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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Environmental Effects and Spacecraft Protection (6)

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EVALUATION OF THE RESISTANCE OF COMPOSITE MATERIALS TO LUNAR DUST ABRASION

Abstract

At the time of the Apollo missions, structural components sent to the moon were mostly made of aluminum, or other metallic materials. Composites offer a lightweight alternative with a low coefficient of thermal expansion, a useful feature in an environment where temperatures will vary from approximately -200 degree Celcius during the lunar night, lasting the equivalent of fourteen earth days, to approximately +100 degree Celcius during the lunar day. Future lunar missions will require lightweight instruments or rovers staying for extended periods on the moon, and will therefore be exposed to these extreme temperatures cycles, for which composites are well suited. However, lunar dust is comprised of highly abrasive, electrically-charged particles with sizes ranging from one hundredth of a micron to one hundred microns. In lunar exploration, dust poses a significant problem due to its pervasiveness, adherence, and abrasiveness, causing premature failure of structures. A preliminary research is done to evaluate the lunar environmental conditions and to create models of the different causes of dust abrasion. Two experiments were done to evaluate the resistance of composite samples, provided by Composite Atlantics, to a regolith simulant, CHENOBI, reproducing the conditions of lunar dust abrasiveness in relation with the models developed. In the first experience, the samples were attached to a rotating shaft and spun in a test cavity filled with regolith simulant. In the second, sandblasting equipment was used to simulate different lunar conditions. Relation between abrasion rate, velocity of particles and hardness of material is analyzed and two equations are developed to evaluate erosion of composite materials depending on lunar environmental conditions. Reference materials are used to compare composites to different types of aluminum used in the space industry. Results show that composite behavior under abrasion by lunar regolith simulant is quite different from what is seen with metallic materials. The surface of the composite samples gets highly eroded in stringent conditions such as being in the vicinity of a landing spacecraft or being used as a fender behind a rover wheel. Composite material requires coatings to resist to the lunar dust abrasiveness in harsh conditions. However, for normal use, where only the dust present above ground is an issue, composites can survive the abrasiveness of the lunar dust for extended periods of time without serious damage.