

Electrical effects on friction and wear in bearings

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Agenda

1. Investigation of electrical discharges in bearings
2. Tribochemical effects and their influence on tribochemical reactions
3. Short outlook on superlubricity and slide bearings

Fraunhofer Institute for Mechanics of Materials

Business Units and Groups

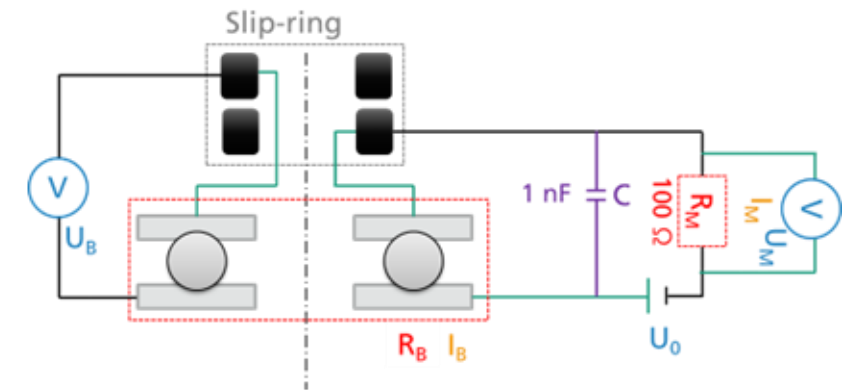
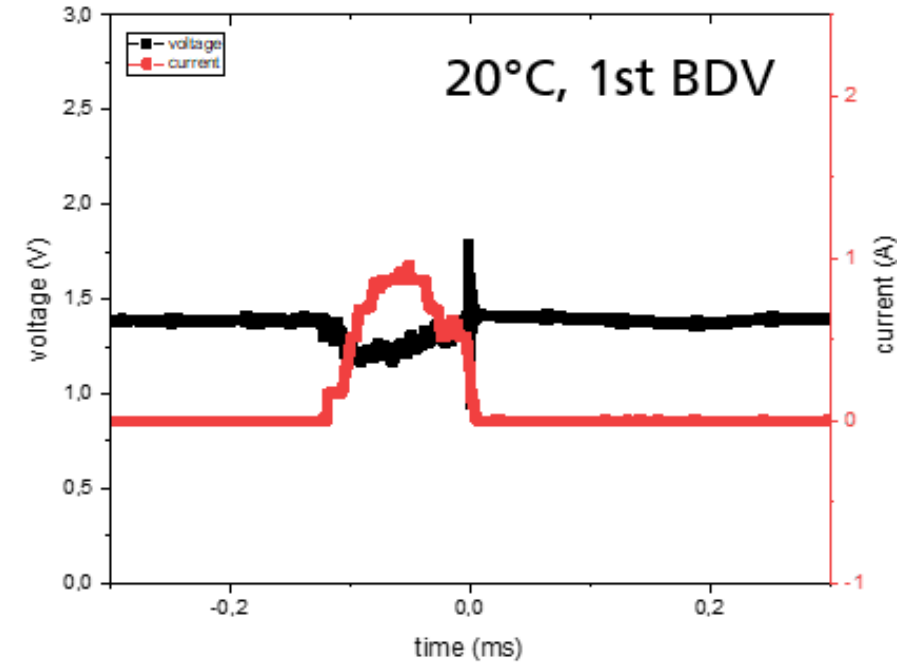
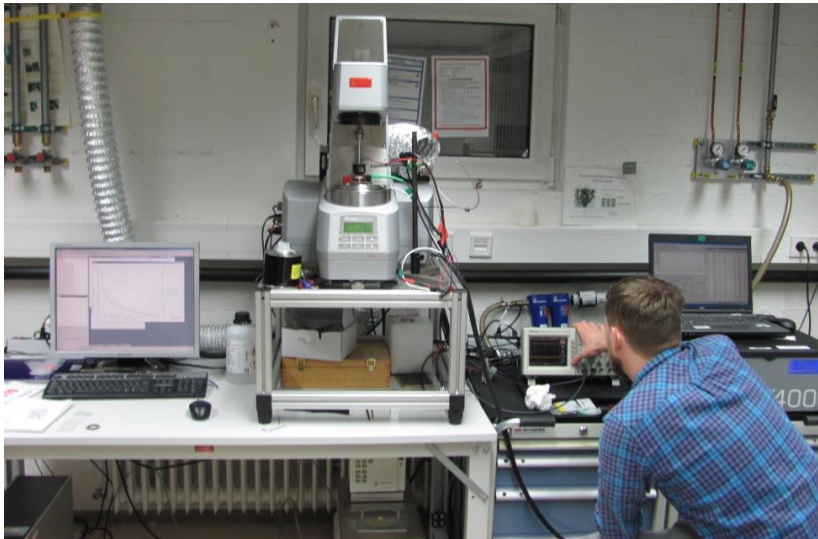


Electrical Discharges in Bearings

Goals

- Measurement of breakdown voltage and energy
- Variable setting of the test parameters
- Effect on damage formation and evolution

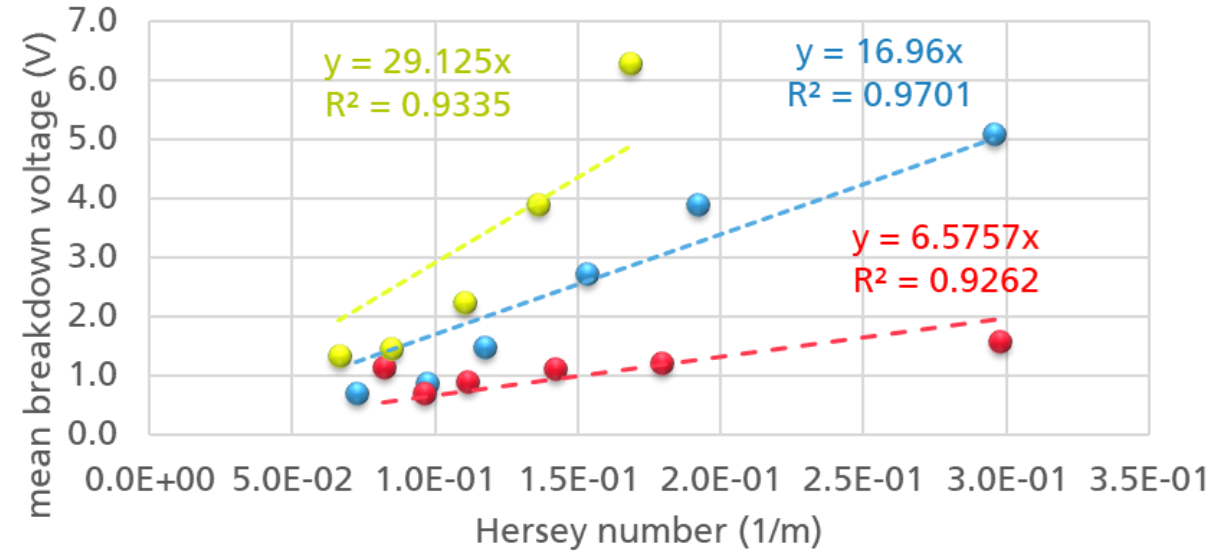
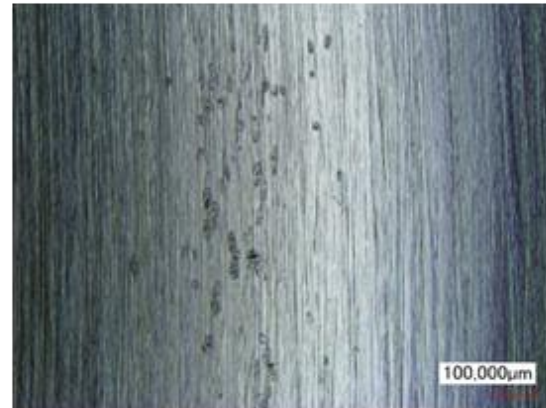
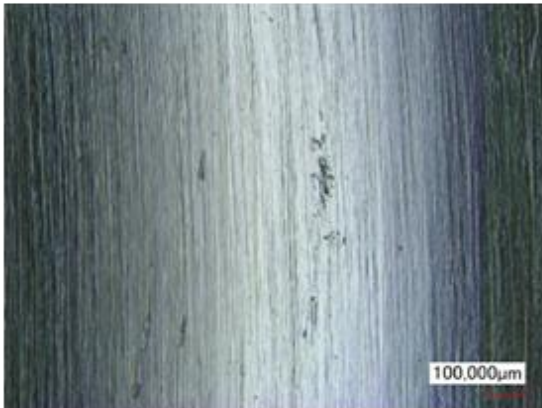
- Outlook:
 - Application of AC voltages and DC voltages > 20 V
 - Transfer to larger rolling bearings



Electrical Discharges in Bearings

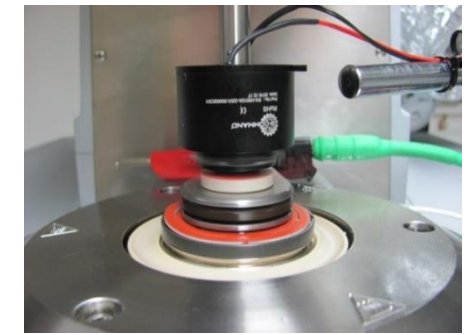
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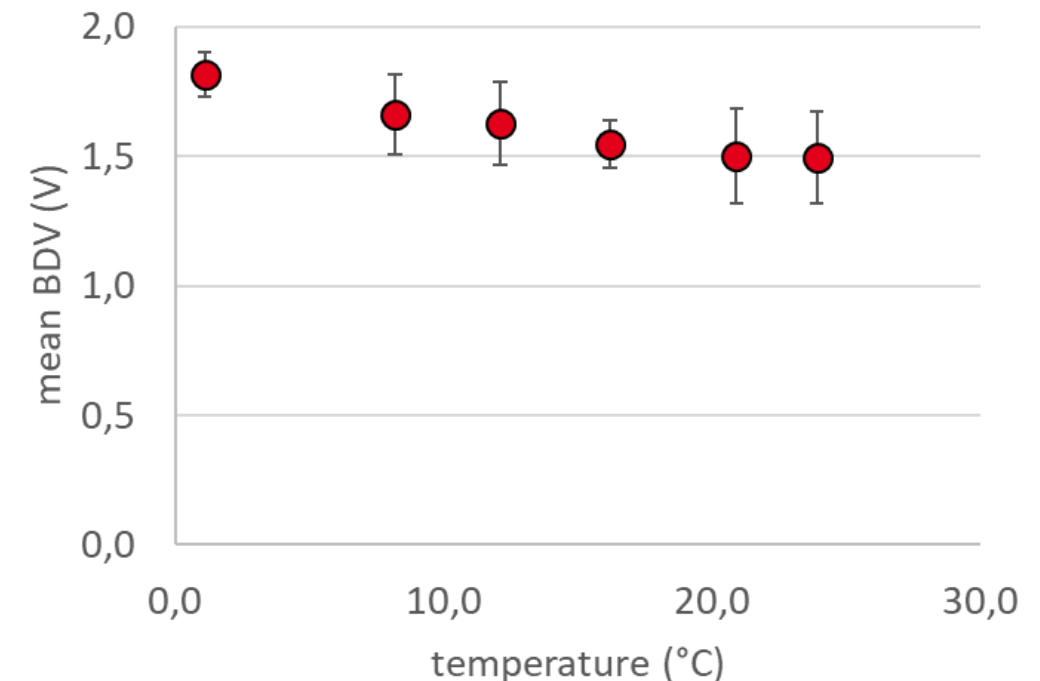
● T27; P3-16, No.29 ● T28; P3-17, No.30 ● T29; P3-18, No.31

Rolling bearing tests with electrically conductive lubricants

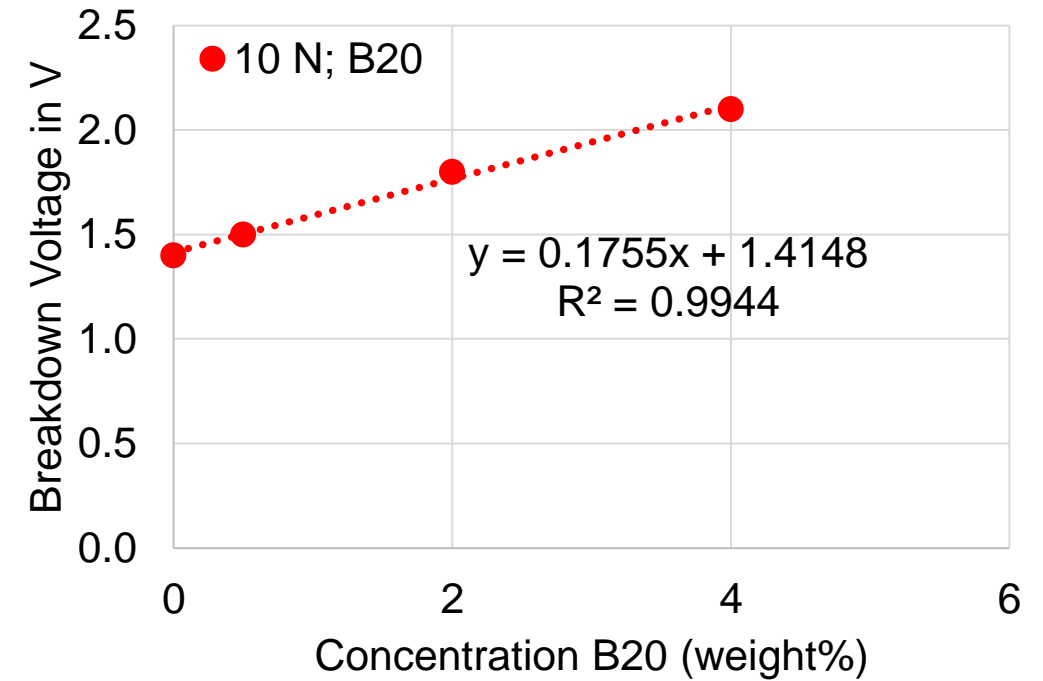
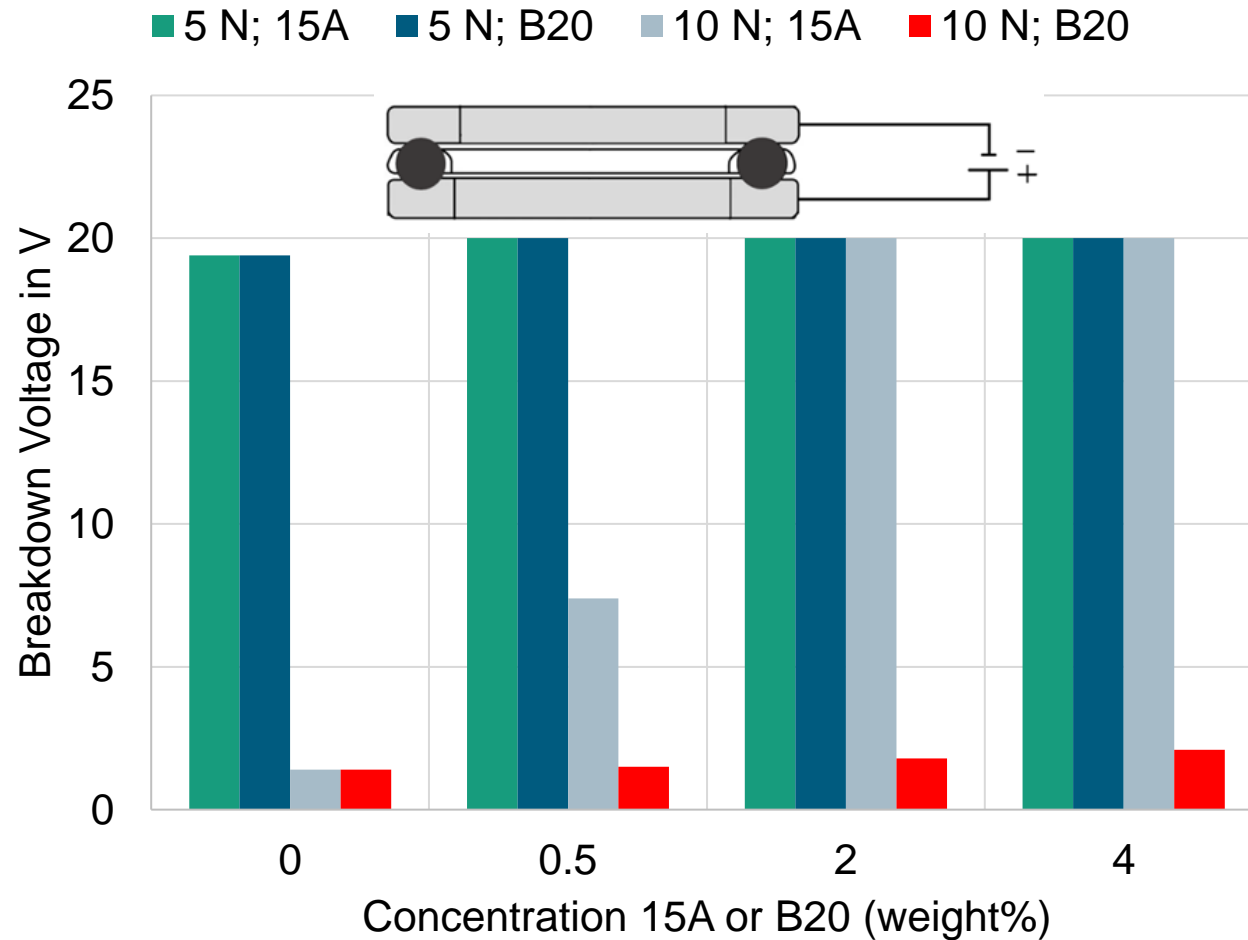


Electrotribological investigation of oils and greases in rolling bearings

- Electrically insulated test setup with slip ring
- Conductivity measurement during friction test
- Influence of electrochemical potentials on friction and wear
- Specification of electrical voltage patterns
- Measurement of breakdown voltage (BDV) of lubricants as a function of viscosity and e.g. of electrically conductive lubricants additivated with ionic liquids



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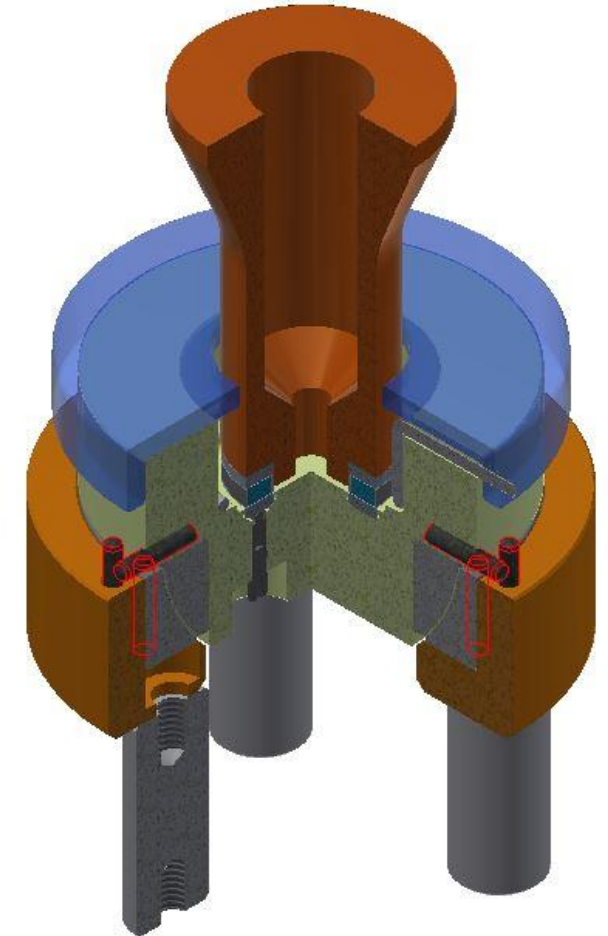
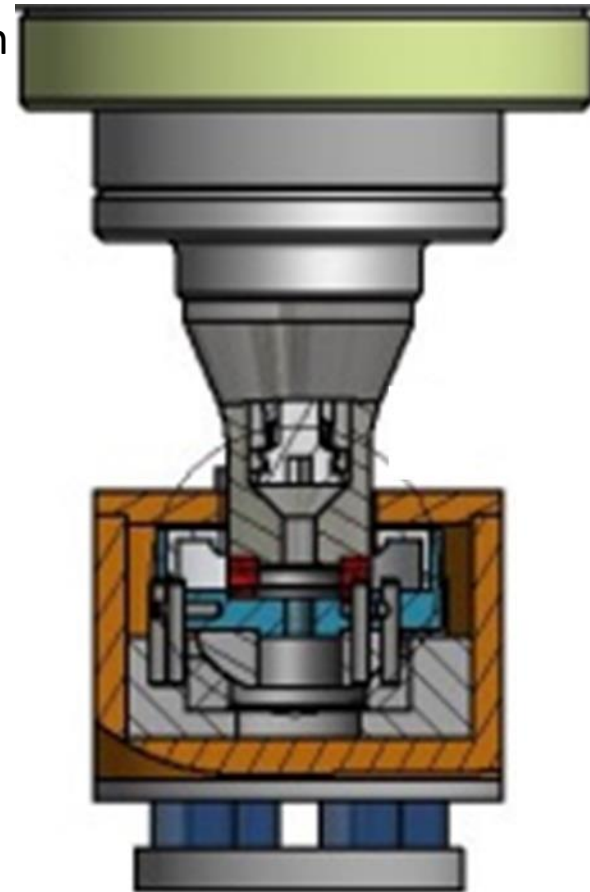
Fernández-Silva, S.D. et al. On the active control of friction in electrified ball bearing prototypes using electro-responsive sustainable lubricating fluids. accepted in Friction, 2024

Roller Bearings und electrical Influence



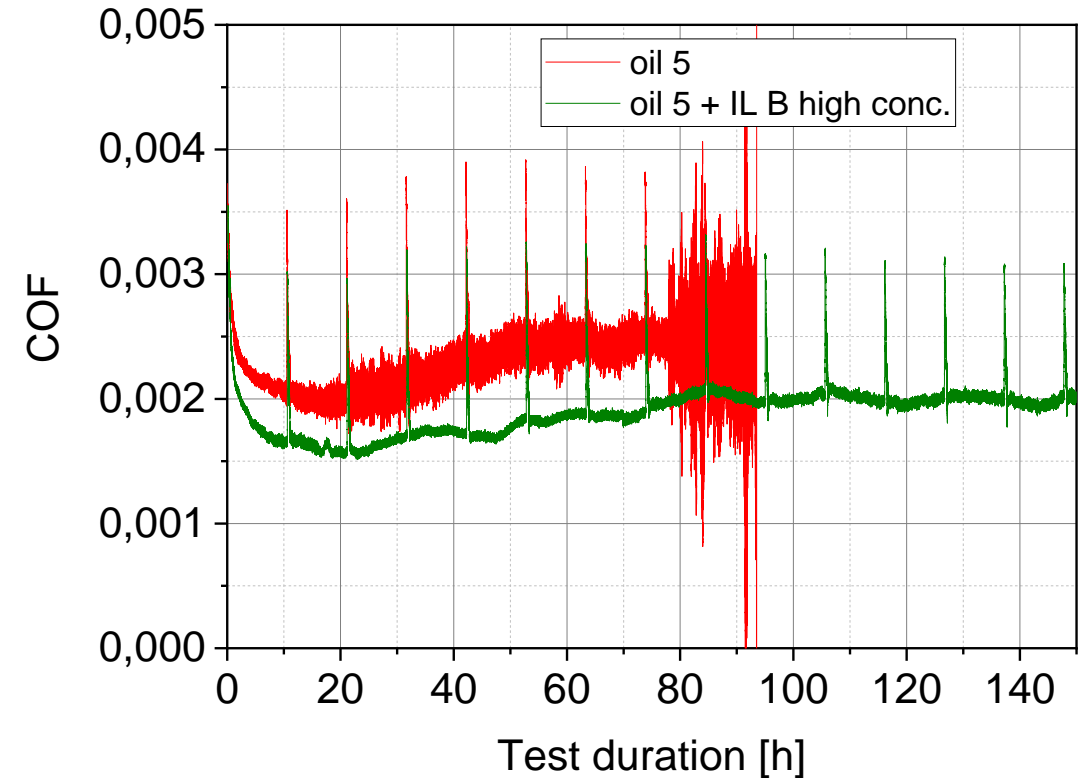
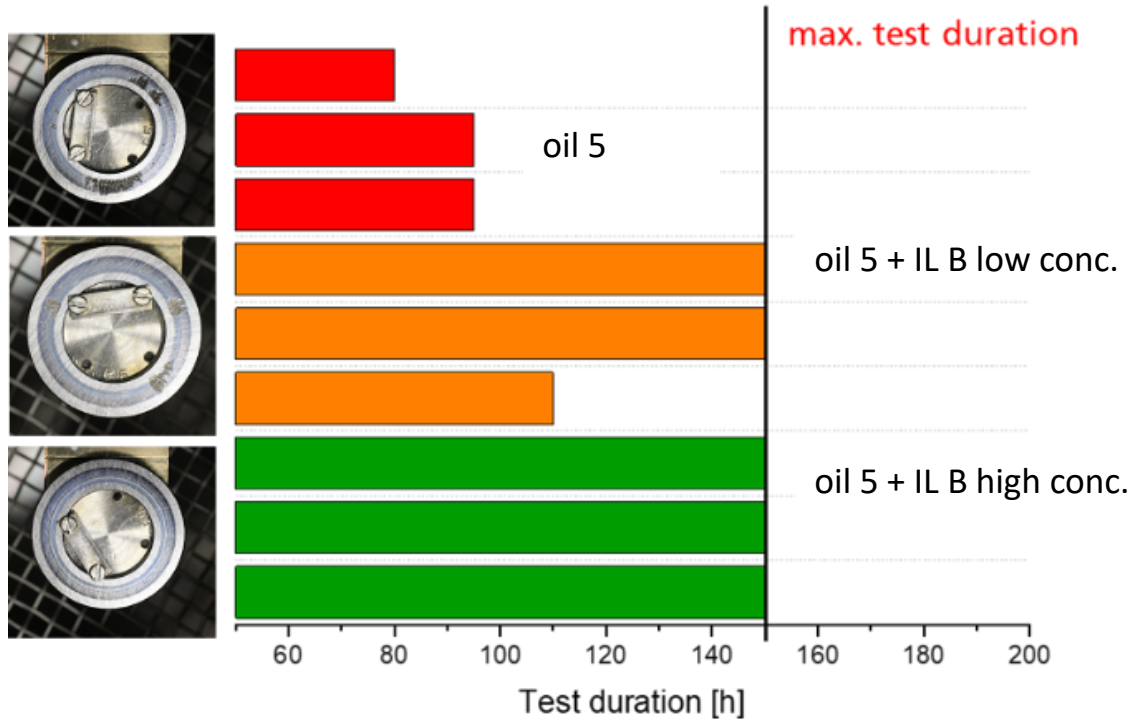
The aim is to investigate the influence of lubricants on bearing life

- Test rig is mounted in a two-axis universal testing machine
- Testing of thrust roller bearings (FAG 81104)
- Test Parameter:
 - Load: 8 kN
 - Speed: 700 rpm
 - Temperature: 90 °C
 - Duration: 150 h
 - el. potential: +/- 2 V
 - Data recording: friction torque, temperature, load, speed, displacement and time



Component testing

Application-oriented testing of roller bearings

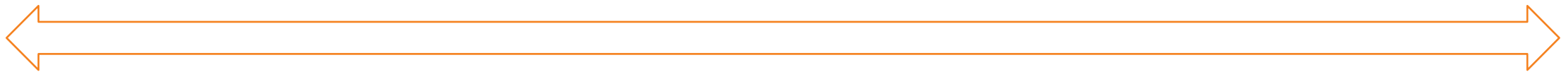


Comparison of COF and test duration of different lubricants.

The additivation of oil 5 with an ionic liquid improves the bearing life.

Electrochemical concepts in rolling bearings

Influence of the applied potential on damage mechanism



+2V



+1V



136644 500x 10 um

-1V



138197 500x 10 um

-2V



136663 500x 10 um

SupraSlide

Business Unit: Tribology

Development of sustainable and efficient tribological systems

■ Motivation

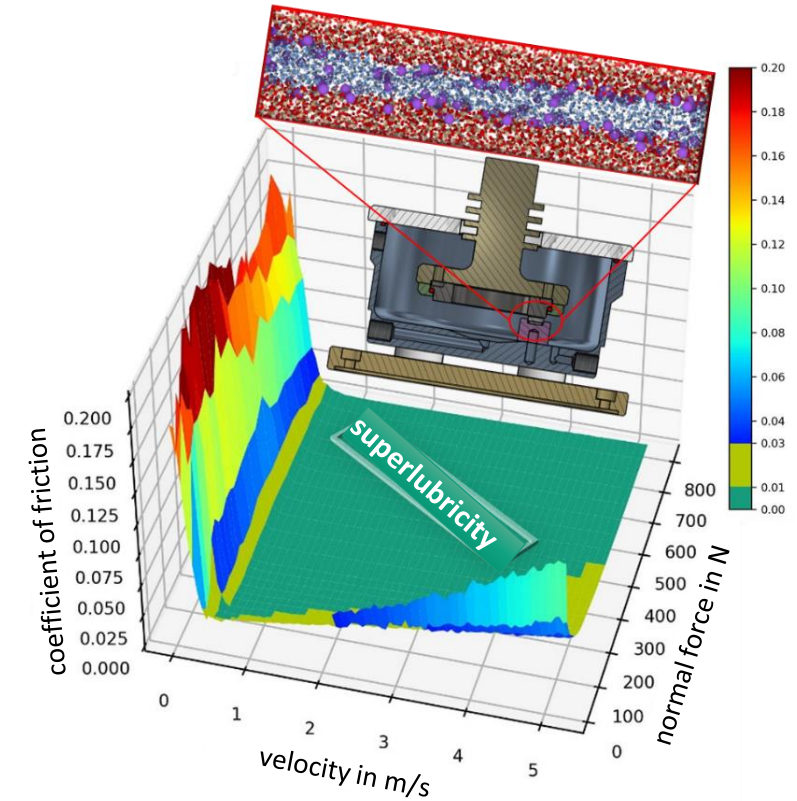
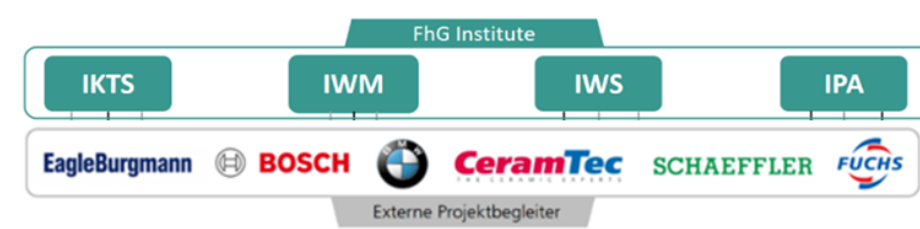
- Energy losses: approx. 23 % (119 EJ) result from friction and wear [1]
- Savings potential: € 970 billion and 3.2 Gt CO2 possible worldwide through tribological optimization [2]

■ Key aspects

- Development and production of high-performance ceramics (IKTS) and diamond-like carbon coatings (IWM, IWS)
- Tribological qualification (IWM)
- Simulation-based identification of tribological mechanisms (IWM)
- Demonstration (IPA, IWM): Linear guides, plain bearings and mechanical seals with minimized friction losses

[1] Holmberg and Erdemir, Tribol. Int. 135, 2019, 389-396

[2] Woydt, 2019

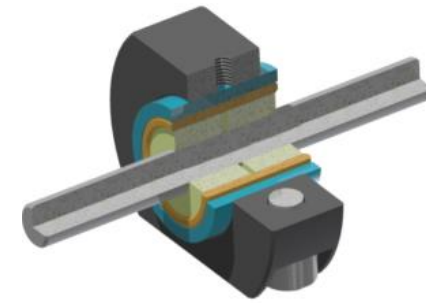
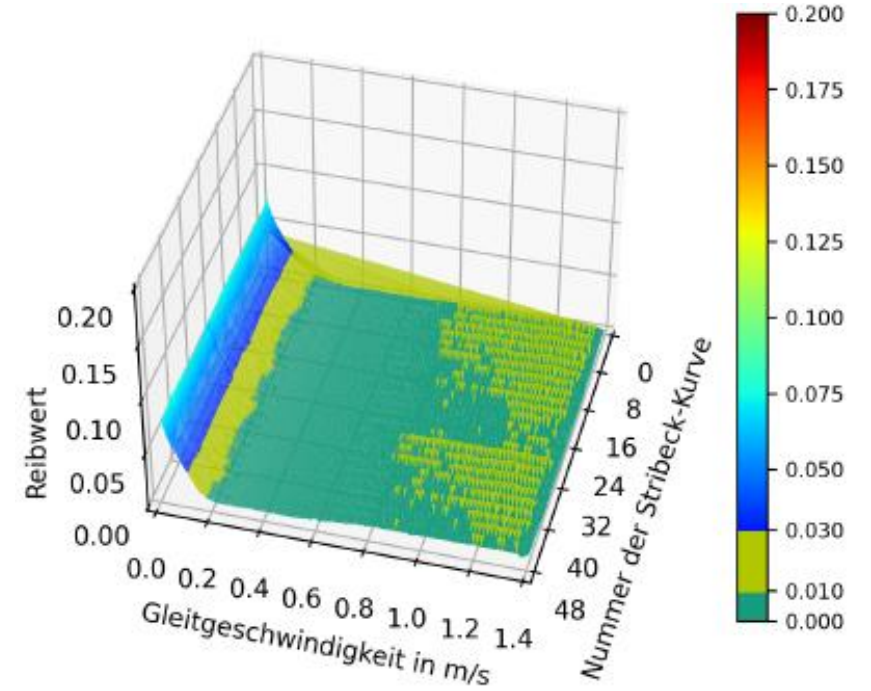
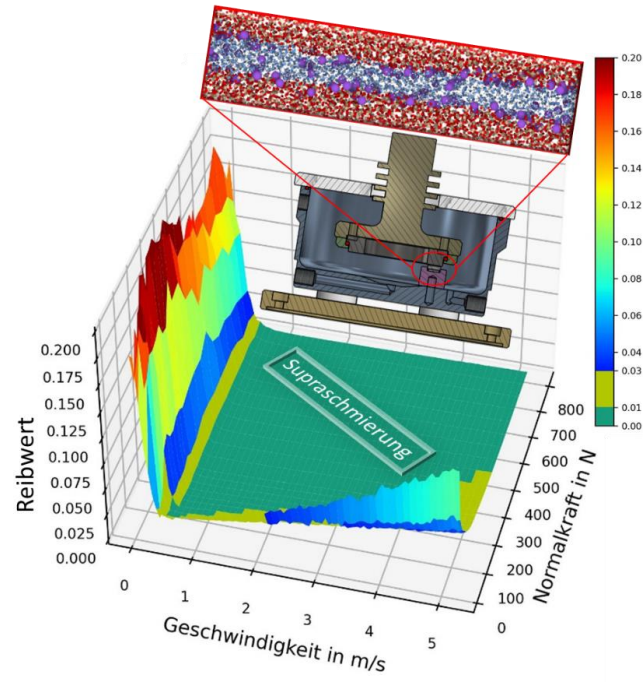
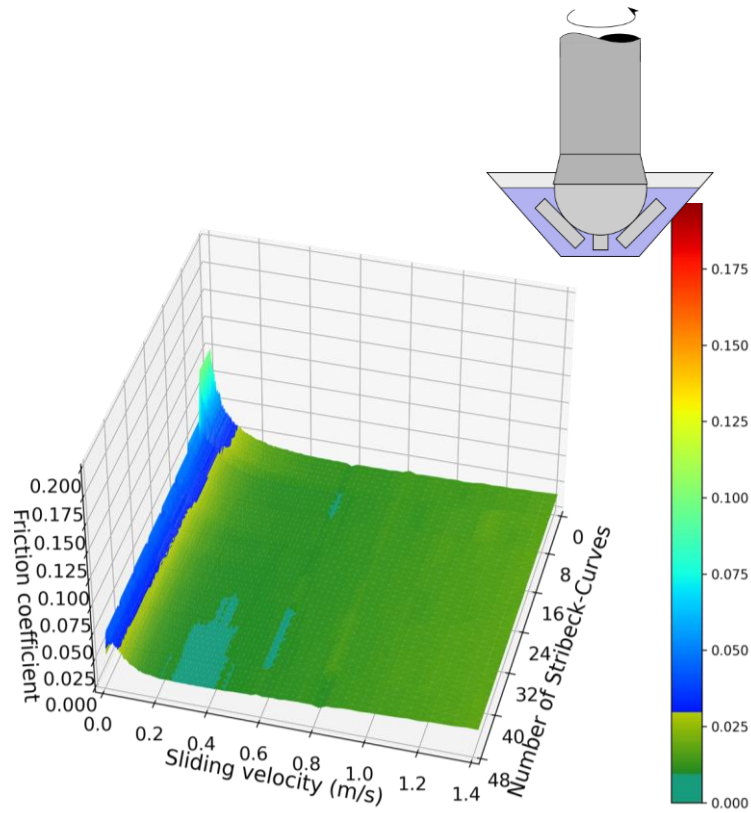


Superlubricity

- Realization of coefficients of friction < 0.01
- Identification of several tribological systems
- Transfer of model to application test

SupraSlide

Business unit: Tribology



Summary

1. Electrical Discharges affect the lifetime of bearings.
2. Electrical potentials have a chemical influence on lubricants and tribochemical Interactions, causing hydrogen-induced damage.
3. Approaches to reduce friction in sliding bearings with novel fluids – is there a possibility to reduce friction losses and increase the robustness of bearings in EV?

Thank You very much!