

#### DAYS OF MECHANICAL ENGINEERING 2014

Laboratory for Tribology and Interface Nanotechnology (TINT) had participated in the event Days of Mechanical Engineering in Bistra. Besides introducing the field of tribology and demonstration of the operation of manual and automatic continuously variable (CVT) transmission, we have developed a new device that demonstrates one of the most important tribological phenomena – friction. The device has four tracks where little cars with different bottom surfaces can be descended. With the help of simple experiments visitors were able to test how different contact materials influence the friction and consequently the sliding properties of the cars.

#### THE BEST DIPLOMA THESIS IN THE FIELD OF MAINTENANCE

At the contest for the best diploma theses in the field of Maintenance in 2014, three thesis of the Laboratory for fluid power and control, a part of our Chair, were submitted. The theses won 2nd (Jakob Pintar: Determination of the characteristics of conventional directional hydraulic valve), 3rd (Rok Jelovčan: High pressure testing of hydraulic cylinder) and 6th place (David Ferlat: Pressure conditions within hydraulic systems directional). With the high classification of this three theses Faculty of Mechanical Engineering earned first place among faculties.

#### NORDTRIB 2014

The 16th Nordic symposium on tribology Nordtrib took place in June in Denmark. The conference was attended by co-workers from Laboratory for Tribology and Interface Nanotechnology that presented their five works from the fields of contact engineering, polymer tribology, wetting influence on friction behaviour, use of nanoparticles in lubricants and adsorption on DLC coatings.

#### EUROPEAN MASTER PROGRAMME TRIBOS

New academic year has begun for TRIBOS Erasmus+ programme students. Second generation of first-year students started their study in United Kingdom, while second-year students continue their studies in Portugal and Sweden. TINT is expecting new first-year students in Ljubljana at the beginning of February 2015.

Joint master programme TRIBOS is an **unique study programme** that enables students to study tribology and surface science at **four renowned European universities**. TRIBOS website has been redesigned and is even more functional and transparent. Candidates for TRIBOS Erasmus+ programme can easily get answers regarding the curriculum, admission, scholarship, and many other relevant information.

Applications for 2015-2017 study period will start in November. More information is available on [www.master-tribos.eu](http://www.master-tribos.eu)



#### LEEDS-LYON 2014

The international conference Leeds-Lyon Symposium on Tribology, 41st in a row, took place in September. This conference is one of the most prominent conferences in the field of tribology, and it was dedicated to the mutual integration of different fields in tribology. The conference was also attended by two co-workers from TINT with lectures entitled »The performance of solid lubricant nanoparticles as additives in PAO oil with respect to the tribofilm and sliding conditions of steel and DLC contacts« and »Characterization of tribo-films formed on DLC coatings in combination with different oils and additives«. Both lectures were accepted with great interest and initiated a lot of questions, comments and suggestions.

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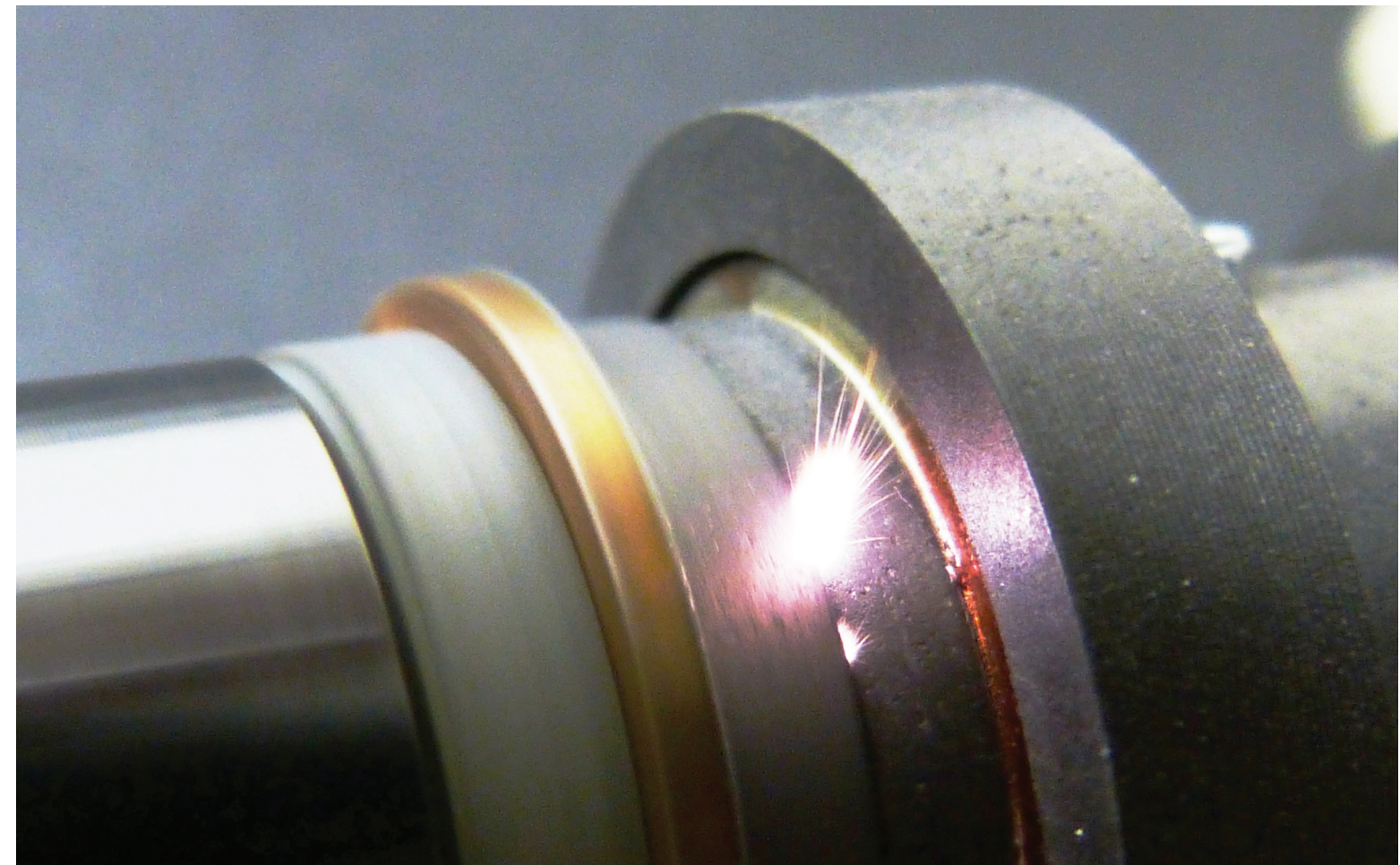
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Laboratory for Tribology and Interface Nanotechnology



## UNCONVENTIONAL CONTACTS can be significantly improved with tribological optimization

Some contacts are intended to work under **unconventional and at the same time very harsh conditions**. Besides the usual loading parameters, such as normal load, temperature and ambient conditions, the sliding contacts can also be subjected to **the flow of electric current between the contacting surfaces**. These contacts are common for numerous electrical devices (electric motors, alternators, etc.) and switches in domestic appliances as well as in industrial and automotive systems. **The electric current can significantly change the tribological conditions** and therefore demands simultaneous **optimization and modification** of tribological and electrical conditions.

*The results of various tests demonstrates significant possibilities for improvements in these contacts, with respect to applied loads, surface topography, formation of in-situ boundary films, changes in contact materials and in the geometry of the contacts. In TINT we can importantly advice and assists towards improvements of such and similar contacts.*

[www.tint.fs.uni-lj.si](http://www.tint.fs.uni-lj.si)

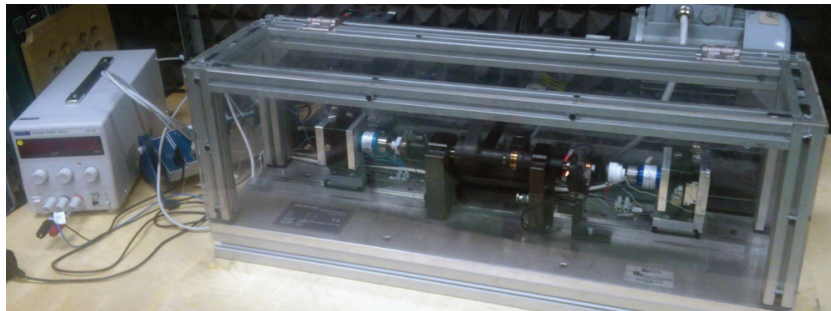




## NEW EQUIPMENT

### TESTING DEVICE FOR SLIDING ELECTRICAL CONTACTS

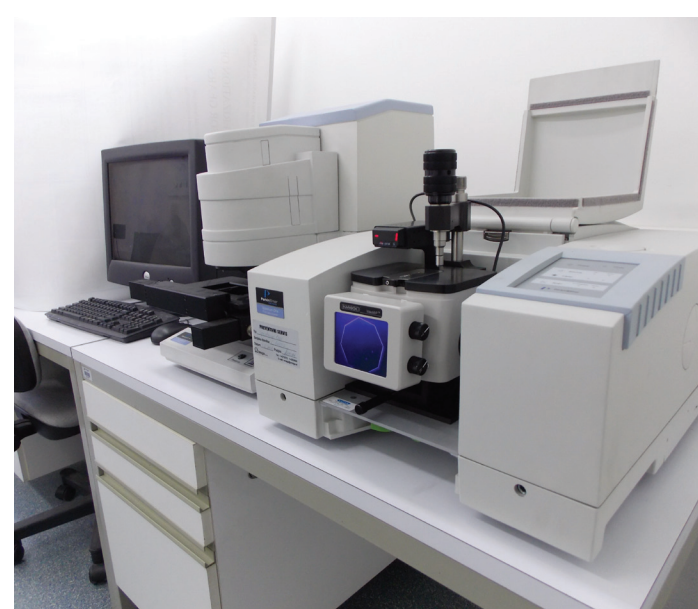
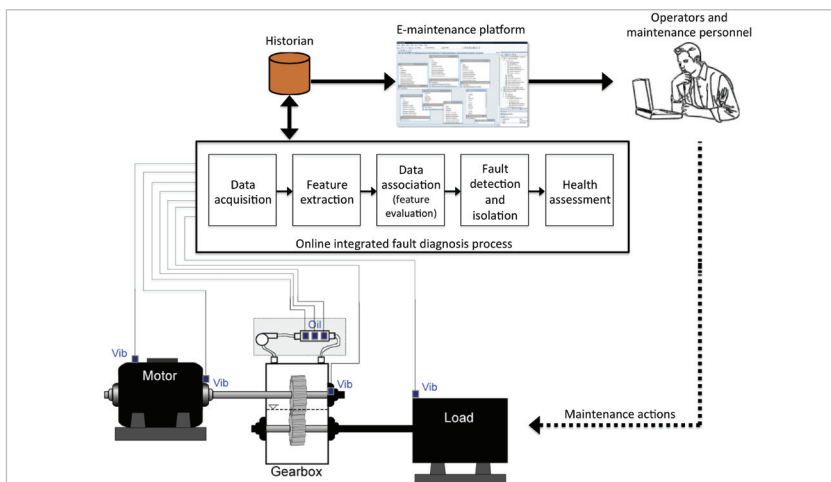
Device for testing sliding electrical contacts was developed in collaboration with Kolektor Group with the aim of analysing electrical and tribological efficiency of various materials in sliding contacts of alternators, commutators, etc. The device enables the detection of contact load, coefficient of friction, contact resistance, temperatures of the contact pairs and environmental humidity. With the new device it will be possible to optimize and improve electrical contacts with different geometries and materials, which is crucial for operation of electrical devices transmitting electrical current through different contacts.



## PhD DISSERTATIONS

### DR. GABRIJEL PERŠIN: FAULT DETECTION AND LOCALIZATION OF MECHANICAL DRIVES BASED ON DATA FUSION TECHNIQUES

The thesis focuses on reliable fault diagnosis of mechanical drives, while considering integration of several condition monitoring approaches. Partial decisions regarding machine condition, obtained independently from vibration and oil analysis techniques, are used within the fusion process based on the incidence table. The incidence table offers in-depth relations between faults and signatures from oil properties or vibration features, used for estimation of final fault probabilities. Analysis of oil parameters is based on trend change detection, followed by qualitative analysis, which reveals the nature of the ongoing change. Vibration analysis is based on spectral kurtosis and filtering, used to extract fault-related non-stationary component from background noise. Experimental validation, which included oil contamination experiment, gear pitting, and bearing inner and outer race damage, proved the proposed approach to offer reliable estimation of fault probabilities, by fusion of partial probabilities obtained by oil and vibration analysis.



### FT-IR ATR WITH VIDEO OPTION

The laboratory obtained a new FT-IR ATR module that enables infrared spectroscopy of surfaces of hard samples, powders and liquids. New ATR modul with diamond crystal enables surface video control with extremely high accuracy. Optional video imaging and an active sampling area of less than 500  $\mu\text{m}$  in diameter enable precise positioning and analyses of inhomogeneous and composite samples. The method is ideal for infrared spectroscopy of extremely hard samples, abrasive powders, fibres, beads, and even corrosive materials.

## PROMINENT PUBLICATIONS

#### J. Jerina, M. Kalin

Initiation and evolution of the aluminium alloy transfer on hot work tool steel at temperatures from 20 °C to 500 °C  
*Wear 319, 234–244, 2014*

#### M. Kalin, A. Pogačnik

Criteria and properties of the asperity peaks on 3D engineering surfaces  
*Wear 308, 95-104, 2013*

#### M. Kalin, M. Polajnar

The effect of wetting and surface energy on the friction and slip in oil-lubricated contacts  
*Tribology Letters 52, 185-194, 2013*

#### J. Kogovšek, M. Kalin

Various MoS<sub>2</sub>-, WS<sub>2</sub>- and C-based micro- and nano-particles in boundary lubrication  
*Tribology Letters 53, 585–597, 2014*

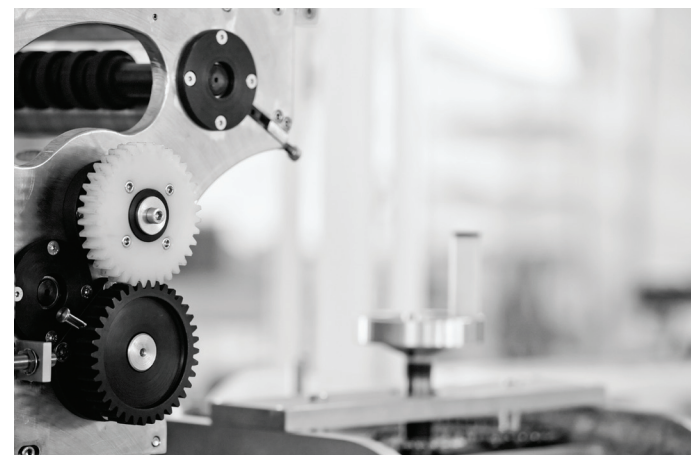
#### M. Kalin, R. Simič, T. Hirayama, T. Geue, P. Korelis

Neutron-reflectometry study of alcohol adsorption on various DLC coatings  
*Applied Surface Science 288, 405-410, 2014*

## POLYTRIB 2014

### 1st INTERNATIONAL CONFERENCE ON POLYMER TRIBOLOGY – POLYTRIB 2014

The Laboratory for Tribology and Interface Nanotechnology (TINT) and the Slovenian Society for Tribology and have organized the 1st International Conference on Tribology of Polymers - PolyTrib 2014, which was held on the 11th and 12th of September in Bled. The conference was attended by over 70 participants from 11 different European countries, representing 17 different research institutes and 20 companies, with as many as 34 participants coming from companies that are related to the tribology of polymer materials. The conference featured 20 lectures, of which 6 were given by invited lecturers. Additionally, 5 contributions were also presented in the poster session. Participants of the conference could, therefore, gain a lot of new information in the field of tribology of polymer materials, and especially also make new acquaintances and business contacts. Due to the very positive response and success of the conference, we believe and hope that we will meet again in 2 years in even greater numbers at the 2nd International Conference on Polymer Tribology, the PolyTrib 2016.



### A CREATIVE WAY TOWARDS PRACTICAL KNOWLEDGE

Approximately 100 students of the Faculty of Mechanical Engineering in Ljubljana were involved in a project called "A creative way towards practical knowledge". 8 of those students participated in various industrial projects under the guidance of the coworkers of TINT laboratory. In the projects we have worked with several Slovenian partners: BSH Home Appliances, Domel, Hidria AET and Kolektor Group; which helped defining the content of the work according to their needs and desires and helped guiding the students on the basis of their knowledge and experience. Some of the topics that the students tackled were the use of polymer materials in fuel pumps, tribological properties of sliding electrical contacts, testing and properties of emulsions for forming processes, tribological properties of polymer materials for high-load applications, testing of materials and lubricants for punching and testing and tribological properties of sintered bearings.



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## SELECTED PROJECTS

### TRIBOLOGICAL PROPERTIES OF SINTERED SLIDING BEARINGS

This year Laboratory TINT has performed a research of tribological properties of lubricant-containing sintered sliding bearings in collaboration with the company Domel d.o.o. In the first part of the project the research was focused on understanding the reasons and mechanisms that caused to the damage and failures of the sliding bearings. In continuation, the testing methodology based on the model tribological experiment was developed and verified that will enable fast, simple and reliable bearings entry checks and quality control of different types or series of sliding bearings. Consequently, improved quality assurance with simultaneous important savings on more demanding test methods have been achieved.

**Partners:** Domel d.o.o. (Slovenia)

### CC ACT – COMPETENCE CENTER FOR ADVANCED CONTROL TECHNOLOGIES

Except for fatal defect (sudden and complete lost of functionality), the 99% of mechanical defects go through beginning phase with distinct and relatively easy-to-recognise symptoms. The role of condition monitoring is to recognize the possibility of defect, to determine the causes and to predict the fault development. With this there remains enough time until the actual defect and for the maintenance work. The aim of this project is to implement the condition monitoring algorithms in industry, to enhance the efficiency of the use of informational sources (vibration analysis, acoustic emissions, wear debris, etc.) by data fusion techniques and to develop the methods, software and hardware equipment for the in time forwarding of machine condition.

**Partners:** Jožef Stefan Institute (Slovenia), INEA (Slovenia), Litostroj Power (Slovenia)

