IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

Author: Mr. Peter Collins
Pennsylvania State University, United States

Dr. Jennifer Edmunson
NASA Marshall Space Flight Center, United States
Mr. Michael Fiske
Jacobs Technology, NASA Marshall Space Flight Center Group, United States
Prof. Sven Bilen
Pennsylvania State University, United States
Prof. Aleksandra Radlinska
Pennsylvania State University, United States

GEOPOLYMER LUNAR CONCRETE UNDER REDUCED-PRESSURE CURING AND VACUUM EXPOSURE

Abstract

Geopolymer concrete has emerged as a promising material for constructing habitats, roads, landing pads, and other necessary infrastructure on the lunar surface. Proper in-situ resource utilization (ISRU) is an important aspect of any candidate lunar construction material. Geopolymer concrete is effective at ISRU, as the lunar regolith can be used in the 'as found' condition and mixed with an alkaline solution, such as sodium silicate and sodium hydroxide, which could also be mostly produced in-situ. It is envisioned that any concrete material on the lunar surface would be deposited with additive manufacturing techniques and would require a temporary cover to mitigate the harsh lunar environment during construction and curing, such as pressure and temperature. Data are needed to set a benchmark for the conditions to be achieved within the deployable cover, as well as material properties after the cover is removed. This novel study investigated the influence of reduced atmospheric pressures during the initial curing period on the compressive strength of geopolymer lunar concrete created with two types of lunar regolith simulant. The simulants used in the study represent the regolith for the lunar mare (OPRL2N) and lunar highlands (OPRH2N) regions. Results show a noticeable decline in strength with a reduction in pressure and visible degradation.

After the deployable cover is removed from the printed segment of infrastructure on the lunar surface, it would then be exposed to the harsh vacuum environment. To understand the importance of curing time within the deployable cover before it is removed, samples were cast and cured for different lengths of time and then exposed to a vacuum chamber capable of achieving 100 mTorr. Control samples were also cast at the same time but left in a standard laboratory environment after curing. The weight change and compressive strength as a function of time in the vacuum chamber were monitored up to 56 days. The results showed that exposure to the vacuum limits further reaction and strength gain in comparison to control samples left in the laboratory environment. This research is in strong alignment with the *2020 NASA Technology Taxonomy* materials area (12.1) and the in-situ resource utilization area (7.1), as it provides necessary data on the geopolymer lunar concrete material to support safe and sustainable options for maintaining a human presence on the Moon.