Argonne NATIONAL LABORATORY

ILLINOIS CENTER FOR ADVANCED TRIBOLOGY

TRI-BOL•O•GY (N) — THE SCIENCE AND TECHNOLOGY OF FRICTION, WEAR, AND LUBRICATION OF INTERACTING SURFACES IN RELATIVE MOTION.

ILLINOIS•CENTER•FOR•ADVANCED•TRIBOLOGY•(N)

A virtual center that brings together the skills and talents of multiple investigators and unique facilities from Argonne National Laboratory and three partnering universities to resolve critical friction, wear, and lubrication issues in **Biomedical Implants, Alternative Energy Technologies, and Extreme Environments**.

The Center's tribology experts will work closely with industry, and with state and federal agencies through jointly funded research projects, to perform leading-edge research on the impact of materials, coatings, and fluids on energy efficiency, durability, and reliability.

The work will culminate in the development of

- Advanced models of the fundamental mechanisms responsible for friction and wear,
- Materials, coatings, surface textures/treatments and lubricant chemistries, and
- Design strategies to improve the performance of critical components.

Health and BioTribology

Long-term durability of artificial joints is becoming more crucial as replacement procedures become more prevalent and are applied to younger, more active patients.

Total joint replacement with biomaterials is now fairly routine, with a greater than 95% success rate. And, while knee and hip joints make up the majority of replacement surgeries, spinal, neck, and shoulder replacements are becoming more commonplace.

In earlier years, the durability of the all-metal implants was very low and resulted in revision surgery within 5 years. Since then, significant progress has been made in development and evaluation of materials for various joint prostheses. However, wear can still be very significant in younger and more active patients.

Through collaboration with orthopedic surgeons at midwestern regional medical centers, The Illinois Center for Advanced Tribology will work to develop lifetime artificial joints that do not require replacement. Once implanted, the durability of the joints should exceed the lifetime of the patient without requiring complex revision surgery. Researchers will work closely with medical institutions to

- Evaluate and develop models of material degradation, and
- Develop replacement biomaterials with tribological behaviors that are similar to the natural joints.

Illinois Center for Advanced Tribology Partners

- **Argonne National Laboratory**
- **Northwestern University's School of Engineering**
- **University of Illinois at Urbana-Champaign's College of Engineering**
- **University of Illinois at Chicago's College of Engineering**

Alternative Energy Technologies

Advanced tribological solutions are required for the production, delivery, and use of alternative fuels.

Dependence on imported petroleum, coupled with concerns about global warming, is behind the urgent push to develop alternative fuels and alternative energy technologies. However, these advanced fuels and technologies come with an entirely new set of friction, wear, and lubrication challenges. For example, the poor lubricity of synthetic diesel fuels (Fischer Tropsch) and the potential for accelerated degradation of engine oils exposed to bio-derived fuels, are among the many problems that must be overcome before alternative energy technologies can achieve their requirements for efficiency, reliability, and reduced environmental impact.

The Illinois Center for Advanced Tribology will

- Study the tribological properties of materials exposed to alternative fuels,
- Develop advanced materials, coating, lubricants, and surface textures to meet tribological performance targets for alternative fuels, and
- Validate the integration of advanced tribological technologies into alternative energy systems.

Extreme Tribology

Severe heat, sandy operating environments, and poor fuel quality are causing premature failure of old and new military vehicles.

Systems operating under extreme conditions that involve high loads, elevated temperatures, high or very low speeds, and dirty environments pose significant challenges to the reliability and durability of critical tribological components. This is especially true in the Middle East, where military vehicles being used were designed 20 to 30 years ago for use in mild climates. In these older vehicles, sand and elevated temperatures are causing premature failure across the board. This is compounded by the hostile conditions that can cut off oil supply systems, leading to engines and other vehicular systems that are starved for lubrication.

In addition, newer systems in more fuel-efficient vehicles require fuels that meet specific lubricity requirements. In many cases, especially in military operations, the quality of the fuel is unknown and the fuel systems may suffer premature failure due to poor lubricity. This will be especially true with the advent of the new ultra-low sulfur diesel fuels that must use additives to improve their lubricity. Exhaust gas recirculation (EGR) is an effective technology to reduce emissions from diesel engines. Unfortunately, reintroduction of exhaust gases back into the combustion chamber accelerates the degradation of engine oils and their ability to protect sliding surfaces. Materials and lubricant technologies are needed to mitigate the aggressive tribological conditions created by EGR.

The Illinois Center for Advanced Tribology will develop materials, coatings, surface texturing, and lubricants that, when integrated together, will provide robust tribological systems that are reliable and durable under extreme conditions. Center researchers will develop

- Super-strong surfaces that can sustain high temperatures and sliding for partial or no lubrication environments,
- High-temperature lubricants that resist oxidation and degradation,
- Nanolubricants for extreme tribological conditions,
- Surface technologies for operating in sandy media,
- Extreme condition seals, and
- Self-recovery/healing surfaces.

The Illinois Center for Advanced Tribology brings together state-of-the-art facilities; world-class expertise; and long-term collaborative relationships with DOE and other federal and state agencies, academia and industry. This comprehensive research approach will ensure the advancement of tribology science and technology in alternative energy technologies, biomedical implants, and extreme environments.

The Center provides a venue to establish joint appointments and to facilitate student exchange and training, and gives access to the critical facilities required for integrated research – ranging from basic fundamental studies to engineered product design.

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Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

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