

Joint ELGI-STLE Tribology Exchange Workshop

11th – 12th November 2026
Marriott Courtyard Amsterdam

Lecturer & Topic Information

Multi-physics & Multi-scale Tribology

Research is expanding across scales and disciplines:

- From **macro-scale** machine components to **nano-scale** contact mechanics
- Integration with thermo-fluids, rheology, surface chemistry, and biomechanics
- Applications in powertrains, bearings, electrical machines, and biomedical joints



Kartik Pondicherry

Anton Paar GmbH, Graz, Austria

Dr. Kartik Pondicherry is a business and technology professional associated with Anton Paar for over 13 years. With a background in engineering and a PhD in Tribology, he is involved in bridging technical innovation with strategic business development in the field of Rheology and Tribology. He is active in the scientific communities and has authored several white papers on innovative test methodologies and has also presented several invited and keynote lectures at international conferences. kartik.pondicherry@anton-paar.com

Model-scale Testing of Lubricants and Greases – Rheology and Tribology

Model-scale tribological testing provides an efficient approach for evaluating the lubricating performance of engine oils and greases under controlled laboratory conditions. In this study, the tribological behaviour of selected engine oils and greases was investigated at different temperatures using model-scale tribological tests. Surface characterisation was subsequently performed using light microscopy and scanning electron microscopy to examine wear features and the formation and build-up of tribofilms on the contacting surfaces. In addition, the rheological properties of the greases were investigated to assess their relationship with lubrication performance. The results provide insights into the influence of temperature, tribofilm formation, and grease rheology on tribological behaviour.



Rich Baker
TriboTonic

Rich is the Managing Director of TriboTonic Ltd, which he founded over seven years ago to provide instrument sales, servicing, and technical support to tribology and petroleum companies across Europe. Prior to this, he spent 16 years at PCS Instruments in roles spanning sales, marketing, and business development.

TriboTonic represents and supports PCS Instruments, Falex Tribology, Flucon, and Metaspec test specimens throughout Europe. Holding a PhD in Mechanical

Engineering from Imperial College, London

He also serves the industry in advisory capacities on various boards and standards committees and is an active ASTM member (chairing the Tribology Tests for Electric Vehicle Lubricants group).

The Bench Still Matters: Connecting Lab Testing to Real-World Problems

Tribology benchtop tests are **still** essential for understanding the interactions between surfaces in relative motion. Conducting these tests allows researchers and engineers to evaluate the performance, durability and reliability of materials and components under various conditions. It has been shown previously that the knowledge gained from tribology testing applies directly to real-world applications, such as improving energy efficiency in engines, reducing maintenance costs in machinery and enhancing the lifespan of industrial equipment. By simulating **realistic** operating environments, tribology tests help predict how materials will behave in practical scenarios, guiding the development of better materials and optimising designs for sustainable and cost-effective solutions.

3 examples will be presented to show how bench top apparatus has been used to develop solutions to real world problems found in wind turbines, rail transport and the automotive industry. We will also touch on how the bench testing is adapting for new challenges in the automotive industry.

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Sergei Glavatskih

KTH Royal institute of Technology

S.Glavatskih is a chair Professor in Machine Elements at the KTH Royal Institute of Technology, Sweden, and a visiting Professor at Ghent University, Belgium. He is an elected member of the Royal Swedish Academy of Engineering Sciences. His research covers machine design, tribotronics and mechanochemical systems. The focus is on the development of more sustainable, environmentally adapted and energy efficient components and systems such as rolling and sliding bearings, gears, wet clutches, seals, threaded fasteners, lubricants (oils, greases, aqueous lubes and ionic liquids). segla@kth.se

Turning the Page on Lithium: Ca Va?



Akepati Bhaskar Reddy
KTH Royal Institute of Technology

Dr. Bhaskar Reddy obtained his PhD in Machine Design in 2022 from KTH Royal Institute of Technology, Stockholm.

A mechanical engineer by training, his current research interests include tribotronics as a tool for condition monitoring and online maintenance, ionic liquids for lubrication, grease tribology, and rolling contact fatigue. His work is supported by an early-career grant from FORMAS, the Swedish Research Council for Sustainable Development. He is also a Visiting Fellow at the School of Chemistry at the University of New South Wales. abreddy@kth.se

Electrically Responsive Lubrication: Toward Active Tribological Systems

Tribotronics integrates lubrication, sensing, and electronic control to create “smart” machine elements capable of responding to changing operating conditions and emerging damage. Electrically responsive lubricants are central to this vision, enabling friction and surface protection to be actively adjusted within a contact.

Experiments with ionic liquids in macroscale rolling contacts show that electric potential can reversibly affect lubricant film thickness and friction. These results indicate that electrical control may provide a means of adjusting contact conditions or restoring film protection when lubrication begins to deteriorate.

The talk will examine these observations, the mechanisms that may govern the response and the influence of lubricant chemistry, potential magnitude and operating conditions. It will also discuss the practical limitations of the approach, including electrochemical stability, power requirements, material compatibility, control strategies and long-term repeatability. Possible applications include bearings and other lubricated components operating under variable loads or with limited maintenance access, such as those found in offshore wind and wave energy systems.



Felix Zak
Optimol Instruments

Felix holds a B.Eng. in Mechanical Engineering from the University of Applied Sciences Kempten, where his thesis examined elastomer compatibility with various lubricants under dynamic load. He also completed a scientific project (EPS) at the Universitat Politècnica de Catalunya Barcelona Tech (UPC), in the Chemical Engineering Department, focused on energy saving in air conditioning systems using a hollow fibre membrane. He then earned an M.Sc. in Aerospace from the Technical University of Munich (TUM), with a pre-thesis on multiphysics modelling

of EHD line contacts based on the Navier-Stokes equations, and a thesis extending a CFD model of the EHD line contact to account for non-Newtonian fluid behavior, thermal effects, and surface irregularities. Since 2022, he has worked as a Development Engineer at Optimol Instruments, and since 2025 has served there as Lead of Applied Tribology Testing & Method Development. felix.zak@optimol-instruments.de

Multiscale and Multiphysics Tribology – From Complex Interactions to Measurable Insights

Tribological systems are governed by a multitude of interacting physical and chemical phenomena across different length and time scales. Mechanical contact, surface topography, lubrication conditions, thermal effects, material deformation, wear and tribochemical processes are often strongly coupled and may exhibit nonlinear interactions. This inherent multiscale and multiphysics nature makes a comprehensive numerical description of real tribological systems highly challenging, particularly when realistic surfaces, materials, operating conditions and evolving contact states are considered.

Experimental tribology offers a complementary approach by directly capturing the integrated response of these complex interactions. Rather than resolving every individual mechanism, controlled tribological experiments can translate the combined effects into measurable system-level responses, such as coefficient of friction, wear, temperature, electrical contact resistance, acoustic emission and other in-situ or post-test characteristics. Systematic variation of operating and material parameters further enables the experimental investigation of complex parameter–response relationships.

This presentation discusses how experimental testing can serve as a practical pathway towards understanding multiscale and multiphysics tribological systems. Particular emphasis is placed on the combination of controlled parameter studies, multi-channel measurements and data-driven methods such as machine learning. By identifying correlations and characteristic response patterns across a sufficiently broad experimental space, such approaches can provide indications of the influence of individual parameters and underlying tribological phenomena. The aim is to illustrate how experiments, simulation and data-driven analysis can complement each other in transforming complex tribological interactions into measurable and interpretable insights.



Francesco Pagano
Tekniker

Dr. Francesco Pagano is a senior researcher and project manager at Tekniker. After studying mechanical engineering, he earned a doctoral degree in Engineering of advanced materials. In his functions, Dr. Pagano is coordinating the European project SiToLub for the development of a digital platform for the design of new lubricants according to the Safe and Sustainable by Design principles. He is also leading important activities in other European projects, for example the construction of a Self-Driving Lab for the formulation and characterisation of lubricants in the recently approved project DIAMOND. francesco.pagano@tekniker.es

SiToLub: AI and simulation tools for the design of safe, sustainable and performant lubricants.

Environmental regulations are becoming increasingly demanding, while uncertainties in raw material availability continue to affect the chemical and lubricant industries. At the same time, the European Commission is promoting the development of advanced materials according to Safe and Sustainable by Design (SSbD) principles. These developments are creating a need for new formulation strategies capable of considering performance, safety and sustainability from the earliest design stages. The EU-funded

SiToLub project (sitolub.eu) addresses this challenge through the development of a digital platform for lubricant design and assessment.

The objective is to support the identification of lubricant formulations that satisfy technical requirements while reducing their environmental impact. The platform can evaluate user-defined candidates and also propose new molecules generated according to the requirements specified for a particular application.



Mathias Woydt
Matrilub

Dr. Mathias Woydt is managing director of MATRILUB Materials I Tribology I Lubrication, with more than 39 years of experience in R&D feasibility studies on disruptive technologies: relationships between CO₂ & friction and sustainability & wear protection, environmentally acceptable lubricants, root-cause failure analysis, slip-rolling alloys, fine ceramics, ceramic composites, thin film and thermally sprayed

coatings, abrasive wear. He's researched alternative lubricant formulations with tribo-testing, including the dissemination of the aforementioned items into industrial applications. He authored more than 390 publications, edited 12 books and has 52 priority patents filed. The publications generated more than 4,300 citations. He is a recipient of the ASTM Award of Excellence and is an elected STLE fellow. He is chairman of the SRV test methods DIN51834, parts 1-7, twelve ASTM test methods and ISO19291 & 20120. He is a board member of the German Society for Tribology www.gft-ev.de. He is lecturer on Tribology at the Technical University of Berlin. For 33 years he was head of division "Tribology & Wear Protection" with BAM Federal Institute for Materials Research and Testing in Berlin. m.woydt@matrilub.de

Efficient characterisation of extreme pressure properties of lubricants using advanced 4-ball test methodology

The four-ball test is an important, standardised test method for the identification of extreme pressure and anti-wear properties of lubricants. The present exposal will illuminate a new extreme pressure test methodology by using a continuous, constant load ramp rate, which is mature and in the standardisation process. Moreover, the method effectively captures the transition from low-wear to high-wear regimes by executing interrupted tests. This enables the determination of a maximum contact stress (load carrying capacity in MPa) until scuffing. The test results are:

- a. Last non-seizure load (LNSL),
- b. Load carrying capacity in MPa
- c. Weld point (load)
- d. Coefficient of friction as a function of load

The methodology of a constant load ramp rate reduces the complexity, testing time and matches the historical horizon of present ASTM, DIN, ISO and SAC tests related to 4-ball testing.

'Wear' and 'wear parts' in contextual relation with 'obsolescence'

In colloquial language, anything that no longer works is referred to as "worn out." The question is: "Does everyone have the same understanding of these terms?" Difficult! To be fair, surprisingly there are still no definitions! Is the term "wear part" limited in terminology to tribologically stressed components? With the EU Ecodesign &

Repair Directives plus the EU definition of goods, legislators are extending the term “wear part” to include material, mechanical, electrical/electronic, digitised components, software, and information, as well as digital content or digital services. The GfT position paper “Wear part” resolves the complexity with the triad of terms “spare part – wear part – wear-out part” in the context of obsolescence.



Boris Zhmud
Tribonex AB

Prof. Dr. Boris Zhmud is an industry insider with over 20 years of professional experience in tribology, lubricants and lubrication engineering. He has authored or co-authored over 90 peer-reviewed publications and has several patents. He is also a Fellow of the British Royal Society of Chemistry (RSC), the Society of Automotive Engineers (SAE), and the Society of Tribologists and Lubrication Engineers (STLE).

Lubricating Greases: Where Rheology and Tribology Meet Together

Abstract: Grease lubrication is one of the most widely used types of industrial lubrication. From a rheological viewpoint, greases are classified as viscoelastic materials. The elasticity is essential for prevention of grease leakage from lubricated joints, whereas the fluidity is essential both for the grease lubricating efficiency and for grease pumpability. The ability to accurately determine rheological properties is invaluable for the optimisation of CAE models that are extensively used in engineering.

The current presentation will cover the latest advances in the grease rheology research with down-to-earth lubrication engineering in focus. The relationships between grease rheology and its tribological properties will be discussed, including the role of different base oils, thickeners, tackifiers and EP/AW additives.



Philipp M. Sieberg is a researcher and lecturer at the University of Duisburg-Essen, Germany, and General Manager of Schotte Automotive GmbH & Co. KG. His research interests are primarily in the area of applied artificial intelligence. One focus is on the use of artificial intelligence for sustainability goals, especially for wear reduction by classifying and identifying the predominant wear mechanisms. Dr. Sieberg is an associate editor of several conferences and is a member of the Executive Committee of IEEE Germany and the IEEE ITSS German Chapter.



Wear behaviour characterisation with unsupervised machine learning

As a systemic behaviour, wear behaviour is influenced by numerous factors besides the physical properties of the tribo-pair itself. Minor variations can significantly alter wear behaviour, leading to divergent results across experiments under nominally identical parameters. Even within a single wear test, the observed behaviour typically results from the mixture and co-action of multiple wear mechanisms. In our previous study, we introduced a method termed as tribo-data map, which represents the force value distribution simultaneously in both temporal and spatial dimensions. It was found that, inside one single wear track, the force distribution also exhibits distinct distribution corresponding to different positions. It implies that the dominant wear mechanism may vary at different positions within the single wear track, and the probability distribution characteristics of the force data can serve as effective parameters for further decomposing the wear data. In this study, wear tests of 316L steel and 42CrMo4 martensitic steel, with Si₃N₄ as the counter body, were performed under different test conditions. The subsequent analysis can be broadly divided into two parts: decomposition and categorisation. Decomposition is to segment the tribo-data map of force value data for each wear test in both temporal and spatial dimensions based on probability distribution characteristics. For categorisation, an unsupervised deep clustering model is employed to cluster the decomposed data. The clustering results are characterised by the worn surfaces analysis through surface topography, SEM images, and EDS analysis. The results indicate that the distribution characteristics of force data can serve as indicators for characterising different wear behaviours.
