What can you do with a Nanonics NSOM/AFM system?

1. Failure analysis of microchips and chemically mechanically polished microchips

- Generate carriers locally using optical capabilities of NSOM without need for electrical connections.
- Light emission from working devices.
- Kelvin probe measurements with and without light injection.
- Integrate potential difference or photovoltage measurements with optical capabilities of NSOM tip.
- Use our optical fiber probe and significantly reduce electrical effects due to the metallic cantilevers in conventional AFM systems.
- Place Nanonics NSOM/AFM 100 on any conventional upright microscope and view tip positioning relative to the sample from directly above through microscope objective. Conventional AFM cantilevers obscure the tip, which sits under an opaque material, and thus cannot be used with a conventional upright microscope.
- Capacitance measurements of gate oxide leakage and dopant concentration.
- Direct correlation of all of the above. Direct registration of simultaneously obtained near-field optical images and AFM images that clearly show that the oxide layers have not been removed and that the NSOM and simultaneous electrical measurements are probing the structure beneath the overlying oxide.
- Fowler-Nordheim oxide thickness measurements exactly overlapped with oxide surface structure.
- Simultaneous NSOM resistivity measurements. For example, correlating resistivity in the titanium saliside layer with overlaid NSOM optical imaging or pn junction resistance with optical imaging through an oxide.
- Correlation of resistivity and optical reflectivity of surfaces
- Correlation of capacitance, optical reflectivity, and AFM at the same resolution for investigating gate oxide leakage or ensuring the leakage is through an oxide layer and not just surface exposure.

2. Polymer Imaging (NPLM-Near-field Polarized Light Microscopy)

- NPLM characterization of polymer microdomain structures; correlation with polymer chemistry
- Simultaneous far-field polarized light confocal microscopy and NPLM additional data on polymer topography and elasticity This category of simultaneous imaging can be done by no other AFM system today. All of these systems which use silicon cantilevers block the point at which the tip is interacting with the sample and therefore no optical imaging can be done at the tip. In addition, no lens can be brought above the tip for the far-field transmission polarized light microscopy because the feedback of silicon cantilevers requires the z control light beam mechanism to be brought directly above the cantilever in other AFM systems.
- An important aspect of polymer microdomain structure is the fact that it is related to polymer
crosslinking, which is a very important parameter in polymer chemistry and physics. The Nanonics system is able to effectively image such structures.

3. Telecommunication and Optoelectronic devices

- Characterizing waveguides, semiconductor diode lasers, microlasers, semiconducting polymers, and solid state materials.
- Measuring optical distribution of light and mode structure at different emission wavelengths of waveguides and micro lasers. Correlating this information with electrical properties of the devices, both on a macro scale and on a micro scale, by using the NSOM tip for monitoring carrier distribution and injected charge. Measuring the thermal distribution in such devices.
- Electric optical switching devices
- Polymer electro-luminescence – either collect or inject light and measure electrical properties of devices made of such materials
- Porous silicon (as in a and b)
- Gallium Nitride lasers (as in a and b). In addition, see nano-etching of such lasers in no. 11
- Measuring light-distribution in electro-optically active crystals as a function of injection of electrical charge.
- Optical fiber and optical waveguide switches characterization.

4. Applications in Bacteriology

- Staining nucleic acids and proteins in bacteria and measuring distribution of specific proteins and DNA and RNA in bacteria.
- Bacterial imaging without staining using specific laser wavelengths, such as in the DNA absorption at 266nm.
- Correlating the previous two measurements with the bacterial life cycle.

5. 3D Optical microscopy/NSOM/AFM combination

- Correlating a CCD digital optical image, a confocal image, or a non-linear optical image obtained through a microscope with NSOM and AFM data at specific points. Use this NSOM and AFM data as super-resolution constraints for mathematical deconvolution algorithms that rapidly de-convolve the entire 3D optical image at resolutions unachievable with lens-based far field microscopy.

6. Biotechnology

- AFM based topographic structure and simultaneous NSOM chemical structure identification by optical staining. On-line correlation of all this data with far field optical images.
- Dissection of specific regions of chromosome correlated with the previous measurement and sequence identification of these regions by the application of PCR technology.
- Relationship of mechanics of specific regions using AFM capabilities with optical imaging (NSOM and far field) of stained DNA and the dissected chemical structure.
• Investigation of the nature of fragile sites.

7. Laser tweezer/ AFM combination

• Correlating laser tweezer forces with AFM detected forces in nano-regions.

8. Gold or silver ball immuno-labeling antibody attachment to specific proteins

• Competitive use of NSOM instead of electron microscopy in pathology laboratories and in investigations of gold and silver labelled biological tissue and sectioned biological tissue, such as brain slices for monitoring neuronal interconnections. In addition, live tissue investigations with such staining is possible.

9. Optical ion sensing

• Ion sensing around membrane channels with NSOM and force sensing of sub-nanometer protein and membrane movements.
• NSOM/Ion conductance/AFM.
• NSOM focal uncaging of neurotransmitters and other molecules for the investigation of synaptic function and plasticity.
• Ion conductance using a multi-channel AFM/optical fiber probe for simultaneous measurements of membrane ion conductivity, channel movement, and optical signals, such as fluorescence of fusing synaptic vesicles, local fluorescence near membrane, and intracellular ion sensing dyes.
• Full correlation of all of the above with far field optical confocal or non-linear optical fluorescence imaging and evanescent wave microscopy.

10. Fountain Pen Force sensing applications

• Chemical writing with single or dual channel nanopipettes.
• Selective etching with gases or liquids.
• Flat panel display correction.
• Tribology with specific lubricants in the fountain nanosensor monolayer deposition.
• Crystal growth with mother liquor in one channel and ion sensing in the other channel using NSOM. To understand the underlying mechanisms that lead to crystal growth, it is crucial to know the ionic environment at and above a specific crystal plane as it grows. When this is coupled to the ability of chemical sensors (also manufactured by Nanonics) to measure surface forces, one obtains a multidimensional view of crystal growth that has never before been achievable. This should lead to new views of how crystals grow and how to coax the growth of crystals, from those associated with small molecular systems to biological macromolecules.
• Lipid dein specific membrane domains with lipid tip coated/force sensing cantilevered nanopipettes.
• Simultaneous capillary electrophoretic delivery of chemicals to cells and with AFM sensing.

11. Photoresist exposure in the UV, deep UV (193nm) and ultra deep UV (157nm) for photoresist
development and characterization in the microelectronics industry

12. Data Storage applications

- magneto optic investigations.
- Etching structures for data storage investigation.
- Optical / AFM integration - optical alterations with AFM detection.

13. NanoRaman, nano IR, nano- two photon and nano-second harmonic spectroscopy

- Apertureless enhancement in nanoregions with unique glass cantilevers nanotipped with a silver particle of controlled size, from two to hundreds of nanometers.

14. Nano-aperture based infra red application

- Local heating for micro-soldering.
- Collection of infrared light for monitoring light distribution in quantum cascade lasers (see also 2 above) and correlating this information with electrical properties of such lasers.
- Vibrational spectral imaging of single molecules and their films.

15. Thermal sensing cantilevered tips with optical sensing

16. Scanning electro-chemical microscopy

- Using multi-channel cantilevered glass tips to perform simultaneous electrochemical and near-field optical imaging. Fully correlated with far-field optical microscopy.

17. Ultra-fast laser spectroscopy and surface modifications (see also no. 2 above)

- Femtosecond pulse delivery in nano-regions.
- Pump-probe spectroscopy. For example, carrier injection in semiconductors together with force sensing techniques.
- Femto-second lithography of metals and metallic structures without associated heating.

18. Monitoring optically induced dynamic structural alterations in proteins, membranes, chalcagonides with microsecond time resolution.

19. Fluorescence NSOM/confocal imaging

- Single molecules, nanocrystals and thin films with and without imposed forces, electrical fields, etc.
- Cellular fluorescence imaging