

FY17 IRTD Executive Summary

Cryo-Gearbox Using Bulk Metallic Glasses

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Harmonic drives are a highly efficient and compact gearing technology that are widely used in robotics and aerospace applications (e.g. Mars Science Lab) due to their excellent torque-to-mass ratio, low backlash, and high positional accuracy. One major problem using any gearing on other planetary bodies is the need for heaters to keep the gearbox from freezing. Currently the Mars Science Lab uses 40% of its daily power output to operate heaters to keep the grease in the gearboxes from freezing. Also wear can limit the lifetime and performance of these systems. One possible solution to this problem could be to use a relatively new material known as Bulk Metallic Glasses (BMGs, also known as Amorphous Metals). BMGs are non-crystalline metallic alloys that exhibit superior mechanical properties. Compared to modern aerospace steels BMGs have a higher strength, higher elastic limit, and lower density. BMGs used in harmonic drives (especially the flex spline) could lead to longer system lifetimes, lower mass, and increased performance. Jet Propulsion Laboratory (JPL) is researching a new method of manufacturing the flex spline by injection molding and is hoping to have reduced costs as well as the benefits listed above. In conjunction with Kennedy Space Center (KSC), JPL is providing gearboxes that KSC will test greaseless in an extreme environment. KSC has completed the assembly and checkout of a test stand that is capable of testing a gearbox in a vacuum of less than 2 milli torr, 100 Kelvin temperature, 250 Nm of load, input and output torque measurements and 120 RPM input speed.