Using Combustion Synthesis to Reinforce Berms and Other Regolith Structures

New structures will require a minimum of maintenance and upkeep.

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The Moonraker Excavator and other tools under development for use on the Moon, Mars, and asteroids will be employed to construct a number of civil engineering projects and to mine the soil. Mounds of loose soil will be subject to the local transport mechanisms plus artificial mechanisms such as blast effects from landers and erosion from surface vehicles. Some of these structures will require some permanence, with a minimum of maintenance and upkeep.

Combustion Synthesis (CS) is a family of processes and techniques whereby chemistry is used to transform materials, often creating flame in a hard vacuum. CS can be used to stabilize civil engineering works such as berms, habitat shielding, ramps, pads, roadways, and the like. The method is to unroll thin sheets of CS fabric between layers of regolith and then fire the fabric, creating a continuous sheet of crusty material to be interposed among layers of loose regolith. The combination of low-energy processes, ISRU (in situ resource utilization) excavator, and CS fabrics, seems compelling as a general method for establishing structures of some permanence and utility, especially in the role of robotic missions as precursors to manned exploration and settlement.

In robotic precursory missions, excavator/mobility ensembles mine the Lunar surface, erect constructions of soil, and dispense sheets of CS fabrics that are covered with layers of soil, fired, and then again covered with layers of soil, iterating until the desired dimensions and forms are achieved. At the base of each berm, for example, is a shallow trench lined with CS fabric, fired and filled, mounted, and then covered and fired, iteratively to provide a footing against lateral shear. A larger trench is host to a habitat module, backfilled, covered with fabric, covered with soil, and fired.

Covering the applied CS fabric with layers of soil before firing allows the resulting matrix to incorporate soil both above and below the fabric ply into the fused layer, developing a very irregular surface which, like sandpaper, can provide an anchor for loose soil. CS fabrics employ a coarse fiberglass weave that persists as reinforcement for the fired material. The fiberglass softens at a temperature that exceeds the combustion temperature by factors of two to three, and withstands the installation process.

This type of structure should be more resistant to rocket blast effects from Lunar landers.

Visible-Infrared Hyperspectral Image Projector

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The VisIR HIP generates spatially-spectrally complex scenes. The generated scenes simulate real-world targets viewed by various remote sensing instruments. The VisIR HIP consists of two subsystems: a spectral engine and a spatial engine. The spectral engine generates spectrally complex uniform illumination that spans the wavelength range between 380 nm and 1,600 nm. The spatial engine generates two-dimensional gray-scale scenes. When combined, the two engines are capable of producing two-dimensional scenes with a unique spectrum at each pixel. The VisIR HIP can be used to calibrate any spectrally sensitive remote-sensing instrument. Tests were conducted on the Wide-field