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FROM REGOLITH TO REBAR: A REPORT OUT FROM A NASA STMD LSIC WORKSHOP ON THE IN-SITU EXTRACTION AND SUBSEQUENT USE OF METALS ON THE LUNAR SURFACE

Abstract

The NASA Space Technology Mission Directorate (STMD) funded Lunar Surface Innovation Consortium (LSIC) hosted a 1-day workshop on Feb 23, 2022 with the goal of developing a common and realistic understanding of what is possible for metal lunar In-Situ Resource Utilization (ISRU) extraction and usage in the near-term, next 5 – 10 years. The NASA Artemis program has the stated goal of putting astronauts back on the Moon mid-decade followed by developing a persistent presence (NASA's Plan for Sustained Lunar Exploration and Development, 2020). The usage of metal derived directly from the lunar regolith to support the construction of facilities on the lunar surface is part of NASA's vision for a sustained presence (In Situ Resource Utilization (ISRU) – Surface Excavation Construction, NAC TIE, January 21, 2021). This workshop brought together 6 speakers from industries developing technologies for the extraction of metals from lunar regolith, with 6 industry speakers on the topic of lunar construction, in-space manufacturing and architecture, led off by visionary presentations from senior NASA STMD officials on how ISRU and surface construction is enabling to a sustained presence. The extraction technologies presented by the 'supply side' ranged from various forms of electrolysis (molten regolith electrolysis, molten salt electrolysis) to direct reduction and thermal approaches including hydrogen reduction, carbothermal reduction and vapor pyrolysis. Each process has different characteristics such as efficiency of extraction, rates of production, power requirements, and complexity of operations as well as what types of metals are produced from highland as well as mare regoliths, purity, and in what forms. This extracted material then becomes the 'feedstock' to the construction and manufacturing industries on the demand side. The considerations of the construction industries include needing to know which metals will be available, their forms and purity levels, what needs to be constructed, technologies for in-situ metals processing, longevity requirements both for the built structure as well as for the technology, and economic considerations such as the cost of the feedstock. In summary, the bringing together of the users of construction resources extracted from the lunar surface with the suppliers of those materials is enabling each group to understand better both what is needed as well as what can be reasonably expected. This will also assist in articulating a long-term strategy for commercial sustainable presence on the Moon. The paper will provide a more detailed outbrief.