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OPTIMIZATION OF MARTIAN REGOLITH AND ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE COMPOSITES FOR RADIATION SHIELDING AND HABITAT STRUCTURES

Abstract

In preparation for long duration missions to the moon, Mars or, even near earth asteroids, one challenge, amongst many others, that the space program faces is shielding against space radiation. It is difficult to effectively shield all sources of space radiation because of the broad range of types and high energies found in space, so the most important goal is to minimize the damaging effects that may occur to humans and electronics during long duration space flight. For a long duration planetary habitat, a shielding option is to use in situ resources such as the native regolith. A possible way to utilize regolith on a planet is to combine it with a binder to form a structural material that also exhibits desirable shielding properties. In our studies, we explore Martian regolith and ultra-high molecular weight polyethylene (UHMWPE) composites. We selected UHMWPE as the binder in our composites due to its high hydrogen content; a desirable characteristic for shielding materials in a space environment. Our initial work has focused on the process of developing the right ratio of simulated Martian regolith and UHMWPE to yield the best results in material endurance and strength, while retaining good shielding characteristics. Another factor in our optimization process is to determine the composite ratio that minimizes the amount of ex sito UHMWPE while retaining desirable structural and shielding properties. This consideration seeks to minimize mission weight and costs. Mechanical properties such as tensile strength of the Martian regolith/UHMWPE composite as a function of its grain size, processing parameters, and different temperature variations used are discussed. The radiation shielding effectiveness of loose mixtures of Martian regolith/ UHMWPE is evaluated using a 200 MeV proton beam and a tissue equivalent proportional counter. Preliminary results show that composites with a 80/20 ratio percent weight of regolith to UHMWPE can be fabricated with potentially useful structural strength. I n addition, Martian regolith, while not as efficient as polyethylene at reducing proton energy as a function of shield thickness, compares well with polyethylene at shielding the 200 MeV protons. These preliminary results indicate that native Martian regolith has promising properties as a habitat material for future human missions. Future work studying the shielding effectiveness and radiation tolerance will also be discussed.