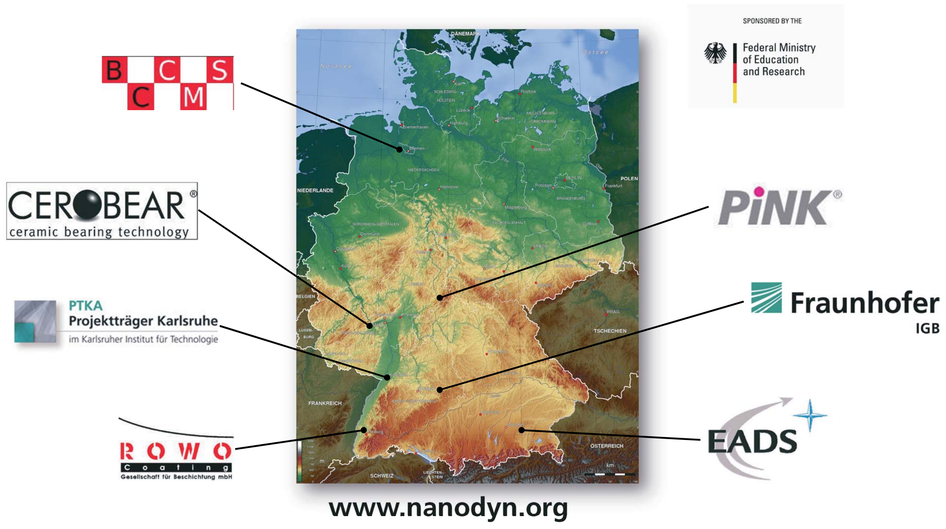

PLASMA FUNCTIONALIZATION OF CERAMIC SURFACES TO ENHANCE TRIBOLOGICAL PROPERTIES OF BALL AND ROLLER BEARINGS

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Motivation

One aspect receiving continuous attention is the performance of key components like rolling bearings in production machinery and equipment. For manufacturing companies, an insufficient reliability of key components means:

- frequent maintenance, leading to machine breakdown
- loss of profit

Hybrid bearings can be operated reliably under poor lubrication conditions. For filling lines, they are already state-of-the-art. To meet future requirements, the wear of these bearings has to be reduced. In this project, a plasma surface functionalization will be used to:

- reduce the bearing friction
- influence the tribology of the bearing in combination with different lubrication media

Tribology

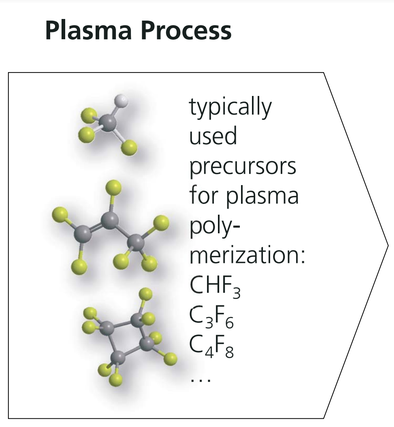
Figure 1, Figure 2: Ceramic / hybrid bearings for food and beverage industry (e.g. filling lines)

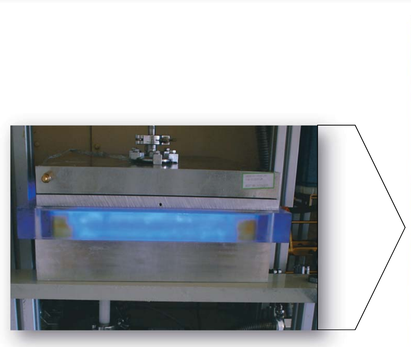
Results

Surface Functionalization

By the deposition of ultra thin fluorocarbon films, different chemical functionalities can be deposited on surfaces. The material properties of the bulk material remain: only the surfaces of the material are optimized by the nano-coating according to the application requirements. An ideal method, in order to accomplish such modifications, is the polymer deposition of thin layers on the material surfaces by plasma processes.
The tribological characteristics of a surface like the stiction and dynamic friction characteristics can be improved to a large extent due to functional films deposited from the plasma.

Plasma Process





plasma reactor for process development (batch process)

next step: plasma coater (Pink Thermosystems)

Characterization of plasma functionalized bearings

The influence of the plasma functionalization will be examined on test rigs designed to analyze the overall rolling resistance and friction of bearings by characterization of:

- friction under different speeds (range of 7 to 1200 rpm)
- friction depending on the interface lubricant-plasma functionalization
- the influence of different lubricants (PFPE-based, media lubrication) and plasma layers

Additionally, corrosion tests under media environment will be carried out on the bearing materials.

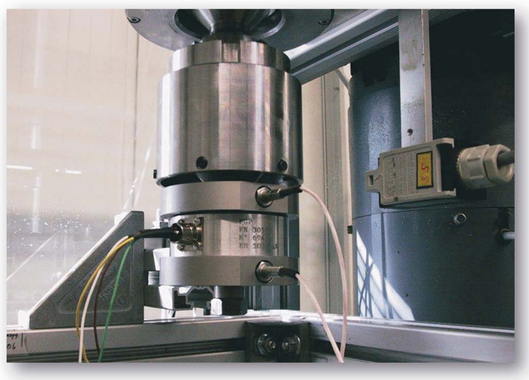


Figure 9: Test rig for friction measurement test bearing 6001/7001

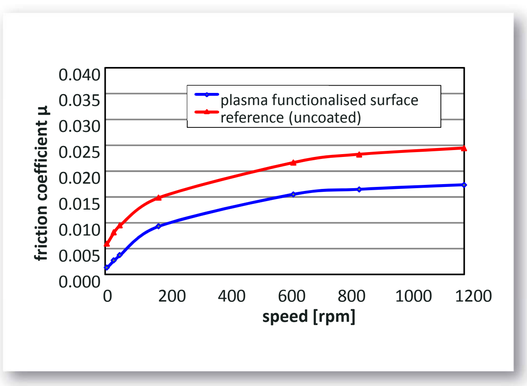


Figure 10: First result plasma functionalized bearings (lubrication: PFPE)

Simulation

Classical Molecular Dynamics (MD) simulations and later on Finite Element Method (FEM) simulations will be applied to analyze tribological processes. Only the most relevant part of friction, sliding friction, can be investigated via MD simulation. Since rolling resistance is negligible compared to hydrodynamic and sliding friction the main microscopic friction can be analysed. Direct comparison to tribological sliding experiments as well as the above mentioned test rig measurement results will yield necessary validation. Therefore, tribometer experiments with bearing-analogue materials are in preparation.

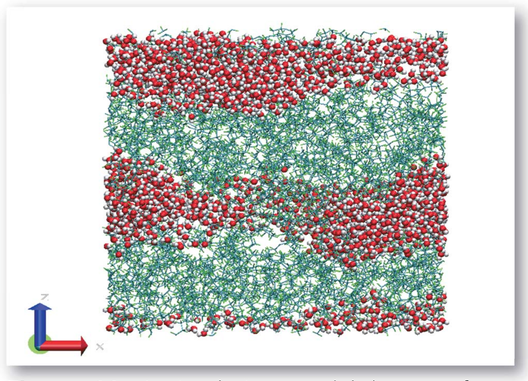


Figure 11: A simulation model (two surfaces and water)

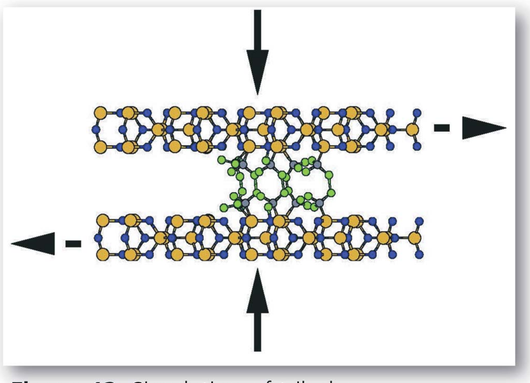


Figure 12: Simulation of tribology

Summary

First tests showed that the friction of rolling bearings can be influenced by means of plasma functionalization. The next step is the analysis of the interfacial interaction between surface and lubricant.

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