Paper ID: 61279
oral

IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Advancements in Materials Applications and Rapid Prototyping (5)

Author: Mr. Robert Mueller
National Aeronautics and Space Administration (NASA), United States

Prof. Emanuela Del Gado
United States
Dr. A. Scott Howe
National Aeronautics and Space Administration (NASA), Jet Propulsion Laboratory, United States
Mr. Nathan Gelino
NASA, United States

CHALLENGES AND OPPORTUNITIES OF MATERIALS FOR CONSTRUCTION IN SPACE: 3D AUTOMATED ADDITIVE CONSTRUCTION (3DAAC) USING IN-SITU RESOURCES

Abstract

The establishment of permanent planetary surface outposts requires multiple landings to build up the required number of assets for outpost completion, and additional landings to deliver crew and logistics to support continuous occupancy. NASA's research has strengthened the argument that many of these issues should be solved by using in-situ resources, particularly the use of local regolith through excavating, emplacement, melting, fusing, and extruding layers in an automated additive manner for large-scale 3D printing. For example, one simple approach is to try to use natural features in the landscape to shield already-landed assets from ejecta thrown up by the descent stage, land on a stabilized surface and later use mobility systems to collect offloaded assets into a single location. However, the technology for in-situ utilization of materials found on the site to create a landing pad for repeat landings still has too many unknowns and is yet unproven. 3D Automated Additive Construction (3DAAC) can overcome a number of limitations for other building technologies in space (excavating, molding, etc). These lessons learnt can then be carried on to future planetary missions, including Mars and beyond.

In this paper, we offer an overview of the challenges and opportunities of in-situ materials and material technologies for construction in space. We provide a perspective of advances in material science for construction materials and related technologies, and of directions that are important and interesting specifically for construction in space. Some of this may come specifically from construction materials, but some could come from other areas of material studies (polymers, smart plastics, self-healing and recyclable materials, colloidal/granular materials, etc). While large-scale 3DAAC techniques have greatly improved and advances in material science can now significantly widen the range of options, the fundamental understanding of local regolith, binding phases and of their behavior in printing conditions and in the built infrastructure in space is still quite limited.

Using advanced materials and 3D printing techniques has unique potential to overcome the current limitations of 3DAAC techniques to provide compact, low-mass / low energy means to use native materials for heat-resistive / pressure-resistive formable structures, either through continuous printing or through prefabricated units in order to provide launch and landing pad surfaces other infrastructure needed.