22nd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Interactive Presentations - 22nd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (IP)

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SPACE COPY: EXPLORING PIONEERING TECHNOLOGIES FOR IN-SITU RESOURCE UTILIZATION AND LUNAR ENABLED ADDITIVE MANUFACTURING FOR INFRASTRUCTURE PRODUCTION IN-SITU

Abstract

The use of additive manufacturing for in-space manufacturing (ISM) of infrastructure, precision tooling, and repair parts are of interest to lunar colonization efforts pioneered by NASA and the greater science community from both a scientific merit perspective, and an economic perspective for reducing lunar resupply payload cost, and frequency. The development of advanced lunar hardware introduces an improved method for additive manufacturing, and the integration autonomous powered material characterization, beneficiation, and qualification sub-systems, allows for the identification, handling and effective use of lunar resources for off-world construction activities. Space Copy introduces a novel, patented, and private technology designed to operate in extreme environments on Earth and in-space to additively manufacture critical supplies using in-situ resource utilization (ISRU) with beneficiated regolith as a primary feedstock for Laser Powder Bed Fusion (LPBF). Currently demonstrated at a technology readiness level three (TRL 3), LUMINAR: the Lunar Utilization for Manufacturing In-Situ with Nano Assembly and Raman Spectroscopy, introduced by Space Copy, operates in various phases to combine Raman spectroscopic material characterization for parameter optimization and chemical diagnostics, in conjunction with beneficiation of small to medium sized particulate for effective particle size distribution to be utilized in a novel Selective Laser Melting (SLM) process that operates in vacuum conditions with consideration of mitigating the challenges associated with microgravity, external radiation, and porosity of prints. Combining materials science with robotics, and effective Positioning, Navigation and Timing (PNT) techniques for near real-time tele-operational capabilities, the future development of lunar hardware for regolith-based manufacturing holds potential for both crewed and uncrewed missions. The integration of autonomous robotics through a series of algorithms controlled by Deep Space Optical Communications (DSOC) ensures near-continuous interaction with lunar hardware from Earth, delivering seamless manufacturing, qualification, and process optimization through direct communication with terrestrial-based operations during the initial operational period. The prototype's compact design and capabilities for continuous regolith processing cycles meet the technical demands outlined by the environmental restrictions of space travel, making the lunar hardware a suitable candidate for a lunar lander, and Earth-based defense applications for extreme and remote environments.