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NOVEL LITHOGRAPHIC PRINTING TECHNIQUES ENABLING SUSTAINABLE AND HIGH QUALITY MULTI MATERIAL MANUFACTURING PROCESS FOR FUTURE SPACE OUTPOSTS

Abstract

Several challenges remain before the full potential of on-orbit manufacturing can be realized. There may be some limitations to the types of items that can be manufactured in space. Such limitations could be caused by a variety of factors, including the materials required for a particular structure, the size of the object to be manufactured, the time required to execute the architecture, the configuration of the object being manufactured, and the raw material needed to support the manufacturing process. The complementary challenge to the relevant fabrication processes is the possibility to achieve the required precision demanded by geometrically complex structures and the ability to be versatile in processing a broad material spectrum.

In this context, novel lithographic 3D printing techniques will be an asset to pave the way towards overcoming these challenges. Currently the European Space Agency is investigating the implementation of such technology in the context of a lunar base. In particular two different applications are being studied:

•Lithography-Based Ceramic Manufacturing (LCM), where the ceramic powder is distributed in a photocurable monomer formulation in presence of a photoinitiator. Ceramic materials are extensively used in a vast number of technological processes as well as in space applications. They are usually considered as the material of choice for applications where other materials such as plastic and metal fail to deliver the required performance. The LCM process will also allow processing Lunar Regolith simulant

adding value to the current material portfolio of this technique, as well as to the range of processes potentially applicable on the lunar or Martian surface.

•Lithography-based Metal Manufacturing (LMM) for processing metallic powders. In contrast to the currently predominantly used powder bed fusion (direct metal laser melting) techniques, this process uses a paste/suspension as feedstock and hence, does not rely on the use of highly spherical gas atomized powders. This will enable the utilization of recycled powders from scrap metals that are available at Moon bases or of metallic alloys reduced from regolith, thus providing higher flexibility in accepting raw material with poor quality and purity.

The paper will address the results from both activities in terms of printed parts quality (roughness, density, resolution and accuracy) as well as the implementation requirements for the whole process chain, including suitable pre and post-processing steps, with the aim to achieve a zero-waste flow in a lunar environment.