MM 17: Topical session: In-situ Microscopy with Electrons, X-Rays and Scanning Probes in Materials Science I

Time: Tuesday 10:15–11:45 Location: H38

MM 17.1 Tue 10:15 H38

Advanced AFM based electrical and mechanical characterization of nanostructured materials under controlled environment — •Christian Teichert, Markus Kratzer, Igor Beinik, Christian Ganser, and Franz J Schmied — Institute of Physics, Montanuniversität Leoben, Austria

Besides morphological characterization, atomic-force microscopy (AFM) based techniques can successfully be employed to study physical properties on the nanometer scale under controlled environmental conditions. Here, we will in particular focus on the measurement of electrical and optoelectronic properties of semiconductor nanostructures under simultaneous irradiation by light via photoconductive AFM and photo-assisted Kelvin Probe Force Microscopy [1-2]. With respect to mechanical characterization, AFM based nanoindentation experiments on cellulosic films and fibers under controlled humidity will be presented [3-4]. Finally, procedures are introduced where the AFM is just used to apply and measure specific forces among nanostructures [5].

[1] M. Kratzer, et al., Phys. Rev. B 86 (2012) 245320. [2] I. Beinik, et al., Beilstein J. Nanotechnol. 4 (2013) 208. [3] C. Ganser, et al., Holzforschung 68 (2014) 53. [4] C. Ganser, et al., Bioinspired, Biomimetic and Nanobiomaterials 3 (2014) 131. [5] F.J. Schmied, et al., Sci. Rep. 3 (2013) 2432.

Topical Talk MM 17.2 Tue 10:45 H38

Forces at the nanoscale: Sliding nanoparticles and pushing molecules — •Andre Schirmeisen — Justus-Liebig University Giessen, Giessen, Germany

The atomic force microscope (AFM) is an indispensable tool for surface characterization in material science down to atomic scales. While most force microscopy applications are related to surface structure characterization, recent progress has been reported in the field of AFM-based surface object manipulation. Minute forces can not only be detected by the cantilever-based sensors, but exerted in a controlled way. An example is the simultaneous manipulation and detection of lateral forces during nanoparticle sliding, relevant for our understanding of microscopic friction mechanisms. In particular the contact area dependence of friction for atomically defined interfaces was found to obey a sub-linear scaling [1], contradicting the widely accepted linear Amontons law. In the extremely sensitive non-contact AFM mode, the tip-induced motion of individual atoms and molecules is possible. In the case of the perylene derivative PTCDA on Ag, the force needed to push the molecule by one atomic lattice site was measured [2], which is directly linked surface diffusion energy barriers. This progress opens the path to study material properties at nanoscale by controlled AFM manipulation techniques.

[1] D. Dietzel et al., Physical Review Letters 111 (2013) 235502.

[2] G. Langewisch et al., Physical Review Letters 110 (2013) 036101.

MM 17.3 Tue 11:15 H38

Controlled scanning probe manipulation and lithography: What can be learned about mesoscale friction and abrasive wear? — •Enrico Gnecco[1,2], Patricia Pedraz[2], and Reinhold Wannemacher[2] — [1]Otto Schott Institute of Materials Research, Friedrich Schiller University Jena, Germany — [2]IMDEA Nanociencia, Madrid, Spain

Atomic force microscopy is an invaluable technique to investigate friction mechanisms on the nano- and mesoscale. We will first focus on nanomanipulation experiments and discuss how the trajectories of nanoparticles on solid substrates are related to the scan path followed by the AFM probe and the friction between particles and substrate. Irregularly shaped Sb islands and wavy glass surfaces are chosen as examples. The discussion will be extended to the formation of wear patterns on compliant surfaces also in relation to the AFM scan path. Solvent enriched polymers at room temperature are an optimum benchmark for this kind of experiments. In this case the dependence of wear patterns on the normal force and scanning velocity is easily explained by an extension of the well-established Prandtl-Tomlinson model for atomic-scale friction. In particular we observe a phase transition between wearless sliding and rippling of the substrate surface, which is reminescent of the stick-slip/continuous sliding transition on the atomic scale. The wearless regime can also be entered by mechanical excitation of the contact resonance during the sliding.

15 min. coffee break