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MICROWAVE HEATING OF REGOLITH SIMULANTS FOR ISRU APPLICATIONS

Abstract

As increasing focus falls on the Moon as a location for post-ISS exploration, many technologies that promise a route to sustainable exploration of this locale are receiving increasing interest. In the context of in-situ resource utilization (ISRU), processing the lunar regolith material, whether for volatile extraction (e.g. H₂O bound within icy regolith) or for fabricating building elements (e.g. radiation shielding, shield-wall building blocks), are being further developed. Microwave heating has existed as a materials processing technology in a variety of scientific and technological fields, and is commonly deployed as a tool to realise dielectric heating within a material. When considering it for Lunar surface applications, it quickly becomes an attractive and versatile tool for many aspects of ISRU, which we will discuss. Owing to the composition and dielectric properties of lunar regolith (and many of its terrestrial analogue simulants), microwaves in the 2.45 GHz range can readily couple to the constituent materials of the regolith and drive rapid subsurface heating (13 mm depth). This process, which has significant advantages over conventional radiative heating, is versatile in its application for resource extraction and potentially fabricating building elements quickly and with significant power efficiency.

Herein, we will present the ongoing work in the field of microwave processing of lunar regolith simulants that is carried out within the Spaceship EAC initiative at ESA and DLR, Cologne. This includes fundamental insights into the interaction of 2.45 GHz microwave radiation with simulant material, approaches into melting simulants under differing compositions, the impact of 'welding' processed regolith together with microwaves and initial experiments with the extraction of H₂O from simulant using microwaves. Issues around the further development of this technology are highlighted, and an outline of the future work within the initiative on this topic is presented.