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MEASURING WEAR AND ABRASIVE RESISTANCE OF AIR PLASMA SPRAYED ALUMINUM OXIDE COATINGS FOR LUNAR EXPLORATION

Abstract

Wear-resistant ceramic and ceramic composite materials can improve durability of spacecraft components during long missions on the Moon's surface. Aluminum oxide porous coatings are lightweight, have multifunctional properties, and have high strength including high hardness and wear resistance. These properties can help improve the durability of structures used in space exploration. Lunar regolith, especially finer dust particles traveling at high velocities, can cause significant wear and abrasive damage to structural components that ensure a sustained presence on the surface of the Moon. With the absence of an atmosphere, regolith particles maintain their high velocities and abrasive properties on large distances and away from where they were generated, for example next to lunar landers. Air plasma sprayed (APS) aluminum oxide has demonstrated the potential to protect critical structures, and this study investigates the wear and abrasion resistance of APS aluminum oxide coatings via Taber abrasion experiments. Taber abrasion offers the advantage of quantifying the wear and abrasive behavior of particles with different shapes on the surface. In this work, an abrasive wheel using lunar regolith simulants with a mean particle size of 90 μm was utilized to evaluate wear properties of specimens after 400 cycles and up to 5000 cycles. The wheel was loaded with 500 g and translated across the specimen surface at a speed of 3600 revolutions per minute. In order to determine whether a bond coat, NiCrAlY, improved the protective behavior of the APS aluminum oxide coating, this experiment focused on testing two series of specimens. Group A had a top coat with a thickness of around 150 μm and no bond coat, and group B had a top coat and bond coat with thicknesses of approximately 150 μm, with a total coating thickness of 300 μm. Microscopic images were collected at low magnification levels to cover a larger surface area. The roughness and thickness of the coating were measured every 400 cycles. The results demonstrated that the bond coat enhanced the abrasion resistance of the APS coating. To continue designing wear-resistant coatings for structural protection in space missions, the multifunctional properties of the APS aluminum oxide coating will be studied. Future experiments will allow to determine whether the APS aluminum oxide coating can protect the structures from other aspects of the harsh space environment such as extreme temperature variations and ionizing radiation.