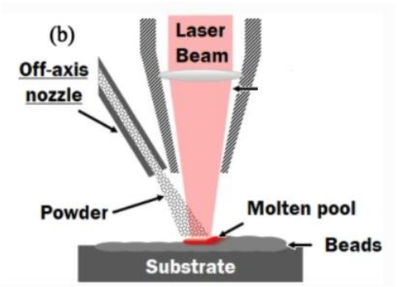
Additive Manufacturing Using Lunar Regolith in a Dirty Vacuum

NASA Marshall Space Flight Center
Engineering Directorate, Materials & Processes Lab
Parker Shake, Advanced Manufacturing Branch – EM42

Overview

- Directed Energy Deposition (DED) in its various forms is proposed to be the primary technology for additive manufacturing on the lunar surface
- A powder bed fusion and DED hybrid approach has been proven out at a low TRL by NASA MSFC EM42
- An injected powder DED system has been designed to operate in the low gravity environments of the lunar surface
- A CAT 3 TE was awarded for $1.4M

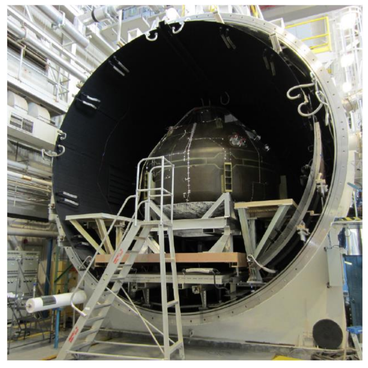


V20 – Dirty Vacuum Chamber

- The V20 Dirty Vacuum Chamber at MSFC will be used for testing
- The new PLANET vacuum chamber at MSFC is also being considered for future work

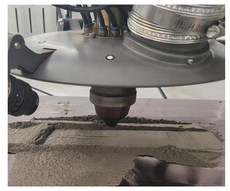
Facility Capabilities:

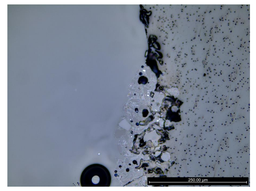
Overall Dimension:	20′ dia. x 28′ deep
Test Article Area:	17′ wide x 22′ deep (see illustration)
Data System:	Pacrats
	IFIX
Temperature Range:	-170C to +200C
Pressure:	$1x10^{-6}$ torr
Thermocouples:	486
Lamps:	9 Zones, 6x 1,600 watt IR Bulbs ea.
RGA:	Yes
TQCM:	Yes
Internal Camera:	IR and Color



Initial Trials

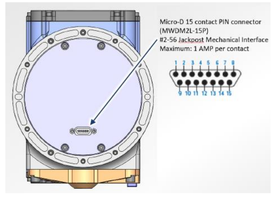
- Melting and stacking single pass beads using the existing Laser Powder Directed Energy Deposition tool in EM42 demonstrated the feasibility of the manufacturing approach






Laser

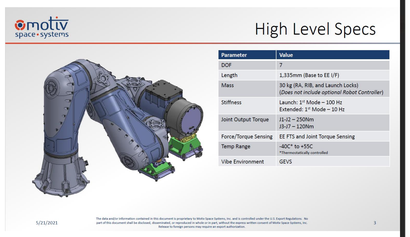
- A 1000W diode laser has been selected for the end effector. This enables a steady beam at powers appropriate for melting regolith

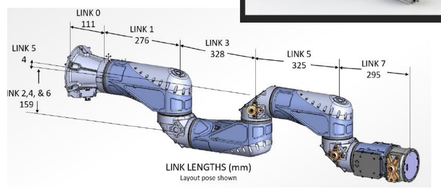


Optic sample shown in RT angle configuration (straight unit is quoted)

Robotic Arm

- A $1.05M Phase III SBIR with Motiv Space Systems was initiated to procure the robotic arm.





Future Work

- The first task will focus on dialing in the robot and laser for operation in the V20. Afterwards a parameter development DOE will be completed to determine the highest performance parameters for additive manufacturing using lunar regolith.
- The end effector is modular any tool that meets the weight and electrical requirements can be used.
- An ECI is being proposed to turn regolith into an aluminum wire feedstock and then will be used in a laser wire DED style set up

Iteration of Process Cycle