O 17: Nanotribulogy

Time: Monday 16:00–17:15 Location: A 053

O 17.1 Mon 16:00 A 053

Imaging and energy dissipation mechanisms on metallic and insulating surfaces studied with AFM in pendulum geometry — •Markus Langer, Marcin Kisiel, Urs Gysin, and Ernst Meyer — Department of Physics, University of Basel, Klingelbergstrasse 82, CH-4056, Switzerland

In pendulum geometry the Cantilever is oscillating perpendicular to the sample surface. This opens the possibility to use ultra sensitive cantilever with spring constants of mN/m with a force sensitivity of $10\mathrm{aN}/\sqrt{\mathrm{Hz}}$. For surface characterisation of mixed materials its useful to image the surface topography first. Calculations show that in pendulum geometry the contrast mechanism is influenced by two types of forces - the axial force and the lateral force gradient. This is confirmed experimentally. To study the electronic contribution in detail, it is necessary to compensate the electrostatic force present due to contact potential difference between the cantilever tip and the sample surface. We used frequency modulated - Kelvin Probe Force Microscopy (fm-KPFM) to compensate the contact potential.
We can distinguish between metallic and insulating surfaces an determine the electronic contribution to the energy dissipation. This effect is enhanced, if we gently functionalize the probe, by covering the tip apex with an insulator or metal.
The measurements are performed on Cu(100) substrate with $0.6ML$ coverage of NaCl. All experiments are done under UHV and cryogenic conditions (77K).

O 17.2 Mon 16:15 A 053

Spin friction observed on the atomic scale — •Boris Wolter[1], Yasuo Yoshida[1], Kirsten von Bergmann[1], André Kubetzka[1], Saw-Wai Hla[2], and Roland Wiesendanger[1] — [1]Institut für Angewandte Physik, Universität Hamburg — [2]Nanoscale and Quantum Phenomena Institute, Ohio University, Athens, Ohio

We present a combined experimental and theoretical study of frictional phenomena occurring when a single magnetic atom is moved over a magnetic surface with the help of a spin-polarized scanning tunnelling microscope tip [1]. By monitoring the spin-resolved atom manipulation traces and comparing them with the results of Monte-Carlo simulations, we are able to reveal the characteristic friction force variations resulting from the occurrence of 'spin friction'.

[1] D. Serrate et al., Nature Nanotechnology 5, 350-353 (2010)

O 17.3 Mon 16:30 A 053

Evolution of nanocrystalline iron surfaces with grain level roughness under sliding contact loads — •Pedro A. Romero, Tommi T. Järvi, and Michael Moseler — Fraunhofer-Institut für Werkstoffmechanik IWM, Wöhlerstraße 11, 79108 Freiburg, Deutschland

Iron systems like steel alloys are one of the main industrial materials in our technological society. Various iron based technologies could benefit from a more fundamental understanding of the nanoscale mechanisms dictating friction and wear in order to improve product performance, efficiency and lifetime. Here, we communicate results from large scale atomistic simulations of nanocrystalline iron systems encompassing hundreds of nanograins and millions of atoms. The constructed model captures the sliding induced plasticity and heating responsible for friction at the contacting interfaces. Controlled pressure simulations will bring forth distinct mechanisms dictating friction and wear in nanocrystalline iron surfaces such as the nucleation and arrest of dislocations at grain boundaries, grain growth, rotation and elongation, as well as grain boundary annealing and motion. The simulations will demonstrate that pure iron nanocrystalline systems prefer to coarsen interface grains while iron-carbon systems prefer to develop an amorphous boundary layer in order to mediate the sliding induced plastic deformation.

O 17.4 Mon 16:45 A 053

Direction dependence of friction for commensurate and moderately incommensurate surfaces — •Michael Wolloch[1,2], Peter Mohn[1], Josef Redinger[1], and András Vernes[1,2] — [1]CMS, Institute of Applied Physics, Vienna University of Technology, Gußhausstraße 25-25a, 1040 Vienna, Austria — [2]Austrian Center of Competence for Tribology, Viktor-Kaplan-Strasse 2, 2700 Wiener Neustadt, Austria

We present results from our calculations of quasi-static sliding of two atomically flat surfaces in dry, wearless contact using the Density Functional Theory package *VASP*. The main focus of our work was to determine to which extent commensurability of the surfaces and the sliding direction effects the friction force. The examined systems include commensurable fcc (111) Aluminium slabs and moderately incommensurate surfaces like bcc (110) Titanium on hcp (001) Titanium. A model consistent with stick-slip friction was devised to calculate the friction forces along sliding paths of up to 1μm on a quantum mechanical basis. To map all forces and energies for rigid and relaxed atomic positions the top slab was scanned over the bottom one on a properly fine grid, which covers the entire unit cell. In this manner, it is shown that the mean friction force depends on the sliding direction and that due to relaxations incommensurate paths may result, counter-intuitively, in higher friction then commensurate ones.

O 17.5 Mon 17:00 A 053

Suppression of electronic friction on Nb-films below the critical temperature — •Marcin Kisiel[1], Enrico Gnecco[2], Urs Gysin[1], Laurent Marot[1], Simon Rast[1], and Ernst Meyer[1] — [1]University of Basel, Klingelbergstr.82 4056 Basel, Switzerland — [2]IMDEA Nanoscience, Campus Universitario de Cantoblanco, Facultad de Ciencias Módulo C-IX, 28049 Madrid, Spain

The origins of non-contact friction are investigated by highly sensitive force microscopy in the pendulum geometry. In this mode probe is suspended perpendicularly to the sample and the tip's vibrational motion is parallel to the surface. In the pendulum geometry very soft (k~mN/m) and therefore sensitive cantilevers can be used avoiding snapping into the contact due to high longitudinal stiffness. The friction forces acting on a sharp probe tip oscillating below 3nm distances from 140nm thick Nb surface have been measured. Measurements reveal a reduction of dissipation in the superconducting state compared to the normal state by a factor 3. Therefore, electronic friction is found to be the dominant dissipation mechanism with power losses of 80ueV/cycle at separations of 0-3nm. Measurement across the critical temperature of Nb film shows that the character of transition is smooth reflecting the increasing normal electron population which are giving rise to the electronic induced friction. A good agreement with the BCS theory has been found in the drop of friction coefficient, as predicted by the theory[1].

1. B. N. J. Persson, Solid State Communications 115, 145 (2000)