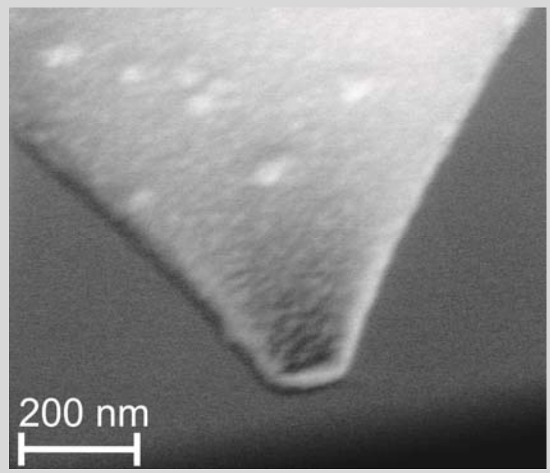
Joint press relase

Saarland University & Leibniz-Institute for New Materials (INM)

19.07.2013

Controlling friction by tuning van der Waals forces

For a car to accelerate there has to be friction between the tire and the surface of the road. The amount of friction generated depends on numerous factors, including the minute intermolecular forces acting between the two surfaces in contact – so-called van der Waals forces. The importance of these intermolecular interactions in generating friction has long been known, but has now been demonstrated experimentally for the first time by a research team led by Physics Professor Karin Jacobs from Saarland University and Professor Roland Bennewitz from the Leibniz Institute for New Materials (INM). Interestingly, the research team has shown that the friction acting at a material surface is influenced by the structure of the sub-surface layers.



Blunted tip of a scanning probe microscope.

Friction is an everyday phenomenon that is sometimes desirable (enabling cars to accelerate) and sometimes not (friction in the form of vehicle drag and friction in the engine and transmission system increase the car's energy consumption). For many scientists and engineers, the ability to control friction is therefore right at the top of their wish list. A possible approach to controlling friction has just been published by researchers at Saarland University and INM. They have discovered that frictional force is affected by the composition of the materials beneath the surface.

The work carried out by the Saarbrücken scientists involved taking a closer look at the intermolecular forces acting between two materials. In order to be able to vary these forces, the researchers worked with polished, single-crystal silicon wafers. 'The wafers are covered with silicon dioxide layers of different thicknesses and are similar to those used in the semiconductor industry,' explained Karin Jacobs, Professor of Experimental Physics at Saarland University.

Jacobs' team precisely measured the friction between silicon dioxide (SiO_2) layers of different thicknesses and the 200-nm tip of an atomic force microscopy probe by carefully scanning the tip across the wafer surface. What the physicists discovered was surprising: although the uppermost layer of the surface always consisted purely of SiO_2, the tip of the atomic force microscope experienced different frictional forces depending on the thickness of the silicon dioxide layer. 'The thinner the oxide layer, the greater the friction,' said Jacobs. The study found that the frictional forces associated with the wafers differed by as much as 30 per cent depending on the thickness of the SiO_2 layer. The effect was also observed when the silicon wafers were covered with a water-repellent monolayer of silane molecules (long-chain hydrocarbons).

'The results of our study have significant implications for many practical applications,' said Professor Jacobs. 'As the strength of the van der Waals forces depends on the composition of a material to depths of up to 100 nanometres, carefully designing the layer structure at the surface of a material can reduce friction. This gives us another approach to controlling friction in addition to the established use of lubricants.'

M. Lessel, P. Loskill, F. Hausen, N.N. Gosvami, R. Bennewitz, and K. Jacobs, „Impact of van der Waals interactions on single asperity friction“.

URL: http://link.aps.org/doi/10.1103/PhysRevLett.111.035502
DOI: 10.1103/PhysRevLett.111.035502

Contact:

Prof. Dr. Karin Jacobs
Universität des Saarlandes
Experimentalphysik
Campus E2 9
D-66041 Saarbrücken
GERMANY

Tel. +49 681 302-71788
k.jacobs@physik.uni-saarland.de

Prof. Dr. Roland Bennewitz
INM - Leibniz-Institut für Neue Materialien

D-66123 Saarbrücken
GERMANY

Tel. +49 681 9300-213
roland.bennewitz@inm-gmbh.de

Homepage www.uni-saarland.de/jacobs
http://jacobs.physik.uni-saarland.de/publikation/publikation.htm