Fraunhofer KIT Karlsruher Institut für Technologie

MIKROTRIBOLOGIE CENTRUM µTC

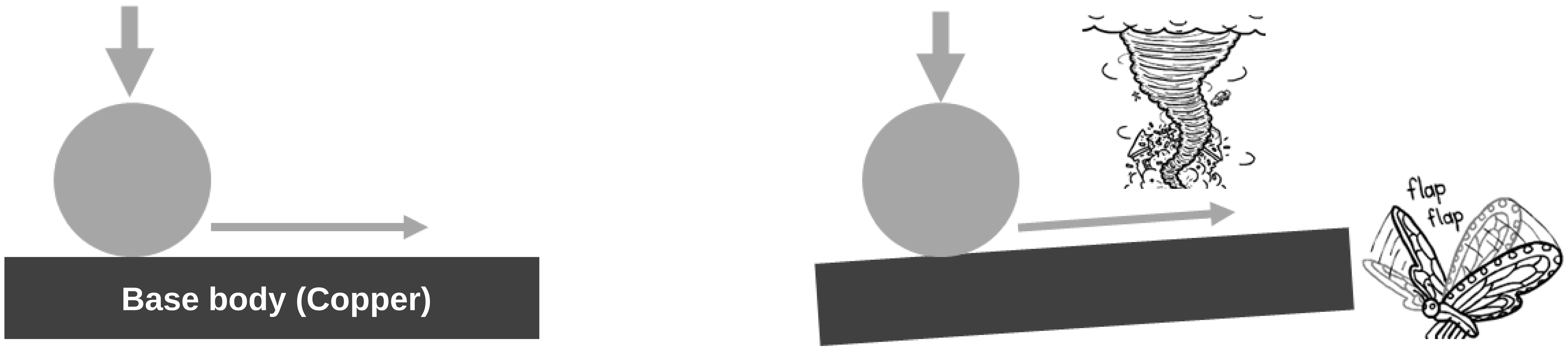
IAM Institut für Angewandte Materialien

BACHELOR’S THESIS / MASTER’S THESIS

Exploring the Butterfly Effect in Tribology

Background

In chaos theory, the "butterfly effect" posits that small initial differences, such as a butterfly's wing flapping in one location, could trigger a series of events that eventually culminate in the formation of a hurricane in a distant location[1]. Similarly, our study found that a 2 µm protrusion on a 132,000 µm sliding track can increase friction by 91%. Achieving a completely flat surface is nearly impossible, and a 2 µm deviation on such a track represents one of the flattest surfaces possible with bearing steel[2]. These findings could partly explain why tribology experiments are difficult to replicate[3] and also provide new insights. For example, even tiny misalignment during sample mounting can result in tilting, this may also affect tribological performance significantly. Understanding these effects is crucial for designing more reliable experiments and enhancing the stability of mechanical systems where friction is critical.



Idea condition **Real condition**

Work program

The goal of this thesis is to explore the impact of the base body (copper) misalignment on tribological behavior in a ball-on-flat contact. This includes designing and conducting experiments with different degrees of tilt and systematically studying how these tilts influence frictional behavior. Additionally, the thesis will utilize Focused Ion Beam Scanning Electron Microscopy (FIB-SEM) to observe whether these tilts cause variations in the copper subsurface microstructure under tribological contact.

Requirements

Students from the field of Mechanical engineering, especially material science, are encouraged to apply. The applicant will be supported by post-doctoral and doctoral researchers in Prof. Christian Greiner’s group in IAM-ZM. Experience with Python, Labview, and Matlab is an advantage, but not a requirement.

Contact

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References:

[1] Lorenz, E.N.: Deterministic Nonperiodic Flow. J. Atmos. Sci. (1963).
[2] Li, Y.: Waviness Affects Friction and Abrasive Wear. Tribol. Lett. (2023).
[3] Blau, P.J.: Lessons learned from the test-to-test variability of different types of wear data. Wear. (2017).