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IN-SITU REGOLITH SOURCING FOR LUNAR PEROVSKITE PHOTOVOLTAICS

Abstract

Perovskite materials have demonstrated numerous photovoltaic applications as solar cell transport and absorber layers, and have further yielded manufacturing benefits (cost, flexibility, and scalability) that make them attractive for next generation solar cell modules. Rivaling the power conversion efficiency of traditional monocrystalline silicon-wafer-based solar cells — 26 percent compared to 27.3 percent — but surpassing them in flexibility, weight, and degradation tolerance, perovskite solar cells have been deemed particularly applicable for in-space applications.

Titania extracted from lunar regolith can be used to produce precursory solution for these solar cells, the in-situ manufacturing of which is projected to benefit from the lunar environment. Radiation has been observed to induce the healing of perovskite solar cell degradation, which is already lessened by utilization outside of a moist, oxygenated atmosphere. The reduced gravitational acceleration exerted by the Moon, relative to Earth, is additionally expected to enable comparably more homogenous doping methods, crystal growth, and scalable roll-to-roll additive manufacturing performance.

An initial review of literature detailing modern terrestrial perovskite solar cells, lunar regolith analyses and excavation proposals, and in-space manufacturing methodologies revealed a disconcerting lack of cross-topical integration. Research is necessary to incorporate these topics within a unified lunar mission concept of operations framework, quantitatively integrating sourcing, manufacturing, and projections of scale, lifetime, and performance. At present, the establishment of a sufficient concentration of precursory compounds in lunar regolith for justifiable in-situ production, the assessment of contemporaneous beneficiation methodologies yielding a sufficient quantity of feedstock thereof, and the potential expansion to incorporate silicon-based solar cells into an in-situ hybrid solar cell technology is most paramount.