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SLM ADDITIVE MANUFACTURING USING A LUNAR REGOLITH ANALOG

Abstract

These last years, a renewed interest has emerged from the major space agencies for space human exploration, with a particular focus on the permanent presence on the moon. This new approach supposes the astronauts to be as autonomous as possible. There is a real need for ISRU (In Situ Resource Utilization) based technologies development fulfilling their different requirements such as oxygen or metallic alloys production from the regolith, or in situ manufacturing of objects, tools repairing of first necessity. Given its flexibility and potential, additive manufacturing is one of the most considered solutions for lunar regolith use of making objects at different scales, from millimetric high thermo-mechanic performance pieces to metric parts of habitat shielding walls [1, 2, 3]. This communication will consider results linked to the activities of the ISRU taskforce in Toulouse [4]. A specific regolith analog, which is an unweathered lava flow located in the Pic d'Ysson (Massif Central, France) [5], available closeby, is systematically used for this purpose because its composition is close to the moon basaltic regolith. A specific methodology has been developed for SLM processing and the study of laser/regolith analog interactions. Main considered process parameters deal with regolith analog absorption, substrate material, laser power, laser scanning speed, hatching distance and laser spot size. This is a step by step methodology which starts from 1D cases (lasered cords) and moves progressively to 3D samples. Complementary experimental methods have been considered to characterize SLM manufactured samples: confocal microscopy to characterize the surface topography and roughness; X-ray-diffraction and scanning electron microscopy, micro-indentation to determine local mechanical properties, compression test and 3 points bending tests to evaluate mechanical properties at a more macroscopic scale. Relationships could be established between properties of the initial analog powder, process parameters, post SLM microstructures and mechanical properties. These results are paving the way to next steps with the objective of manufacturing small high performance parts.

[1] Isachenkov M. et al. (2021) Acta Astronaut, 180, 650–678 [2] Taylor L. et al. (2016) Planet. Space Sci. 126, 1-7 [3] Goulas A. et al. (2016), Rapid Prototyping Journal, 22(6), 864-870 [4] Gibilaro M. et al. (2021), "ISRU taskforce in Toulouse", NESF-ELS [5] Souchon A. L. et al. (2011), Icarus, 215, 313–331