3-D printing and Moon dust: An astronaut's kit for future space exploration?

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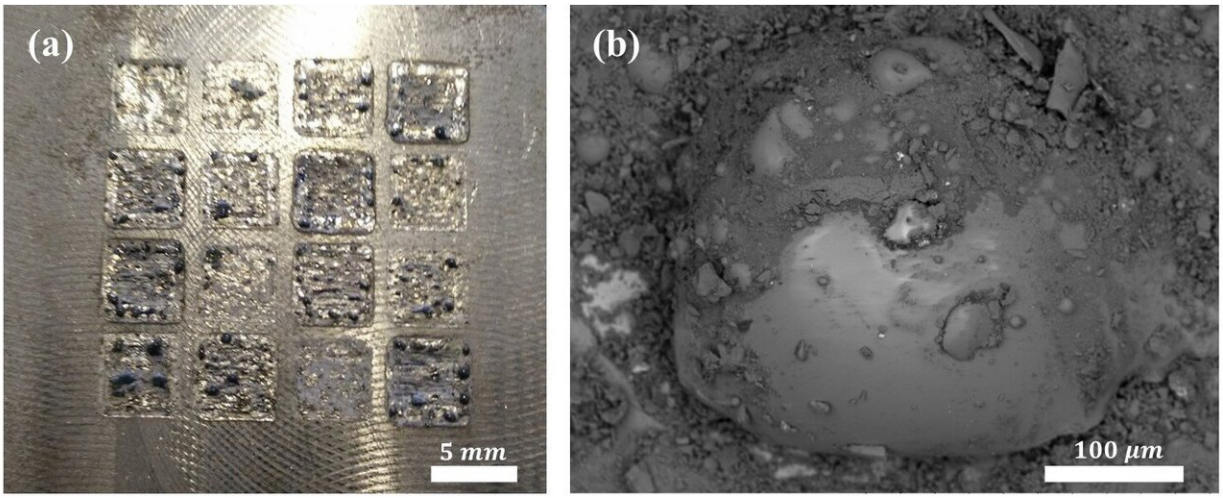

(a) Preliminary tests for the 3-D Printing of lunar regolith simulant NU-LHT-2M on a carbon steel baseplate and (b) SEM image of the same. Credit: Politecnico di Milano

One of the major challenges related to space exploration is the development of production technologies capable of exploiting the few resources available in extra-terrestrial environments. Laser 3-D printing of lunar dust may be the answer to such queries. Reduction of elevated supply chain costs and times connected to space exploration were amongst the main drivers which brought together the joint investigation on behalf of the Department of Mechanical Engineering and Department of Aerospace Science and Technology of the Politecnico di Milano on

the feasibility of 3-D printing a lunar regolith simulant (NU-LHT-2M).

Additive manufacturing or 3-D printing systems may allow the realisation of components when required, employing locally available resources and through a direct conversion from the digital CAD geometry to the final object. 3-D printing can thus enable the manufacturing of lightweight structures, with improved performance (heat exchange, impact resistance, etc.) and greater reliability due to significant reductions in the number of components.

The research was coordinated by Professor Bianca Maria Colosimo, (Department of Mechanical Engineering), and was carried out with support of the Italian Space Agency (ASI) and European Space Agency (ESA). The project saw the collaboration of a team from the Department of Mechanical Engineering who worked on the development of the laser 3-D printer led by Prof. Barbara Previtali with the support of Dr. Ali Gökhan Demir, Leonardo Caprio and Eligio Grossi (Department of Mechanical Engineering), who developed the prototype 3-D laser beam printer. Concurrently, a team from the Department of Aerospace Science and Technology composed by Prof. Michéle Lavagna, Prof. Giuseppe Sala and Lorenzo Abbondanti-Sitta contributed by providing the lunar dust simulant, cooperating during the various experimental campaigns and conducted materials characterization of the final products.

First author of the study "Determining the feasible conditions for processing lunar regolith simulant via laser powder bed fusion," published in the peer-reviewed journal *Additive Manufacturing*, is Leonardo Caprio, Ph.D. candidate in Advanced and Smart Manufacturing at the Politecnico di Milano. He stated that "A stable system architecture based on the use of an efficient laser source is fundamental in order to enable the technological transfer from a prototypal system to space applications." The research demonstrated that

lunar powder or regolith could be 3-D printed through the optimisation of processing conditions and laser parameters. Following the research's positive results, it was possible to define guidelines for the design of a future 3-D printing system for use in space.

The ASI-Politecnico Agreement Project Manager Danilo Rubini said: "The Italian Space Agency, which has training and research support as its cornerstone, sees partnerships with universities of national excellence as one of its priorities." The partnership with the Politecnico di Milano is a perfect example of cooperation between institutions and universities which starting from basic research to generate technologies and applications which contribute to socio-economic growth. If we consider the impact that space activities and satellite data can have on our daily lives, we can see how space is an always growing enabling element. Technological developments such as 3-D printers and additive manufacturing when applied to space elements, such as the lunar regolith, can contribute to new lunar missions through in-situ-resource-utilisation (ISRU) but may also help us to understand how to improve the management of terrestrial resources."

More information: Leonardo Caprio et al, Determining the feasible conditions for processing lunar regolith simulant via laser powder bed fusion, *Additive Manufacturing* (2019). DOI: 10.1016/j.addma.2019.101029

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