Conductive AFM

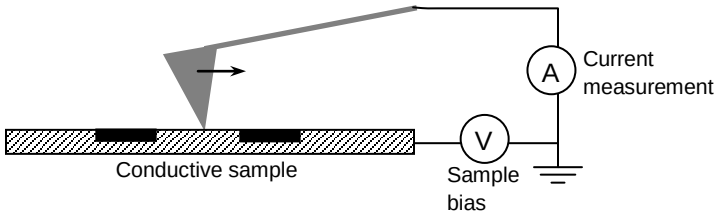
for DPN 5000 System

Summary

Atomic Force Microscopy (AFM) modes enable specialty measurements of surface properties and tip-sample interactions. Surface charge density, potential, conductivity, and capacitance are some important electrical surface properties measured by AFM modes. Additional modes are also possible for the analysis of magnetic and thermal properties of the sample although specific probes may be required. Measurements of surface properties and tip-sample interactions are extremely important for the investigation of, for instance, surface electronic states, corrosion processes, and surface chemistry in general. Semiconductor industries, especially for novel solar energy applications, memory storage and nanotechnology research laboratories, can directly profit from such measurements. AFM modes can also be used as a tool for lithographic applications. Dip Pen Nanolithography® (DPN®) is a technique for patterning surfaces with molecules while Field Emission Lithography (FEL) utilizes ultra-short potential pulses for sub-micrometer surface machining using electrical discharge.

Conductive AFM

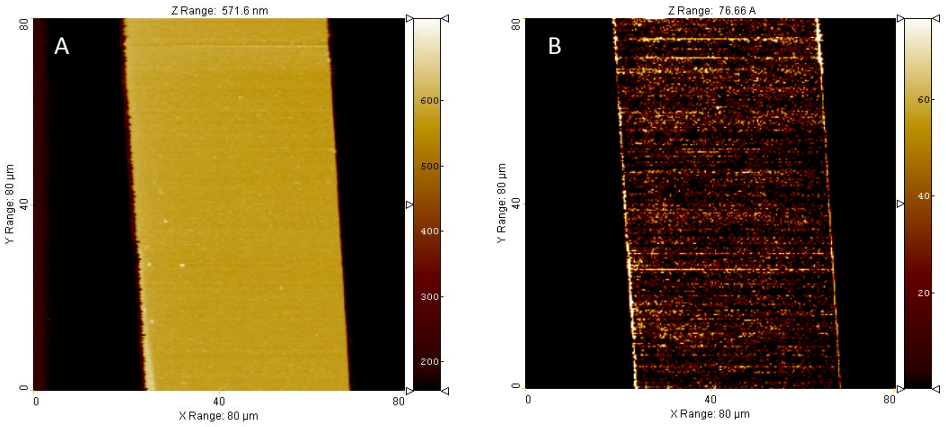
Conductive AFM (C-AFM) allows the user to measure sample conductivity while recording simultaneously the surface topography. In principle, this measurement is accomplished in contact mode and the current between a conductive sample and metal-coated tip is measured with constant bias. Typically, the tip is grounded (at the negative input of a precision operation amplifier) while the potential is applied to the sample. This configuration allows a much more sensitive current measurement since it is done from the tip side. Current measurement from the sample (presumably a large conductive surface) can be significantly noisier due to capacitive phenomena over the large surface. A switch gain is available to the user on the side of the Mode Buffer Board for different sensitivity levels. The typical samples for C-AFM are generally conductors or semiconductors and the current sensitivities ranges are ±20 μA/V (LO), ±200 nA/V (MED), ±2 nA/V (HI) (please, refer to the C-AFM tutorial in this manual for a more detailed description of user's operations).



Conductive AFM

Conductive AFM imaging

With C-AFM it is possible to image topography and conductivity maps simultaneously. Image A shows the topography of a gold "finger" deposited on glass, while image B represents the conductivity map obtained simultaneously during the scan. Because of the low resistivity of the tip, a 976 kΩ resistor was placed in series at the input of the I/V converter on the modes buffer board. It is possible to see that the edge of the finger appears more conductive. This is simply due to the lower contact resistance when the tip "hits" the sides of the finger while scanning, probably due to a higher force and/or larger contact surface area.



C-AFM images of a gold finger deposited on glass. A) topography B) conductivity map. Conditions: 150 mV bias (tip grounded); gain on MED; 976 kΩ resistor in series to limit the current; current scale nA (total range 77 nA).

Conclusion

NanoInk's modes utilize the pre-mounted specialty tips already connected with a flexible miniaturized coax cable. This enables high flexibility as well as a low-cost solution to advanced research applications. The mode buffer board, located under the scanner cover, provides electrical contacts as well as low profile surface-mount electronic components for low-current measurement. Placed in close proximity of the tip, it enables very sensitive current measurements and accurate biasing.

For more information including pricing, please contact NanoInk Sales Department at sales@nanoink.net or 1-847-679-NANO.