Technology and Research Directions

The 6th World Tribology Congress, Beijing, China, September 2017, was attended by more than 2000 people. The day's proceedings began with two plenary papers presented by acknowledged global researchers in their respective fields. The range of plenary paper topics was very wide.

Tribology for Space Technology

Lubricants for space travel must have very low volatility and function from extremely low to high temperatures, while at the same time being radiation stable. Traditionally tungsten and molybdenum were used as solid lubricants, and research is focussed on tungsten based solid lubricants due to its higher operating temperature. In recent years fluid lubricants have been developed that are based on polyolefin substituted cyclopentane, polyalkylated cyclopentane, silicon hydrocarbon, silicone oil, perfluoro polyether, polyphenylene oxide, fluorine bromine oil, and corresponding greases.

Biolubrication: Beyond Tribology

Osteoarthritis is becoming a serious global disease, particularly as human longevity increases. Over the past 15 years or so hydration lubrication has emerged as a new paradigm for understanding lubrication in aqueous and the biological environment. In this mechanism, water molecules in the hydration layers of the phosphatidylcholine lipids can provide lubrication through their property of being strongly bound while at the same time being very fluid. Thus they resist being squeezed out under normal stresses as high as several hundreds of atmospheres, and become very fluid when sliding, which can reduce the coefficient of friction to as low as 0.0004.

Advances in Tribological Coatings for More Efficient and Green Transportation Technologies

Tribological coatings such as diamond like coatings (DLC) on metal surfaces can provide ultra low wear and friction, and have been used for many years. These coatings are applied to the metal surfaces during production, and current research is showing positive results in using designer lubricants that can deposit hard ceramic substrates onto a metal surface during operation.

Recent Lubrication Research Activities in SKLT

The State Key Laboratory of Tribology was founded in 1986, and has a complement of 28 full professors, 34 associate professors and 34 post-doctoral fellows. The focus is on tribology in general, and in particular in friction reduction, or super lubricity, which is generally defined as a coefficient of friction below 0.01.

Multiphysic Interfaces of Contact and Relative Motion

Tribological surfaces under contact and relative motion are highly complex. Phenomena such as friction, wear, material deformation, noise, tribochemical reaction, lightening, and electromagnetic charging can occur, which make it extremely difficult for tribologists to have full understanding of the tribological interfaces of surfaces. Tribological interfaces are also energy converters, where mechanical, electrical, magnetic, chemical, thermal, and nuclear energies are transferred. To more fully understand surfaces in relative rubbing motion, mechano-electro-magneto-chemico-thermal coupling has been added to the mechanical, thermodynamic, chemical, and magneto-electro-elasticity modelling that is currently used.

Influence of Tribology on Global Energy Consumption, Costs and Emissions

About 23% (119 EJ) of the world's total energy consumption originates from tribological contacts. Of that 20% (103 EJ) is used to overcome friction and 3% (16 EJ) is used to remanufacture worn parts and spare equipment. By taking advantage of new surface, materials, and lubrication technologies, energy losses due to friction and wear could potentially be reduced by 18% in the short term (8 years), and 40% in the long term (15 years). The largest short term energy savings are envisioned in transportation (25%) and power generation (20%), while the potential savings in the manufacturing and residential sectors are estimated to be about 10%. In the longer terms, the savings would be 40%, 55%, 25% and 20% respectively.

Stress-Induced Thermal Activation in Tribology: From Rheology to Tribochemistry

Most tribological experiments are carried out at the macroscale where, while they can provide useful relationships between load, friction and sliding velocity, they do not reveal whence these originate. Computer-based, molecular-scale simulations are starting to provide some insights and are certainly the way forward but they have yet to be linked fully to the macroscale laws of friction and sliding derived from experiment.

Tribology and Materials for Hydrogen Energy

Hydrogen fuel cells have a high energy efficiency, and are seen as the ultimate clean energy. Tribology will play an important role in ensuring the reliability and safety of hydrogen systems.

Highlights of the general Track papers were the general focus on energy saving and the potential that tribology has to reduce global energy consumption, and to increase the efficiency and durability of all types of equipment. Atomic modelling through to design changes and the use of specialised ceramic coatings or surface textures were presented. An example was the use of a shark skin biomimetic paint that has reduced the drag of large commercial airliners by 3%.

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