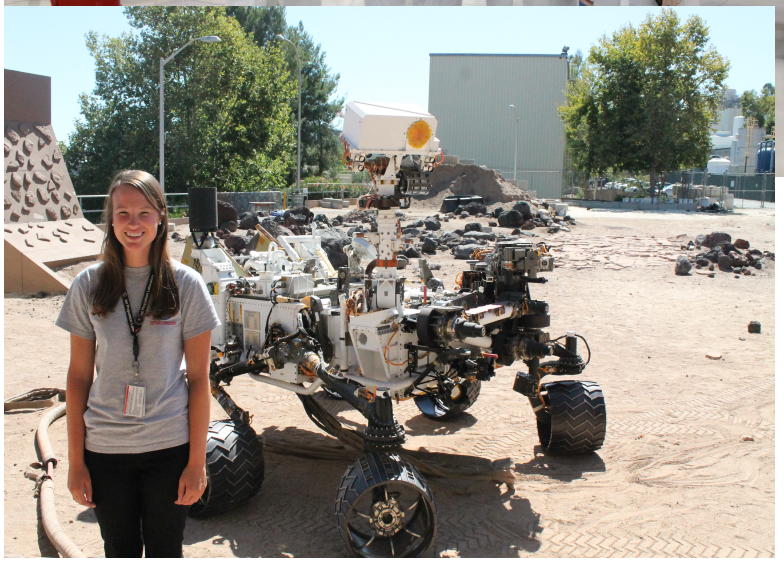
- Corrosion did not greatly effect organics
- Each metal type is suitable for container
- Organics still recoverable in high percentage





NASA Research Experience





Acknowledgements

Dr. Fei Chen, Planetary Protection Group

Dr. Moogega Cooper, Planetary Protection Group

Erol Chandler, STEM Teacher and Researcher Fellow

Martin Matthews, STAR Master Teacher

Elizabeth Nagy-Shadman, STAR Research Assistant

And a Thank You to all of the Planetary Protection Group and STAR Program!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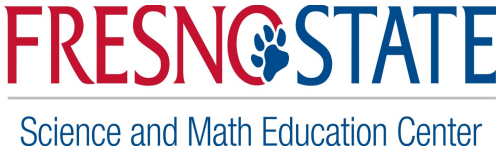
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