

Module on Atomic Force Microscopy (AFM)

By

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Atomic Force Microscopy (AFM)

- **Brief History**

- **Scanning Tunneling Microscope (STM)**

- ◆ Developed in 1982 by Binnig, Rohrer, and Weibel at IBM Zurich, Switzerland
- ◆ Binnig and Rohrer won the Nobel Prize in Physics in 1986

- **Atomic Force Microscope (AFM)**

- ◆ Developed in 1986 by Binnig, Quate, and Gerber, as a collaboration between IBM and Stanford University

- **Definitions**

- **Scanning Probe Microscope (SPM)**

- ◆ Family of microscopies where a sharp probe is scanned across a surface and the probe/ sample interactions are monitored

- **There are Two Major Forms of SPM**

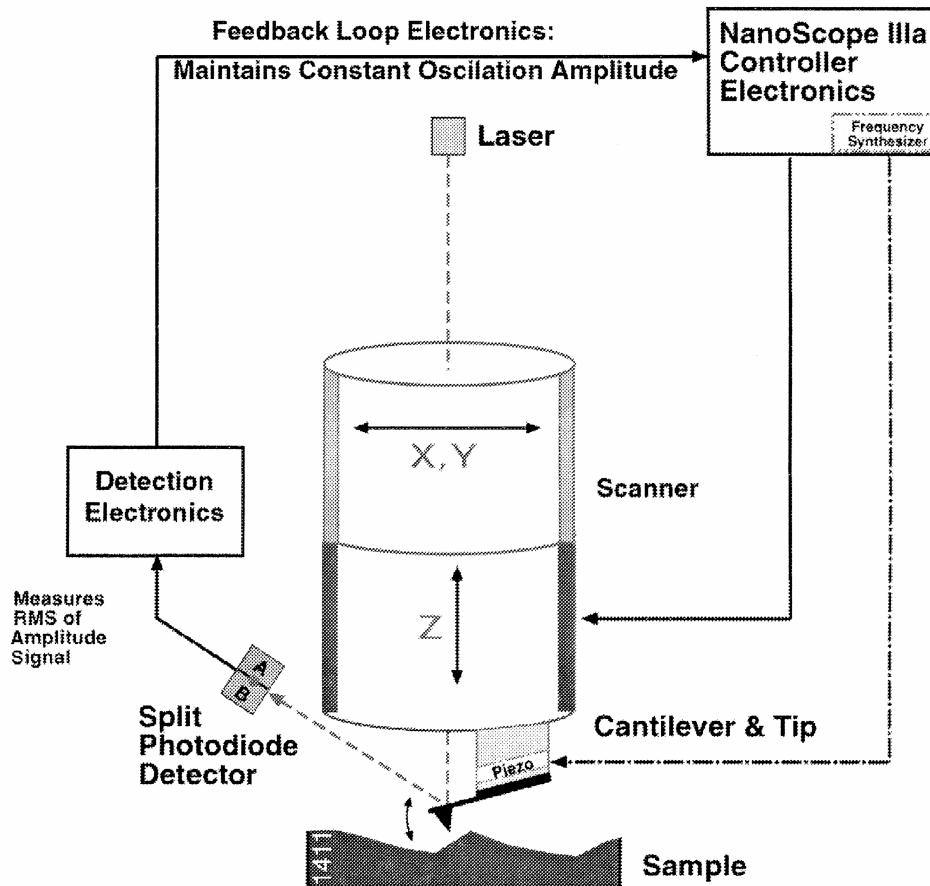
1. STM
2. AFM

- **There are 3 Major forms of AFM**

- ◆ Contact Mode AFM
- ◆ Non-Contact mode
- ◆ Tapping Mode

Atomic Force Microscopy (AFM)

Figure 4.0a Feedback Loop Electronics



- Tapping Mode AFM
- Cantilever oscillates at about 200 kHz with amplitude of about 20-100 nm
- Feedback is constant RMS amplitude of the Photodiode detector
- Piezo moves z to obtain topographic image

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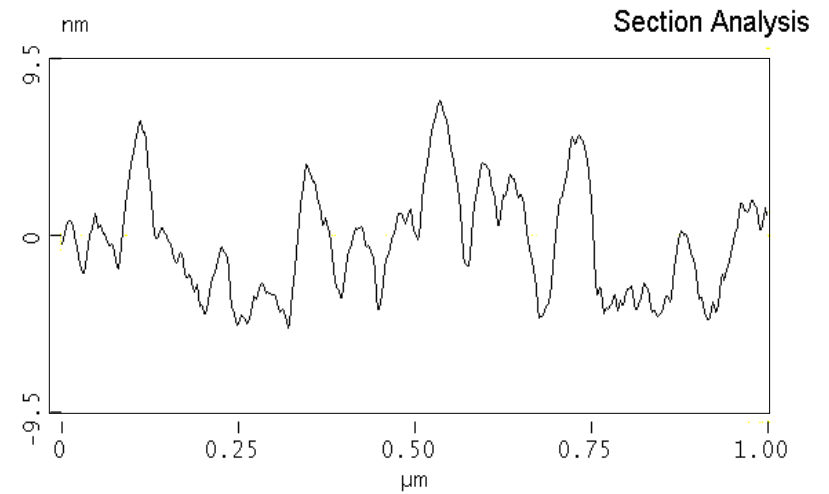
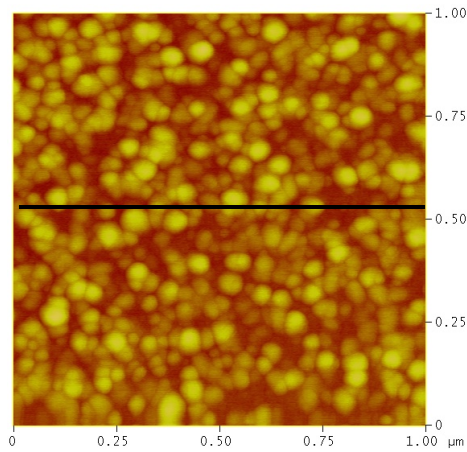
Contact mode AFM
Lateral Force
TappingMode AFM
Non-contact AFM
Force-volume imaging
Magnetic Force
Electric Field
Surface Potential
Scanning Tunneling Microscopy
Operation in fluid
Phase Imaging
Quadrex ³
Scanning Capacitance
Conductive AFM
Nanolithography
NanoManipulation
4-point probe
NanoIndentation
Scanning Spreading resistance
Torsional Resonance Mode

- A number of SPM Probes are Available to use for Nanotechnology Characterization

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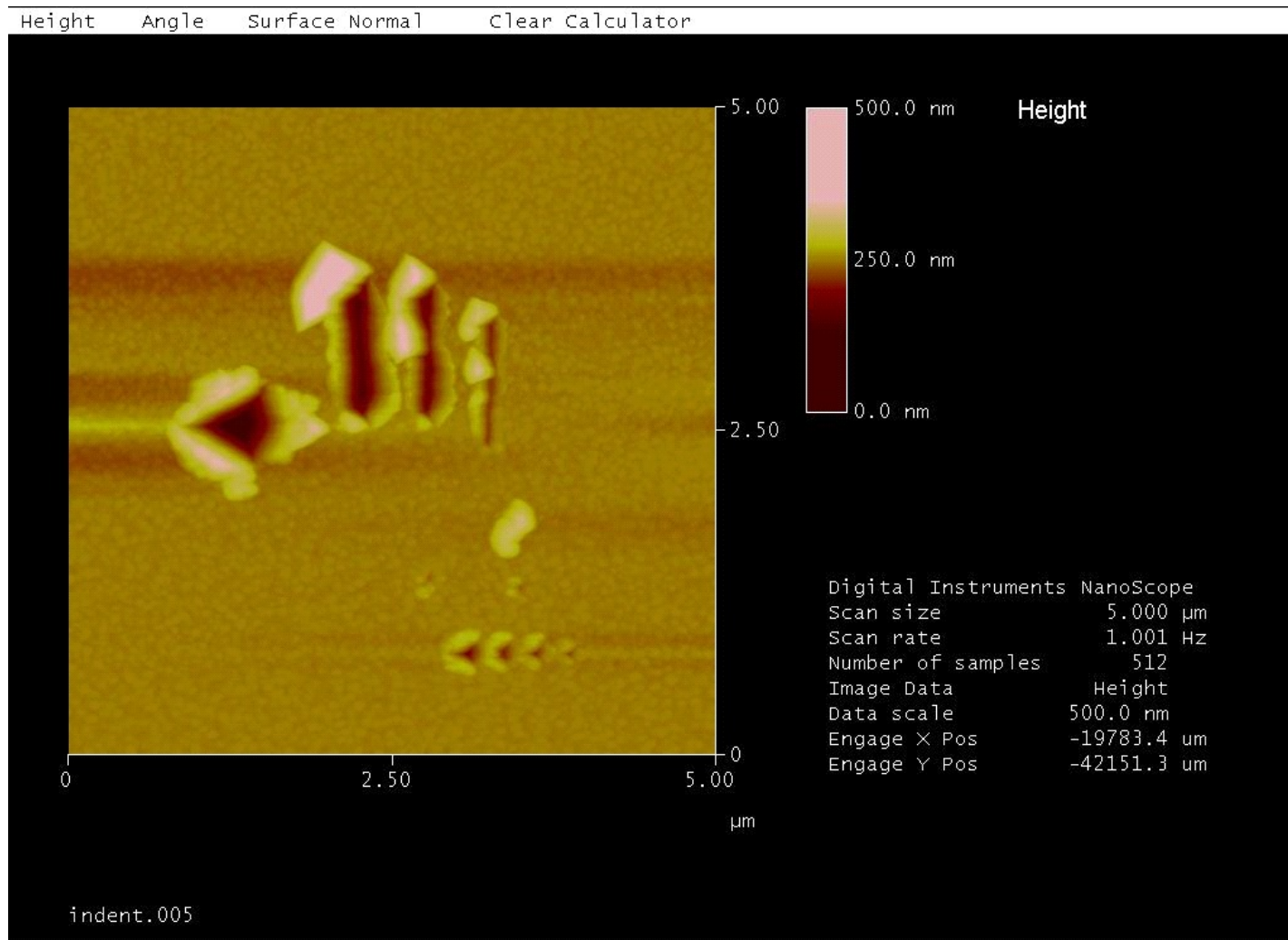
500 Å Metal Oxide on Silicon Wafer

**Average Roughness
(Ra) = 2.26 nm**



Nano Indentation with AFM

Atomic Force Microscopy (AFM) Analysis – Nano Scratching in Gold



AFM Summary

- AFM used to observe the surface morphology at high magnifications.
- Accurate height (roughness) measurements can be made.
- A large range of “modules” are available to measure a number of surface properties.