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

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APPLICATION OF AMORPHOUS METAL THERMAL SPRAY COATING FOR NON-LUBRICANT WEAR-RESISTANT MOBILITY COMPONENTS FOR THE LUNAR ENVIRONMENT

Abstract

Since the earliest satellites and lunar rovers, lubricating movable components for spacecraft has always been a prime concern. Research has shown that the lunar surface poses the most significant challenge for mobility components due to its low but persistent gravity, the ubiquity of charged dust particles, lack of atmosphere, severe radiation exposure, and extreme temperatures.

Current spacecraft typically employ liquid lubricants with low evaporation rates to counter the loss of lubricant to vaporation. However, data from existing spacecraft show that such liquid lubricants are also liable to chemical breakdown due to exposure to radiation, and when expressed under multiple temperature cycles. Many spacecraft thus employ a lubricant reserve container or porous structure to supplement the lost lubricant.

Solid lubricant films are also occasionally employed for space use, but have a limited timeline due to their significant wear properties. The lack of atmospheric oxygen to replenish oxide layers at the boundary film lubrication also pose additional risks and shortens the potential lifespan of solid lubricant films. Degradation from contamination by the charged, therefore adhesive, lunar dust is also a challenge.

This paper proposes amorphous metal thermal spray coating as a potential solution for the non-lubricant sliding surface mechanism for mobility components on the moon. Amorphous metal has higher wear resistance due to their compact molecular structures, and are less susceptible to deformation due to temperature extremes. Amorphous metal films, applied in thermal spray mechanisms can also be made with extremely low friction coefficients, allowing them to serve as sliding-surface bearings.

The contained research showcases the wear resistance properties and low friction coefficients of Fe-Mo-Cr and Fe-Cr-Si amorphous metal composites as developed by Kolon Industries. These properties are then applied to bearing components in lunar mobility solutions, or lunar rovers, to evaluate the potential advantages of using these materials in lieu of heated liquid lubricants.