SCANNING PROBE MICROSCOPY BASED NANOLITHOGRAPHY & NANOMANIPULATION

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In recent years, the standard capabilities of Scanning Probe Microscopy (SPM) have been augmented with a wide range of new instrumentation, applications, and scanning modes. In this talk, we will present a few of these modes with a focus on nano-manipulation & nano-lithography. The instrumentation and probes as well as the applications are discussed in detail.

a) NanoManipulation

One of the strong features of SPMs is that they can be used not only for imaging, but also as a local spectroscopy and as a (bottom up) fabrication tool. A closed loop (or linearized) feedback system, integrated into the XY axes of the SPM scanner, is the key factor to get a precise and stable platform for the nanofabrication. Indeed, the closed-loop system allows one to position and move the SPM's probe in non-standard patterns with nanometer precision, eliminating typical piezo scanner artefacts like hysteresis, creep and non-linearity. When doing this type of work, it is crucial to have a swift change from imaging mode to fabrication mode and a complete control of force interaction and tip/sample voltage during the nanofabrication. In the presentation, examples will be shown on how the SPM can be applied for nanofabrication using various nanomanipulation modes, all at ambient conditions. One example of mechanical manipulation is shown in Figure 1. The images are collecte din standard tappingmode, while the polymer macromolecules are moved by 'pushing' in contact at a predefined force. Choice of experimental parameters and conditions (scan speed, forces,…) will be discussed.

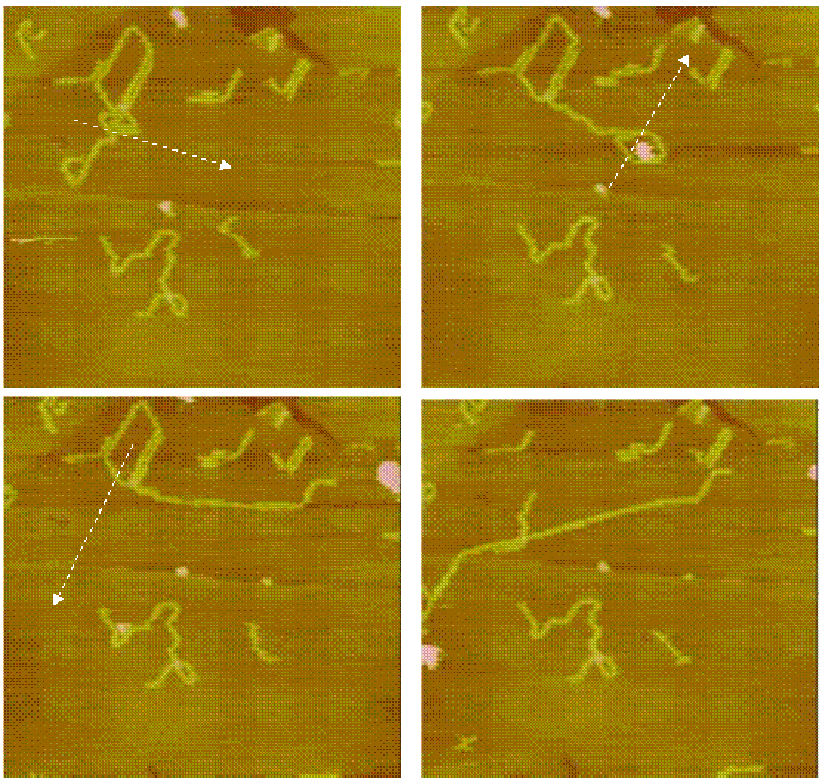

Figure 1: Nanomanipulation of jacketed polystyrene macromolecules on HOPG. The arrows indicate the manipulation 'moves'. Imaged in tappingmode, manipulated in contact mode. 500x500nm scans. Cooperation

with M. Moeller and B. Tartsch (Uni. Ulm, Germany).

b) NanoLithography

A second family of SPM-base nanofabrication methods is centered around nanolithography. In SPM-based nanolithography, a voltage, force or other physical interaction is used to locally modify and pattern surfaces. Examples will be shown on nanolithography using anodic oxidation whereby a voltage between tip and sample can cause a local oxidation with well controlled width and height of the features. Other modes that will be covered are: nanolithography based on force pulses and dip-pen technologies. Figure 2 shows an example of anodic oxidation of a silicon sample.

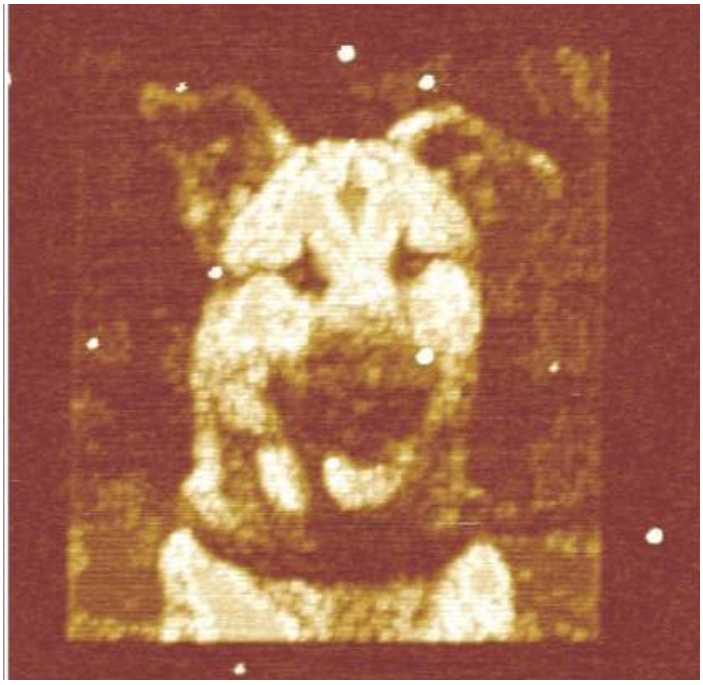

Figure 5: Nano-dog: Anodic oxidation of a Si sample. Image size is 3.7 um. Anodic oxidation was performed by applying a pulsed bias to the tip while scanning in tapping mode. The bias pulses correspond to the intensity of an imported bitmap file.