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IN-SITU MANUFACTURED LANDING PADS AND BERMS TO ENABLE SUSTAINABLE OPERATIONS ON THE LUNAR SURFACE

Abstract

One huge challenge for sustainable lunar operations are the potential adverse effects on surface infrastructure caused by regolith particles, covering the lunar surface. Due to the lack of atmosphere, these particles are not affected by weathering and remain sharp and jagged. Thus, they can damage lander and/or ascend vehicles whose engine exhaust plumes swirl up dust particles. Furthermore, the low gravity environment and the lack of atmosphere do not decelerate the particles as much as on Earth. Therefore,

they stay above the surface longer and can travel at higher velocities across larger distances than they would on Earth. This results in risks also for other infrastructure on the moon, such as antennas or solar panels. Electrostatic forces are an additional potential problem, particularly for future crewed missions with high cleanliness requirements. Consequently, to enable sustainable exploration of the Moon, the risk of lunar regolith particles needs to be managed. But already for missions planned for the near future, such as the European lunar lander of ESA's Argonaut project, the challenge of plume/regolith interaction needs to be tackled. One potential solution is the construction of lunar landing pads, which minimises liberation of loose regolith particles, and berms, which minimise the resulting effects of the remaining regolith particles. Such structures can potentially be realised with in-situ manufacturing techniques, which already show promising results. Manufacturable structures can be similar in their material properties to a variety of materials like concrete, technical ceramics or glass with melting temperatures above 1300 K, depending on the regolith composition. Within the LUNAR ISLANDS (LUNAR In-Situ LANDing Structures) activity, funded by the European Space Agency, an international consortium led by TU Dresden is assessing the effectiveness of in-situ manufactured structures on the containment of high-velocity particles that are generated by the plume-surface interaction of landers. This involves the manufacturing and characterisation of samples from lunar regolith simulants, experimental investigations in the form of cold gas and hot fire tests as well as numerical simulations of the interaction of exhaust plumes and lunar regolith. This contribution provides an overview of the activity, its objectives and work plan, and presents initial results of the first part of the activity. This comprises the driving parameters and requirements for lunar landing pads and berms, which have been derived from numerical simulations in combination with an in-depth analysis of the state of the art.