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TTRF

8th TTRF-TAIHO International Symposium on Automotive Tribology 2025

1. Date : Wednesday, April 16, 2025 10:15 - 17:05(JST) <Reception 17:45-19:15>
2. Venue: 2F, Large Hall, WINC AICHI, 4-4-38 Meieki, Nakamura-ku, Nagoya-city, Aichi-pref, Japan
3. Theme: "Lubricants" for Adapting to Diversified Powertrains
4. Program:

< Opening >		Moderator Toru Desaki	
10:15-10:20	Opening Address		Toshio Niimi Organizing Committee Chair (Taiho Kogyo)
< Honorary Lecture >		Chair Motoichi Murakami (Japanese Society of Tribologists)	
10:20-11:10	Honorary Lecture 1:	The "EV(Electric Vehicle) Shift" was an Unrealistic Policy After All	Toshio Fujimura (Aichi Institute of Technology)
11:10-12:00	Honorary Lecture 2:	Tribological and Reliability Considerations and New Technologies for Loss Reduction in Hydrogen Engines.	Yuji Mihara (Tokyo City University)
12:00-13:00	<Lunch>		
< Session 1 >	Solid Lubricants and Greases	Chair Takashi Nogi (Kyodo Yushi)	
13:00-13:30	Lecture 1:	Effects of Grease Composition and Properties on Electrical Pitting Prevention for Ball Bearings	Yurie Yamashita (JTEKT)
13:30-14:00	Lecture 2:	Solid Lubrication Properties of Coordination Polymers with Two-Dimensional Layered Crystal Structures	Hiroshi Eguchi (Nagoya Institute of Technology)
14:00-14:30	Lecture 3:	Nanoparticles as Next-Generation Lubricant Additives: Performance and Challenges	Fabrice Dassenoy (Ecole Centrale de Lyon)
14:30-14:45	General Discussion		
14:45-15:15	<Break>		
< Session 2 >	Lubricants	Chair Kazuo Tagawa (ENEOS)	
15:15-15:45	Lecture 4:	Development of Diesel Engine Oil without Metal-Based Antiwear and Detergent Additives	Yasunori Shimizu (Idemitsu Kosan)
15:45-16:15	Lecture 5:	Development of Oil Film Forming Polymeric Additives Contributing to the Improvement of Anti-Seizure Property of e-Axle Fluid	Kazushi Ueno (Sanyo Chemical)
16:15-16:45	Lecture 6:	Study of Doped-DLC Coatings in Combination with Functionalized Polymers for Enhanced Wear Resistance and Friction Reduction	Fábio Emanuel de Sousa Ferreira (University of Coimbra)
16:45-17:00	General Discussion		
< Closing >		Moderator Toru Desaki	
17:00-17:05	Closing Address		Tomohiro Kano (Taiho Kogyo)

5. Reception: 17:45-19:15(JST) 6F Exhibition Hall

6. Abstract

Honorary Lecture 1	The "EV(Electric Vehicle) Shift" was an Unrealistic Policy After All	Toshio Fujimura (Aichi Institute of Technology)

In the automobile industry, the "EV shift" has been called for as a CO_2 reduction measure since around 2016. However, many automakers have finally come to the realization that it's dangerous to promote EVs simply because of zero emissions while driving, without analyzing issues such as power supply capacity/emissions coefficient, cost, driving range, etc., and that EVs aren't likely to be the savior of CO_2 reduction in the near future.
Some believe that the EV shift has plateaued due to the sluggish sales of EVs caused by the abolition of subsidies in China and other countries, but rather it should be recognized that EVs have entered a "valley of death from which they cannot climb out" for the time being. Not only from a technical perspective, but also from global sales trends, it's clear that HEVs and PHEVs are superior overall in terms of actual CO_2 reduction effects and response to customer needs.
In addition, CO_2 reduction applies to owned vehicles (both new and existing vehicles), and the CO_2 reduction target for owned vehicles is 48% by 2030 compared to 2019.
A realistic path to CO_2 reduction lies in the expansion of HEV/PHEV and the early introduction of drop-in fuels to existing vehicles.

Honorary Lecture 2	Tribological and Reliability Considerations and New Technologies for Loss Reduction in Hydrogen Engines.	Yuji Mihara (Tokyo City University)

The combustion gas of a hydrogen internal combustion engine contains a lot of water vapor. When the water vapor condenses on the cylinder wall, the condensed water causes deterioration of the lubricating oil, increasing friction loss and the risk of seizure. In this study, the cylinder wall temperature was changed from 40°C to 80°C, and the water content and changes in the components of the lubricating oil were verified through experiments. As a result, the water content increased 17 times compared to diesel fuel, and changes in the oil properties were also confirmed. In addition, the effects of ultra-fine bubbles will also be introduced, as well as loss reduction technologies that contribute to improving the thermal efficiency of internal combustion engines.

< Session 1 > Solid Lubricants and Greases

Lecture 1	Effects of Grease Composition and Properties on Electrical Pitting Prevention for Ball Bearings	Yurie Yamashita (JTEKT)

The increasing use of battery electric vehicles (BEVs) and hybrid electric vehicles (HEVs) has raised concerns about electrical pitting in bearings supporting driveline motors. Electrical pitting can cause noise, vibration, and early bearing damage. Electrical pitting resistance is often required to increase bearing reliability in electric vehicles (EVs). Developing electrical pitting preventive greases is needed for downsizing and cost reduction of bearing units in EVs. Recent studies have intended to reduce volume resistivity by using greases with added carbon black (CB). While greases with added CB reduce volume resistivity, their long-term effectiveness in preventing electrical pitting is uncertain due to potential aggregation and structural degradation of CB particles. This study evaluated the electrical pitting life of greases with added CB used in office equipment and greases without added CB used in industrial machinery motors, considering factors such as volume resistivity, oil film thickness, and aggregation prevention. Results showed that greases with added CB, despite their low volume resistivity, had shorter pitting life due to particle aggregation. Conversely, different types of urea greases without added CB, using different thickener types or oil types, exhibited a strong correlation between volume resistivity and pitting life. A new grease containing organophilic phyllosilicate, which offers low volume resistivity and prevents aggregation, extended bearing life by 2.5 times compared to greases with added CB.

Lecture 2	Solid Lubrication Properties of Coordination Polymers with Two-Dimensional Layered Crystal Structures	Hiroshi Eguchi (Nagoya Institute of Technology)

Inorganic materials with two-dimensional (2D) crystal structures, such as graphite and molybdenum disulfide, are widely used as solid lubricants. Their weakly stacked layered crystal structures are easily cleaved by shear force to exhibit solid lubricities. Although inorganic 2D materials are an important type of solid lubricant, their structural designability is limited due to their chemical stability. Thus, it is difficult to tune their solid lubricity for specific uses by changing their crystal structures. Herein, we demonstrate the performances of 2D coordination polymers (CPs), which consist of metal ions and organic ligands, as a new candidate for solid lubricants. Compared to conventional layered solid lubricants, 2D CPs exhibit high structural diversity by choosing the combinations of metal ions and ligands, thus their properties can be easily modified. We investigated the solid lubrication properties of two kinds of 2D CPs with layered crystal structures, namely copper benzene-1,4-dicarboxylate and silver thiolates using ball-on-disk friction tests. These results suggest that 2D CPs with layered structures are potential candidates as new solid lubricants that compensate for the conventional ones.

Lecture 3	Nanoparticles as Next-Generation Lubricant Additives: Performance and Challenges	Fabrice Dassenoy (Ecole Centrale de Lyon)

Over the past two decades, there has been a growing interest in the use of nanoparticles for tribological applications. Research has highlighted their exceptional lubricating properties, particularly in terms of friction reduction and anti-wear performance, making them promising candidates as additives in automotive lubricants. This potential has garnered significant attention from additive manufacturers, oil companies, and the automotive industry, all of whom face the dual challenge of developing lubricants that support evolving engine technologies while complying with increasingly stringent environmental regulations.

This presentation will explore the performance of nanoparticles as lubricant additives, delving into how key parameters influence the effectiveness of nanoparticle-based lubricants. We will also discuss the lubrication mechanisms at play when nanoparticles are introduced into lubricants.

Special emphasis will be placed on the critical aspects of formulating nanoparticle-based lubricants, with particular attention to the indispensable role of dispersants.

Lastly, we will consider how nanoparticles can address the emerging challenges of conventional lubricants, particularly in light of the growing adoption of electric vehicles in the automotive market.

< Session 2 > Lubricants

Lecture 4	Development of Diesel Engine Oil without Metal-Based Antiwear and Detergent Additives	Yasunori Shimizu (Idemitsu Kosan)

In response to stringent emission regulations, diesel vehicles are equipped with Diesel Particulate Filter (DPF) to capture Particulate Matter (PM) from exhaust gases. However, DPF regeneration is required to burn off accumulated soot, while metallic ash from engine oil additives leads to clogging and increased fuel consumption. Despite efforts to reduce ash content in diesel engine oils, the presence of metallic ash continues to impact DPF performance, requiring more frequent regenerations and potentially leading to reduced satisfaction for drivers.

To address these challenges, Idemitsu has developed a novel ashless diesel engine oil that replaces traditional metal-based antiwear and detergent additives. Laboratory and engine tests indicate that this new oil meets JASO DH-2 standard excepting oil chemical properties, demonstrating promising valve train wear protection, piston detergency and other performances. Actual vehicle tests conducted in Japan confirmed its practical performance, with no trouble such as significant increase in acid number or kinematic viscosity, despite nearly zero total base number which is widely used as a lifetime indicator for engine oils. This presentation will introduce the effects of the ashless engine oil on DPF performance and present results from engine durability and actual vehicle tests, highlighting its potential to enhance achieving CO_2 reductions.

Lecture 5	Development of Oil Film Forming Polymeric Additives Contributing to the Improvement of Anti-Seizure Property of e-Axle Fluid	Kazushi Ueno (Sanyo Chemical)

As CO_2 emission regulations have been tightened to prevent global warming, electric vehicles are becoming increasingly popular in the automotive industry. It is important to further improve the cruising range of electric vehicles, and various technological measures are required to improve energy efficiency. For example, e-Axles, which are drive motor systems that integrate an electric motor, inverter, and reduction gear, contribute to longer cruising range due to their compact size and light weight.

As for the fluid to be used in e-Axles, a special fluid that matches the characteristics of e-Axles has become necessary instead of the conventional ATF. In the case of e-Axles, where the same fluid is used to lubricate the reduction gear and cool the electric motor, the viscosity of the fluid should be low to reduce energy loss due to viscous resistance and enable efficient cooling. However, simply reducing the viscosity generally results in poor lubrication and, in some cases, mechanical seizures. Therefore, it is necessary to prevent such seizures by formulating appropriate additives.

This presentation will describe the characteristics of novel oil film forming polymeric additives developed for e-Axle fluids to improve anti-seizure property.

Lecture 6	Study of Doped-DLC Coatings in Combination with Functionalized Polymers for Enhanced Wear Resistance and Friction Reduction	Fábio Emanuel de Sousa Ferreira (University of Coimbra)

The integration of metallic elements into diamond-like carbon (DLC) coatings has attracted significant attention for enhancing functionalities in various applications. This study explores the interaction between functionalized polymers and doped-DLC coatings to elucidate their tribological properties and wear resistance. Doped-DLC coatings were deposited on steel substrates using deep oscillation magnetron sputtering, and different doped concentrations were achieved by varying number of pallets. Tribological tests were conducted using ball-on-disk tribometry, revealing reduced friction and improved wear resistance of doped-DLC coatings when paired with PLMA-b-PDMAEMA polymer compared to PLMA. Surface characterization through SEM-EDS analysis unveiled the formation of transfer films derived from carbon-rich polymers, contributing to the observed reduction in wear rates. Overall, doped-DLC coatings exhibited promising potential in mitigating friction and enhancing wear resistance when combined with specific functionalized polymers, indicating avenues for diverse industrial applications. This comprehensive investigation not only advances the understanding of tribological behavior but also facilitates the development of tailored materials with superior performance in real-world applications.