Two Problems, One Solution – Microwave Sintering of Lunar Dust. R. R. Rieber[1] and M. A. Seibert[2], [1]Richard.R.Rieber@jpl.nasa.gov Mailstop 179-206, [2]Michael.A.Seibert@jpl.nasa.gov Mailstop 264-422; Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr. Pasadena, CA 91109

Introduction: The fine fraction lunar dust was a headache for Apollo astronauts and engineers and is creating havoc in many many new lunar exploration concepts. However, the harmful properties of lunar dust, such as small size, glass composition, large, abnormal surface area, coatings of nano-phase iron, among others, lead to a unique coupling of the dust with microwave radiation [1]. This coupling can be exploited for rapid sintering of lunar soil for use as a construction material that can be formed to take on an infinite number of shapes and sizes [1].

The most simple application of this technology is a microwave road-paver. This device will be able to create hard surfaces in the immediate area of astronauts for walkways, roadways, or landing pads. These hard surfaces will mitigate the effects of dust by limiting the exposure in the immediate area of habitats and minimizing the amount of dust kicked up by the descent engines of landing spacecraft.

Basics of Microwave Heating: The key to the microwave heating of lunar soil is the coupling of certain microwave frequencies to specific materials [2.3]. This will improve the efficiency of the device and expedite heating of the soil. Since lunar soil is composed of a variety of materials, a broadband microwave emitter must be used such as a magnetron or a traveling wave tube amplifier. This must be aimed into a tunable resonance chamber that can be autonomously adjusted to resonate the specific frequency that will couple with the material in the chamber [2,3].

R&D Roadmap: The various steps to designing, building, and testing a lunar regolith sintering device are laid out below.

Bench-top Sintering: The first step is to characterize the power, frequency, and duration requirements for sintering lunar dust. This will be done with soil simulants in a bench-top microwave heating instrument. Soil simulants have worse dielectric properties than lunar soil [1] and will provide worst-case figures.

Once initial characterization is complete, the chamber of the bench-top device can be swapped out for a prototype of the chamber to be used in the next step.

Static Sandbox Sintering: The second step is to create a device with a cavity open to the surface. The bench-top device previously described will need to be scaled-down and fitted into an instrument that will be able to sinter the surface of a simulated lunar surface (sandbox) while stationary to characterize the required duration for sintering a solid surface.

Translational Sandbox Sintering: Pending the success of the static sintering tests, the static device will be mounted on a simple mobility system. This system could be as simple as mounting the above device on rails and moving it by winch via a cable. This will allow experimentation with various forward progress rates.

Integration with Rover: The final step will be to redesign device and integrate it with a current lunar mobility system. The current plan is to integrate the device with JPL's ATHLETE rover and utilize the multiple degrees of freedom of the legs to enhance the placement and mobility of the device.

When this version of the device is complete, a multitude of tests and experiments can be performed to investigate mobility, transportability, progress rates, degrees of freedom, etc. This initial version could be utilized as the first flight version to further validate the system to prove it can be a relied upon method of construction.

Conclusion: Microwave sintering is a technology that has a great potential to provide both a method of construction along with the ability to mitigate the problems with lunar dust in the immediate area of a fixed lunar settlement. The concept relies on technology proven on Earth, however a large amount of research and development lie ahead in determining the fundamental requirements of the device and proving it is a viable technology for the lunar surface.

References: [1] Taylor, L. A. and Meek, T. T. (2005) *JAE*, **18**, 188–196. [2] Barmatz, M. *et al*. (1995) *JPL TRS 1992+*. [3] Jackson, H. W. and Barmatz, M. (1994) *Material Research Society Proceedings Report* **347**, 317-323.