IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

Author: Mr. NamSuk Cho
Unmanned Exploration Laboratory (UEL), Korea, Republic of, whitewh0519@uel.co.kr

Mr. YeongSeop Kim
Unmanned Exploration Laboratory (UEL), Korea, Republic of, yeongseop.kim@uel.co.kr
Mr. TaeYoung Lee
Unmanned Exploration Laboratory (UEL), Korea, Republic of, taeyoung.lee@uel.co.kr
Mr. KangSan Kim
Space Generation Advisory Council (SGAC), Korea, Republic of, antonio.stark@spacegeneration.org

3D PRINTING TECHNOLOGY DEMONSTRATION USING SYNTHETIC LUNAR REGOLITH SIMULANT WITH POLYMER ADDITIVES

Abstract

The 2020s have seen a mix of countries coming up with plans for lunar exploration, many of which have been geared towards a long-term human presence on the lunar surface. While some proposals are based on pre-fabricated modules launched and expanded on the moon, many proposals utilize 3D printing technology to create base habitat structures, scaffolding, or at least outer walls to serve as radioactive shields. These technologies account for the melting and 3D printing of lunar materials for construction purposes.

This study empirically validates the feasibility of such approaches using the Korean Lunar Simulant (KLS-1) synthetic lunar soil. The simulant is mixed with plastic polymer powder, and heated to create a non-homogeneously mixed substance of mud-like viscosity. This substance is then processed through a screw kneader to spread the simulant and polymer into a more homogeneous state, before being extruded through a nozzle to build structures.

The feasibility of construction through this method is presented in two cases. The first case is via a fixed nozzle that is filled and then cooled inside a brick container to manufacture tiles that can be fitted together to build structures. The container-tile model allows for compacting of the substance to create denser and more heat-resistant products that can be used to build spaceship landing sites on the lunar surface, which are necessary to situate spaceship landing sites near existing human habitats.

The second case is via direct extrusion to construction sites via a controlled, variably located nozzle. The nozzle can move in either a closed-space (with limited x-y plane movement) through a frame where the nozzle is maneuvered, or an open-space via the nozzle located at the end of a robotic arm. The direct extrusion additive manufacturing model provides for more versatile modeling of habitats, especially in the use of curves, but the end products have lower densities, and design-to-product accuracy is also low due to the time required for the mix to harden.

The study concludes that 3D printed composites using lunar regolith stimulants and plastic polymer powder provide a method to construct lunar habitat structures with sufficient rigidity.