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U.S. ARMY RDECOM

Tribology and Lubrication Science for High-Performance Power Transmission

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S&T Campaign: Sciences for Maneuver
Energy and Propulsion

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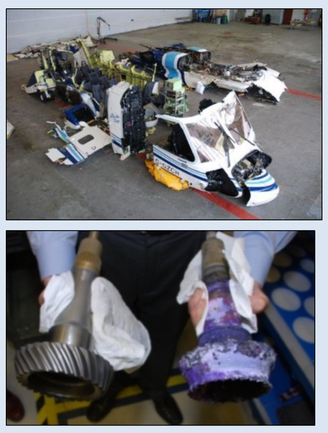
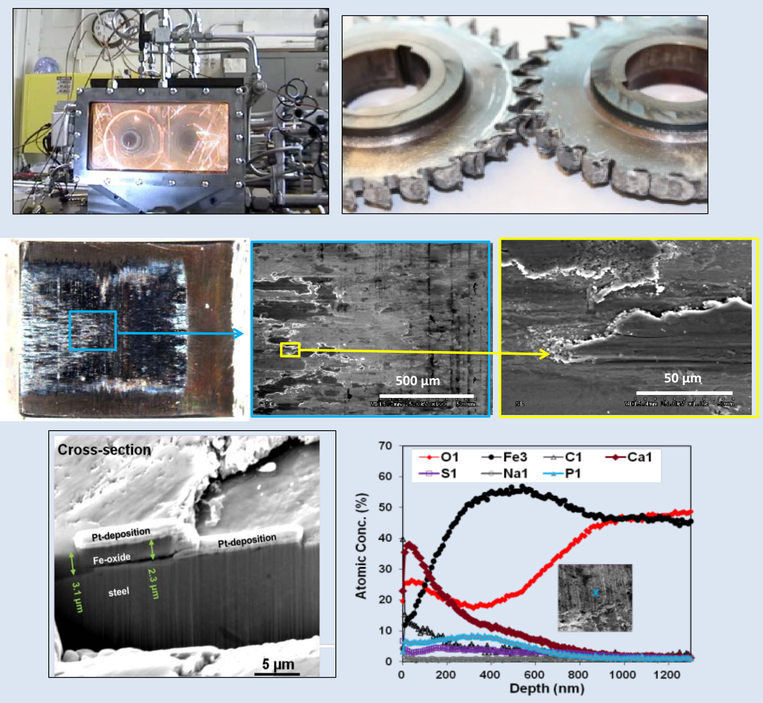
Research Objective

Increase our understanding of the physics and chemistry of extreme lubrication conditions, thermomechanical degradation, and material failures at moving interfaces to support the development of robust vehicle drive trains with increased power density capabilities



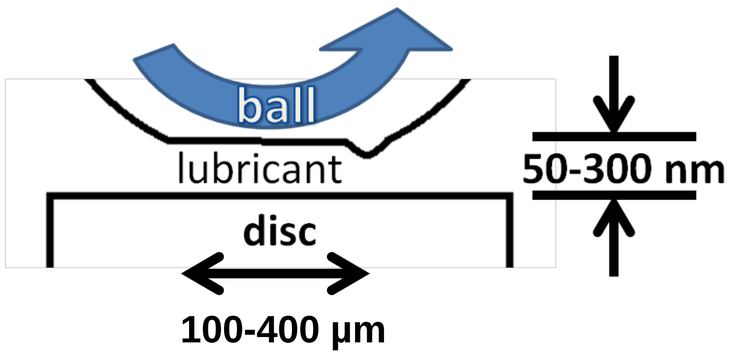
Crash of a Sikorsky S-92 helicopter following loss of oil from main gearbox on 12 March 2009 (Image courtesy of Flight Global, www.flightglobal.com)

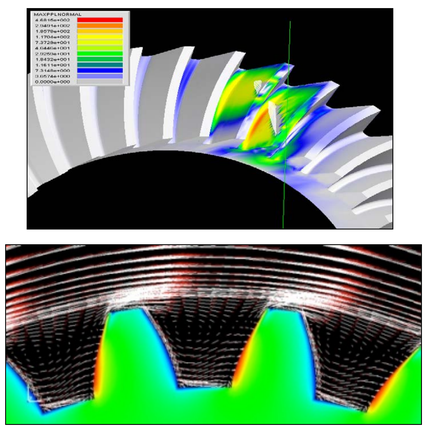


Loss-of-lubrication leads to rapid material failure through flash heating, oxidation, and adhesive wear.

Challenges

- Innovative approaches are needed to create material and tribological solutions for high performance and extreme lubrication conditions (starved lubrication, loss of lubrication, high contact pressures, high relative surface velocities)
- In situ measurement of lubricating fluid film and interfacial physics and chemistry remain elusive
- Modeling is multiscale and complex
  - High-velocity, high-pressure and high-temperature solid-solid and solid-fluid interfaces
  - Scuffing, thermal softening, wear and oxidation degradation on metallic surfaces
  - Integration of chemical models

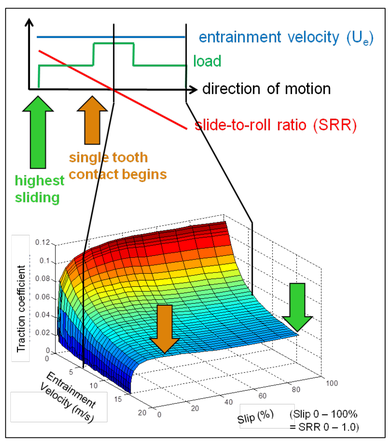


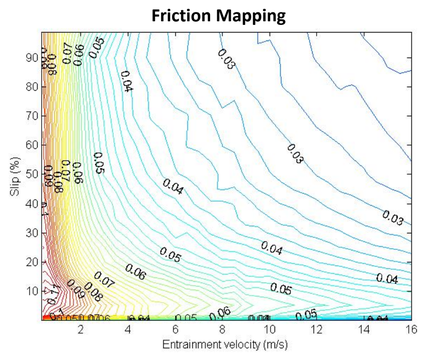


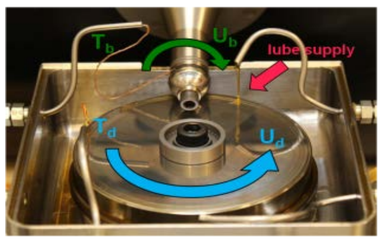
Elastohydrodynamic lubrication contacts are difficult to observe with in situ methods.

ARL Facilities and Capabilities Available to Support Collaborative Research

- Wedeven Associates Machine (WAM) high-speed ball-on-disc tribometer with a wide range of contact conditions (relative surface speeds up to >30 m/s, large range of slide-to-roll ratio, skew, load)
- High-speed bearing rigs
- High-speed gear rigs at NASA Glenn Research Center
- High Performance Computing resources
- Interfacial physics and chemistry expertise and surface analysis expertise (AES, XPS, SEM, etc.)
- Laser scanning confocal microscope available for profilometry and fluorescence imaging/spectroscopy







WAM tribometer can measure a wide range of tribological conditions relevant to high speed contacts. Lubricant properties can be extracted, and starved lubrication scenarios can be explored.

Complementary Expertise/Facilities/ Capabilities Sought in Collaboration

- Engineered surface structures, thin solid films, functional coatings, modified surface chemistry, nanoscale or colloidal lubricant additives, and novel lubricant chemistries with potential to increase load carrying capacity, reduce friction under high loads, or increase operation under starved lubrication conditions
- Complex models that can incorporate the large range of scales involved and relevant physics and chemistry
- Improved models of relevant portions of the tribological contact and failure modes for integration into a multiphysics model (elastohydrodynamic lubrication, boundary lubrication, mixed lubrication, tribological heating, chemical and physical modification under sliding conditions, etc.)

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