Development and Evaluation of Titanium Space Suit Bearings

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The Z-2 Prototype Planetary Extravehicular Space Suit Assembly is a continuation of NASA's Z series of spacesuits, designed with the intent of meeting a wide variety of exploration mission objectives, including human exploration of the Martian surface. Incorporating titanium bearings into the Z series space suit architecture allows us to reduce mass by an estimated 23 lbs per suit system compared to the previously used stainless steel bearing designs without compromising suit functionality.

There are two obstacles to overcome when using titanium for a bearing race- 1) Titanium is flammable when exposed to the oxygen wetted environment inside the space suit and 2) titanium's poor wear properties are often challenging to overcome in tribology applications.

In order to evaluate the ignitability of a titanium space suit bearing, a series of tests were conducted at White Sands Test Facility that introduced the bearings to an extreme test profile, with multiple failures imbedded into the test bearings. The testing showed no signs of ignition in the most extreme test cases; however, substantial wear of the bearing races was observed.

In order to design a bearing that can last an entire exploration mission (~2 years), bearing test rigs were developed that allow for the quick evaluation of various bearing ball loads, ball diameters, lubricants, and surface treatments. This test data will allow designers to minimize the titanium bearing mass for a specific material and lubricant combination around a maximum contact stress that will allow the bearing to survive the life of an exploration mission.

This paper reviews the current research and testing that has been performed on titanium bearing races to evaluate the use of such materials in an enriched oxygen environment and to optimize the bearing assembly mass and tribological properties to accommodate for the high bearing cycle life for an exploration mission.