Solar 3D Printing of Structures for Off-World Bases

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Kickstarting a space economy will require building communication relays, refueling depots, repair depots, hotels and mining bases from in-situ resources in strategic locations between Earth, Moon and Mars. It would be too expensive to transport all the raw material from the Earth's surface and hence new methods of material extraction and construction needs to be found.

Critical to these steps is the need for a low-cost and efficient means for construction of habitats and physical structures. Utilizing networks of small spacecraft and robots to perform the task will reduce cost, enable scalability and robustness. The idea of 3D printing structures has risen to the forefront of construction methods for its ability to be sent in advance of the primary mission and build structures autonomously. Two distinct challenges are inherent in this concept: the 3D printer needs to be supplied material and it must have the ability to generate a significant amount of heat to melt the material.

Refining this printing technology to be as energy and resource efficient as possible is of the utmost importance to future space missions. Once this is achieved it will be economical to build lunar and planetary bases in-situ. Reducing the necessary supply of material to the additive manufacturing process and the power consumption leads to a reduction in the size of these early missions.

In an effort to confront these challenges, we are working to develop an additive manufacturing process based on the principles of the Selective Laser Sintering (SLS) technique whereby a heat source (a laser in the case of SLS) heats the material its liquefaction point before returning to a solid form. By replacing the laser in the SLS process with a large Fresnel lens, we aim to focus
enough sunlight to be able to liquefy the material and create solid shapes. In this way, the system fully relies on renewable solar energy for its operation.