O 35: Poster Session - Tribology: Surfaces and Nanostructures

Time: Monday 18:15–20:00 Location: P1C

O 35.1 Mon 18:15 P1C

Temperature dependent friction measurements of manganite films — •Niklas Weber, Hendrik Schmidt, Richard Vink, and Cynthia A. Volkert — Institute of Materials Physics, University of Göttingen, Germany

In this project, we use lateral force microscopy to investigate how friction of manganite films can be controlled by the properties of the surrounding materials. Recently we reported [1,2] a four-fold increase in the friction coefficient of $La_{0.7}Sr_{0.3}MnO_3$ as it is heated through the metal-insulator transition (MIT) and a two-fold increase upon resistively switching a $La_{0.55}Ca_{0.45}MnO_3$-film. Possible contributions from electrostatic forces and electronic and phononic dissipation were considered, with the conclusion that only dissipation via phononic channels were of the necessary order of magnitude.

To investigate the role of depleted surface layers and test the idea of phononic dissipation channels, temperature-dependent friction measurements near the MIT of a $(La_{0.6}Pr_{0.4})_{0.67}Ca_{0.33}MnO_3$ film were performed. However, the friction shows no evidence of the MIT and instead decreases continuously with temperature in accordance with the well known thermal lubricity effect [3]. Measurements of the effect of applied voltage on adhesion and friction indicate an insulating surface layer on the metallic phase, which may obscure possible changes in the friction of the film at the phase transformation.

[1] H. Schmidt et al., arXiv:1611.02684; [2] H. Schmidt, Ph.D. thesis, University Göttingen, (2018); [3] Barel et al., Tribology Letters, 39(3), 311-319, (2010).

O 35.2 Mon 18:15 P1C

Theoretical study of rotational transmission and friction of solid-state gears — Huang-Hsiang Lin[1,2], •Jonathan Heinze[1], Alexander Croy[1], Rafael Gutiérrez[1], and Gianaurelio Cuniberti[1,3] — [1]Institute for Materials Science and Max Bergmann Center of Biomaterials, TU Dresden, 01069 Dresden, Germany — [2]Max Planck Institute for the Physics of Complex Systems, 01187 Dresden, Germany — [3]Dresden Center for Computational Materials Science, TU Dresden, 01062 Dresden, Germany

Downsizing gears to the nanoscale has become an emergent technology for implementing microscopic mechanical system. Here, we theoretically investigate how rotational motion can be transmitted across many gears by using molecular dynamics simulations. In particular, the influence of the elastic properties and the shape of the gears is elucidated. Furthermore, we study the effect of friction coming from the substrate and we find that the dissipation is dependent on the gear size and also its initial angular velocity.

O 35.3 Mon 18:15 P1C

Temperature dependence of friction anisotropy on crystalline materials — •Jennifer Konrad, Dirk Dietzel, and Andre Schirmeisen — Institute of Applied Physics, Justus-Liebig University Giessen, 35392 Giessen, Germany

On the nanoscale, the dependence of the friction force on the sliding direction is a well-known phenomenon. This anisotropy occurs as a consequence of the surface structure and is related to different energy barrier heights along different directions of the sample surface. If the sample temperature is varied, the friction force as deduced from the thermally activated Prandtl Tomlinson Model is expected to change, which has a direct influence on the stability of the different sliding directions. In this work, the directional friction force is analyzed under UHV conditions as a function of temperature on different crystalline materials. Our results show that not only the absolute friction and the anisotropy are influenced by temperature, but also the wear depends on temperature on ionic crystals.

O 35.4 Mon 18:15 P1C

Non-linear friction and load-induced hybridization on epitaxial graphene/SiC — •Bartosz Szczefanowicz[1], Andreas Klemenz[2], Michael Moseler[2], and Roland Bennewitz[1] — [1]INM - Leibniz Insitute for New Materials, Saarbrücken, Germany — [2]IWM - Fraunhofer Institute for Mechanics of Materials, Freiburg, Germany

Graphene as 2D material is tough in plane but exhibits weak interactions normal to the plane. These features result in excellent tribological properties such as ultralow friction, which was demonstrated by Atomic Force Microscopy (AFM) measurements on many different substrates. For epitaxial graphene grown on SiC(0001) [1], friction forces increase dramatically above a threshold in normal pressure [2]. We present experimental results recorded by AFM in ultrahigh vacuum for the velocity dependence of friction in the low and high pressure regime. Molecular dynamics simulations identify the pressure-induced local and intermittent hybridization of graphene with the underlying SiC(0001) substrate as origin of the friction increase. A similar rehybridization from sp2 to sp3 and creation of covalent bonds under the pressure of an AFM tip has been suggested to explain extraordinary stiffness results [3]. We discuss models to bridge the time gap between molecular dynamics simulations and AFM experiments, which lead to quantitative agreement.

[1] K.V. Emtsev et al., Nature Materials 8 (2009), 203 [2] T. Filleter and R. Bennewitz, Physical Review B, 81 (2010), 155412. [3] Y. Gao et al, Nature Nanotechnology, 13 (2018), 133.

O 35.5 Mon 18:15 P1C

Atomic Scale Mechanisms in Nanoindentation and Scratching of MoS_2 — Azad Kirsan, •Mattis Gossler, Florian Wullschläger, and Bernd Meyer — Interdisciplinary Center for Molecular Materials and Computer-Chemistry-Center, FAU Erlangen-Nürnberg

Molybdinum disulfide (MoS_2) as a 2D layered material is a very efficient solid lubricant which can be also applied under extreme conditions, for example, in vacuum. To obtain first insights into deformation and degradation mechanisms at high loads, we performed atomistic simulations of nanoindentation and scratching of MoS_2 thin films. For the plastically deformed and ruptured MoS_2 layers we analyze the changes in the chemical bonding pattern of the Mo and S atoms. The results are compared to amorphous structures obtained by *ab initio* molecular dynamics simulations in order to evaluate the reliability of our applied atomistic potential.