National Aeronautics and
Space Administration

NASA's
Game Changing Technology
Industry Day
June 29-30, 2016

Bulk Metallic Glass (BMG) Gears

Presented by
Dr. Scott Roberts
NASA Jet Propulsion Laboratory,
California Institute of Technology

TECHNOLOGY DRIVES EXPLORATION

Bulk Metallic Glass (BMG) Gears

- BMG Gears is developing dry lubricated and non-lubricated planetary and strain wave gearboxes fabricated from new bulk metallic glass alloys for power constrained cryogenic environments.

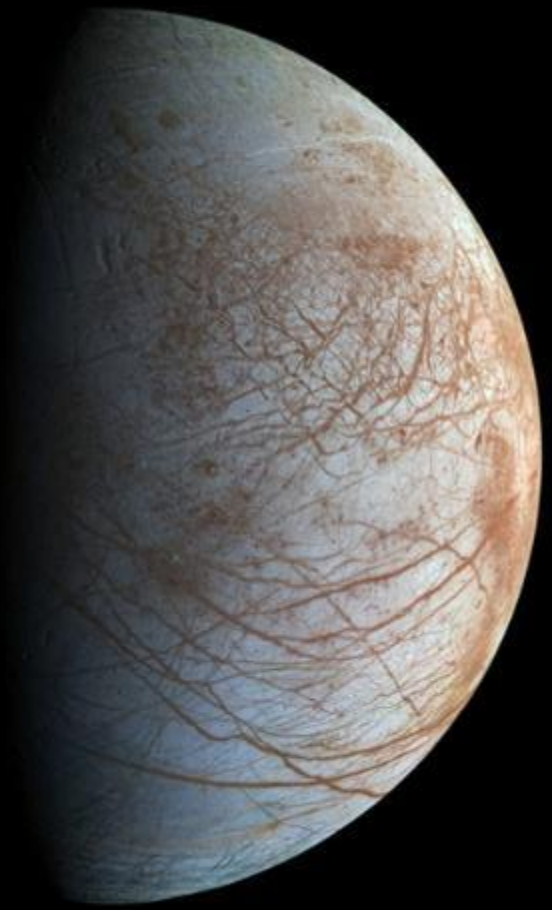
- The technology enables mechanisms to function in cryogenic environments, such as on the surface of Europa, without having to use heaters thus allowing more science return for the available power.

BMG Gears - Motivation

- Future NASA missions, such as landing on and investigating the surface of Europa where the temperature is below –170 °C, will be very power constrained.

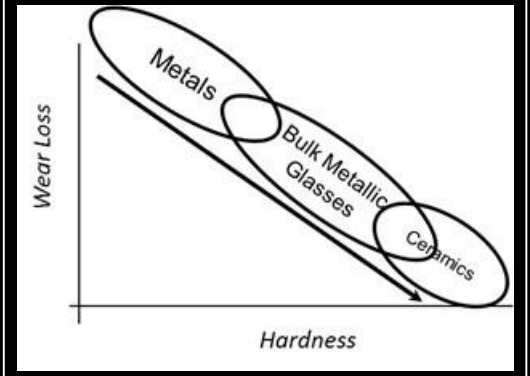
- The use of power hungry heaters to allow mechanism like robotic sampling arms to function will reduce the mission lifetime and decrease the science return.

- Newly developed BMG alloys for planetary and strain wave gearboxes enable them to function with dry lubricants or even unlubricated, thereby requiring no electrical power for heaters to operate, reduced system complexity, and increased mission lifetime/science return.

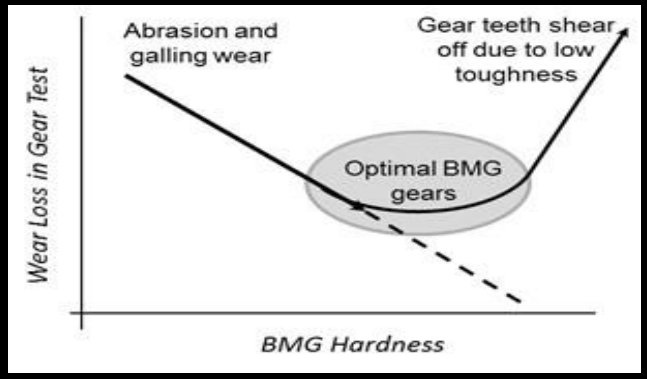


Planetary Gearbox Development

BMGs considered for combination of hardness, toughness, modulus



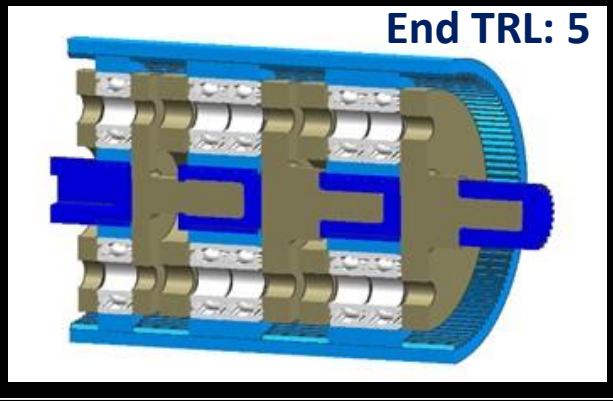
Pin on disk and spur gear testing used to screen potential alloys and down select for gearbox component fabrication and testing.



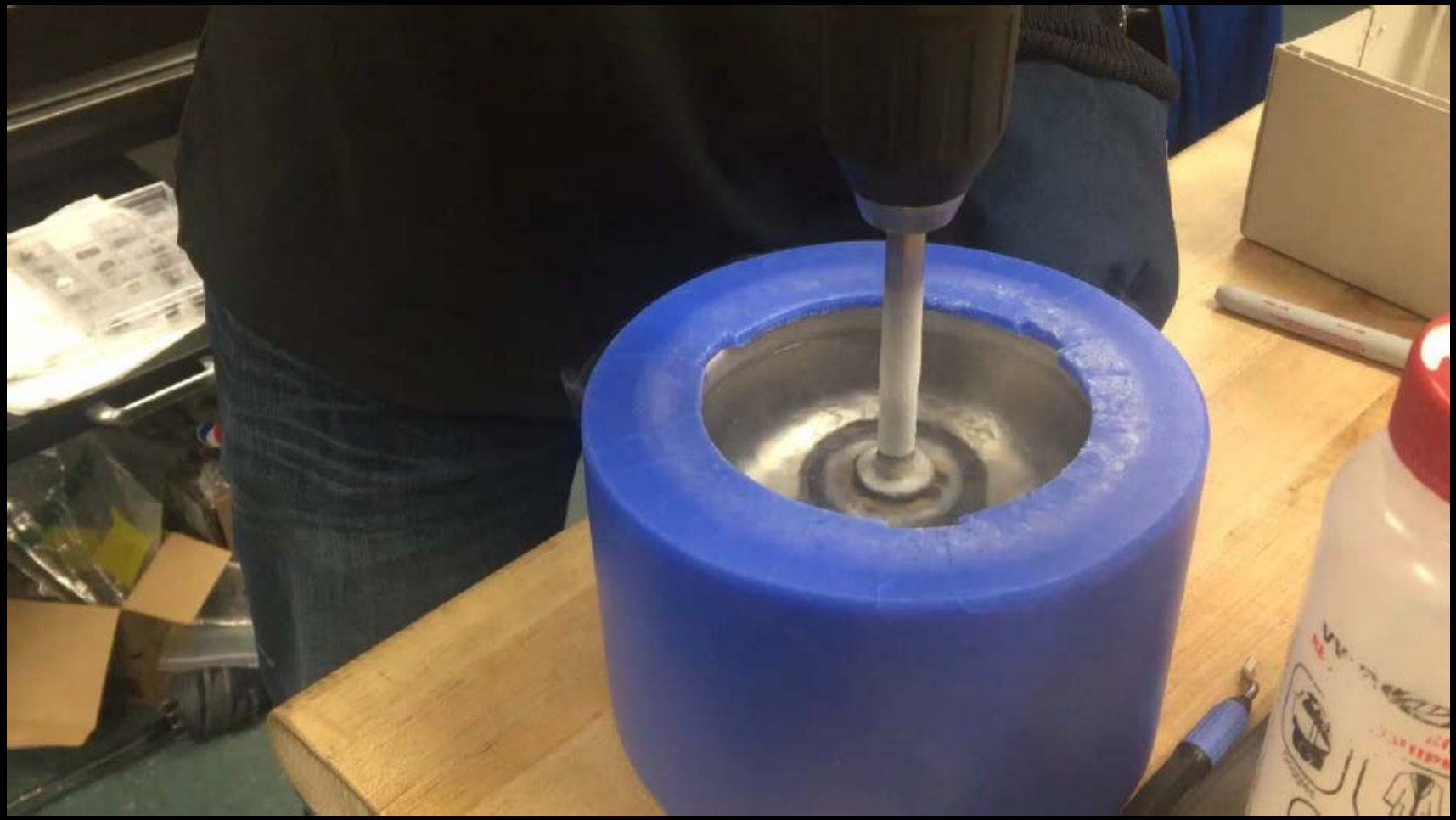
One step casting of gears

Proof of concept demonstrated in hybrid steel/BMG gearbox (MoS_2 dry lubricated BMG planet gears) tested to Mars Rover conditions.

Next steps: Fab and test custom 3 stage planetary gearbox to Europa conditions.



Low Temperature Elasticity



Gearbox Operation

BMG Gears - Partnerships

- Current Partnerships
  - Alloy feedstock manufacturing – Materion
  - Component fabrication by direct molding– Visser Precision Cast (VPC)
- Future Partnerships
  - Gear, bearing, gearbox manufacturers
  - End users with a need for heater-less cyro-capable gearboxes
  - Those interested in capitalizing on the properties and manufacturability of these alloys

BMG Gears – Benefits & Next Steps

- Industry could benefit from the unique properties and manufacturability of these alloys for applications beyond the cryo-mechanism applications we are currently focused on. NASA would benefit from the commercialization of these alloys through increased availability and reduced cost.

- Next Steps For The Project
  - Completion and release of material specifications for the new BMG alloys
  - Continue development and testing of prototype gearboxes including testing in relevant mission environments (thermal, shock, vibration)
    - Target: Europa Lander Robotic Sampling Arm CDR ~Q2 FY18

Contact Information

For more information about this technology or to discuss potential collaboration efforts:

Scott Roberts
Scott.N.Roberts@jpl.nasa.gov
(818) 354-5175