

“Microwave Processing of Planetary Surfaces for Volatile Extraction”

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In-Situ Resource Utilization will be necessary for sustained exploration of space. Volatiles are present in planetary soils, but water by far has the strongest potential for effective utilization. The presence of water at the lunar poles, Mars, and possibly on Phobos opens the possibility of producing LOX for propellant. Water is also a useful radiation shielding material and water (and oxygen) are expendables that are also required for habitation in space.

Because of the strong function of water vapor pressure with temperature, heating soil effectively liberates water vapor by sublimation. Microwave energy will penetrate soil and heat from within much more efficiently than heating from the surface with radiant heat. This is especially true under vacuum conditions since the heat transfer rate is very low. The depth of microwave penetration is a strong function of the microwave frequency and to a lesser extent on soil dielectric properties. Methods for measuring the complex electric permittivity and magnetic permeability are being developed and have been measured for some lunar soil simulants at 0.5, 2.45, and 10 GHz from room temperature down to liquid nitrogen temperature.

A new method for delivery of microwaves deep into a planetary surface is being prototyped with laboratory experiments and modeled with COMSOL MultiPhysics. We have plans to set up a planetary testbed in a large vacuum chamber in the coming year. Recent results will be presented.