Lateral Force Contrast on Dots produced by Dip-Pen Nanolithography® (DPN)

Introduction

Several different lithography techniques exist that allow modi cation of material surfaces during or after their microfabrication. One of the most versatile of these techniques probably is the so-called Dip-Pen Nanolithography™ (PDN). DPN™ is the nanoscale equivalent to writing with a fountain pen, in which the tip of an atomic force microscope (AFM) cantilever acts as the pen (Figure 1). The ink , which can consist of a wide variety of nanoscale materials, is transferred from the tip to the sample surface through a water meniscus that automatically forms between tip and surface at ambient humidity.

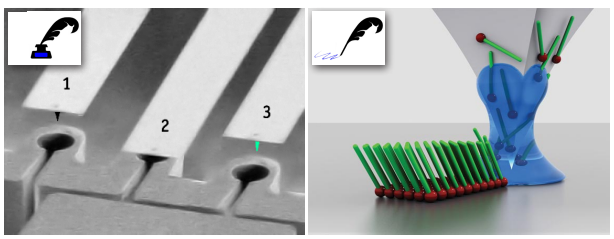

Figure 1: Principle of Dip-Pen Nanolithography® (DPN). (Left) Loading: A cantilever [1] is dipped into a nano-well of ink [2] and is retracted [3]. (Right) Writing: The loaded cantilever is brought into contact with the writing surface, and ink is being deposited through a self-forming water meniscus. Images courtesy of Nanoink Inc.

The strength of DPN™ lies in its high patterning resolution (15 nm) and accuracy (5 nm). This way, it is possible to deposit new substances (e.g. Thiols or other chemicals) onto a surface in a highly controlled manner and on a tiny scale, resulting in exciting new applications. The technique of Dip-Pen Nanolithography™ was reported by Professor Chad Mirkin at Northwestern in 1999, who was awarded the patents for the process. The exclusive license for the DPN™ technology resides with NanoInk, Inc., which is the sole provider for DPN™ equipment. The characteristics of materials deposited by DPN™ are usually studied by Lateral Force Microscopy (LFM), as it is one of the few techniques capable of detecting material differences at such high resolutions. The Nanosurf easyScan 2 FlexAFM offers LFM in combination with easy handling, making it an obvious choice for DPN™ analysis.

Lateral Force Microscopy

Lateral Force Microscopy allows areas with different frictional attributes to be distinguished. Differences in frictional attributes can arise through differences in viscosity, elasticity, adhesion, capillary forces, surface chemistry, or electrostatic interactions of the materials involved. When a cantilever is scanned statically and perpendicularly to its longitudinal axis, a torsional