Scanning Probe Microscopy across Dimensions

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Scanning Probe Microscopy is a high-resolution type of microscopy that allows for investigation of sample surfaces varying more than seven orders of magnitude in size, in measuring conditions as versatile as ultra-high vacuum, air or aggressive gases, as well as fluids such as water or oil. Furthermore, certain types of Scanning Probe Spectroscopy allow for acquisition of mechanical properties on the nanoscale and their spacial correlation to topographical as well as chemical information.

Major results of investigations of three different model systems are presented:

- The formation of nanohillocks on atomically flat insulating CaF_2(111) surfaces can be exclusively induced by the potential energy of highly charged ions and shows a potential energy threshold. For projectiles with different kinetic energies, a shift in the threshold charge state for hillock formation is measured. The surprisingly sharp and well-defined threshold can be linked to a solid-liquid phase transition. [e.g. PRL 100 (2008) 237601, NIM B 258 (2007) 167, Rad. Eff. Def. Solids 162 (2007) 467]
- Interactions between individual protein molecules are observed with a Prototype Small Cantilever Atomic Force Microscopy in real time on the single molecule level. In particular, the distribution of the lifetimes of complexes formed by individual molecules of the chaperonin protein GroES binding to and then dissociating from individual GroEL proteins, which were immobilized on a mica support, peaks near five seconds. [Nature Struct. Biol. 7 (2000) 644]
- Live diatoms are imaged in ambient conditions, providing novel structural details of their surface. The thickness of the organic layer covering the siliceous skeleton was determined to be 10 nanometers and the diatom adhesion molecules were characterised, inspiring man-made adhesives that are tailored to tough and strong high performance applications in textiles, ropes, construction materials, aeronautics, and biomedical applications such as implant materials and prosthetics. [e.g. J. Eng. Tribol. 220(J8) (2006) 787, J. Microsc. 212 (2003) 292, Mat. Sci. Technol. 18 (2002) 763]

These results illustrate the high potential of Scanning Probe Instrumentation and Methods in Experimental Physics.

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