Lithography by Local Oxidation of Titanium

Nanosurf® Application Note

Atomic force microscopy (AFM) has had a great impact on the development of the nanotechnology because of its demonstrated ability to fabricate nanostructures. Local oxidation of metallic surfaces by atomic force microscopy has shown to be a lithographic method for the fabrication of devices and patterning of structures at nanometer scale.

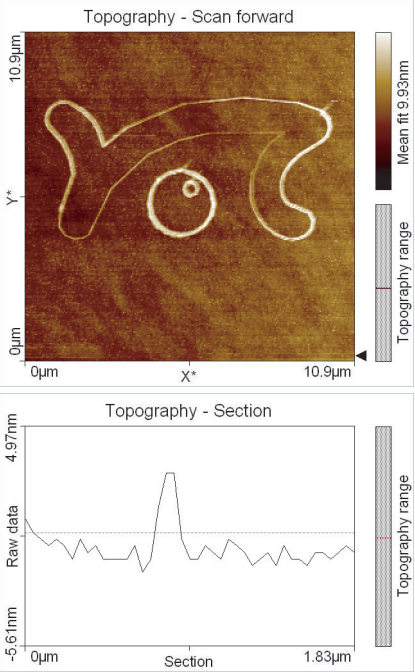

Figure 1: Lithography in static mode

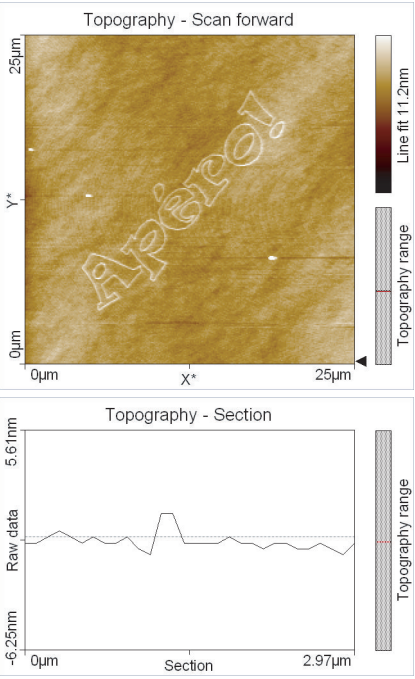

Figure 2: Lithography in dynamic mode

An example is the AFM-induced oxidation on titanium thin films which produces titanium oxide structures. Titanium oxide has excellent dielectric properties for microelectronics or high-density-storage applications. Moreover, titanium oxide films can be used for many other applications, such as wear-resistant coatings and as a low-adhesive surface material, to reduce the formation of bacteria on biomaterials.

In this technique, the oxide structures grew on surfaces by the application of a bias voltage between the surface and the AFM probe tip. The AFM probe is used as the cathode and the adsorbed water created from a regulated ambient humidity is used as electrolyte. The ions in the water play an important role to the formation of the surface. In addition to the short cut current, a current carried by the ions in the liquid flows from the tip through the water to the titanium surface. This current induces a electrochemical reaction on the surface which transforms the titanium to titanium oxide by binding the OH^- and O_2^- ions from the water film. The titanium oxide patterns are created by scanning the AFM tip over the samples surface.

The presented images were realised with an easyScan 2 large scan AFM.
Figure 1 shows an oxidised pattern written in static mode. The height of the lines is between 1nm and 5nm. The lines are about 100nm large. The different line dimensions are due to the different speed of writing. Figure 2 shows an oxidised pattern written in dynamic mode. The height of the lines is 2nm. The lines are about 120nm large.

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