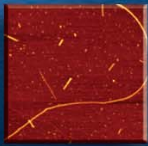
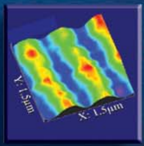
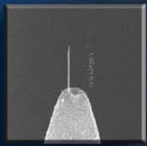
NANONICS IMAGING Ltd.

Shedding light on the unseen



MultiView 1000™

BIOLOGY
CHEMISTRY
PHYSICS
MEDICINE
TEST & MEASUREMENT
RESEARCH & DEVELOPMENT

INTRODUCTION

MultiView 1000™

Since its incorporation in 1997, Nanonics Imaging Ltd. has been focused on bringing to the market near-field scanning optical microscopy systems (NSOM) which incorporate ease of use and flexibility in their design and construction. With one of the largest assembled teams of scientists specializing in near-field optics and with its connection to a world-class laboratory working in this field, Nanonics Imaging has and will continue to provide its customers with cutting-edge, robust and flexible NSOM and scanning probe microscopy (SPM) systems.

Bridging the gap between complementary microscopy techniques, our unique system architecture enables our customers to combine far-field imaging, NSOM, AFM, confocal microscopy and Raman spectroscopy, to name a few, into fully integrated and modular systems.
Our in-house team of experts works with each customer on a one-to-one basis to provide customized solutions that suit the particular requirements of the research to be undertaken. Nanonics Imaging's continuous, high-quality consultation and support of our customers facilitates successful research - which is, after all, the ultimate goal.

MultiView 1000™

shedding light

The award winning MultiView 1000™ (formerly NSOM/SPM-100™) is the first system available that fully integrates all forms of scanned probe microscopy (SPM) with conventional optical microscopy. Designed around Nanonics' patented, award winning 3D Flatscan™ scanner technology and incorporating sophisticated cantilevered optical fiber probes, this instrument can simply and transparently be combined with any inverted, upright, or dual optical microscope.

Normal Force Sensing

With cantilevered optical fiber probes, the MultiView 1000™ system does away with much of the complexity long associated with near-field imaging. Awkward shear-force techniques are a thing of the past as the normal-force sensing capability of the probe makes tip approach identical to that used in ordinary atomic force microscopy.

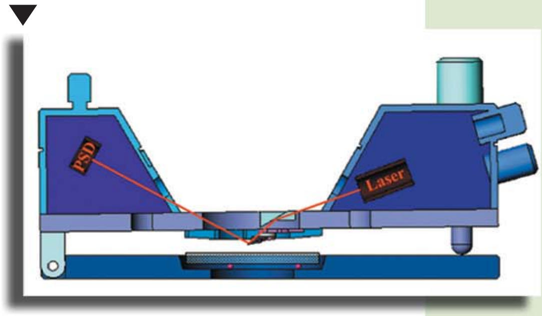
Large Z Scan Range

The large, 70-micron x, y and z-range of the Nanonics 3D Flatscan™ makes it ideal for optical sectioning in confocal imaging. Used in this way, the MultiView 1000™ integrates conventional far-field imaging, confocal microscopy, AFM, and near-field optics in a single system.

Open System Architecture - reflection, transmission, and collection imaging

The unique geometry of the Nanonics NSOM head and cantilevered probes leaves the optical axis free both above and below the sample, allowing the user to view the tip positioning during scanning and to perform NSOM imaging in reflection, transmission, and collection modes.

▲ MultiView 1000™ Head ▼



Integration with Complementary Techniques

The open system architecture also enables the MultiView 1000™ to be integrated with other instruments:

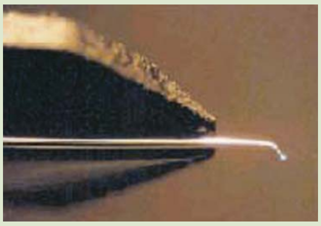
- Commercial micro-Raman microscopes, such as those developed by Renishaw Plc. This combination permits correlation of SPM topographic, thermal and electrical properties of a sample surface with micro-Raman spectra.
- In SEM/FIB systems the MultiView 1000™ can be simply and transparently placed inside the SEM/FIB sample chamber providing simultaneous AFM/SEM imaging.

Electrical and Thermal Measurements

The flexibility of the MultiView 1000™ also makes it compatible with numerous types of specialized SPM and NSOM probes.

For example, Nanonics designs wired probes that are capable of performing simultaneous AFM and thermal measurements, NSOM/electrical/topographic measurements, or AFM and electrical measurements, such as spreading resistance and capacitance.

on the unseen



▲ *A cantilevered NSOM probe*

Probes

The standard probes used in Nanonics systems are cantilevered optical fibers. They provide for normal force feedback, have unique advantages in permitting a second channel of illumination or collection, and allow transparent, integrated and simultaneous far-field, lens-based imaging. Straight NSOM fiber probes, micromachined cantilevered NSOM probes and standard, silicon AFM probes can also be used with the MultiView 1000™. In addition, Nanonics produces customized fiber probes to customer specifications, such as probes with tip lengths greater than 500μ for deep-trench probing and probes with unique force constant and resonance frequency combinations.

Complete NSOM/AFM/Confocal Systems

Nanonics provides a complete NSOM/SPM microscopy system, including a host microscope with confocal detection, a control system, an illumination/detection system, and the widest variety of additional system accessories available on the market.

Modular & Customized Systems

Another important advantage of the MultiView 1000™ is its modularity. Because the Nanonics system readily sits on the sample stage of any conventional far-field microscope and is compatible with most commercial control systems, users can also incorporate the MultiView 1000™ into pre-existing microscopy systems. Our in-house team of experts also works with each customer on a one-to-one basis to provide customized solutions that suit the particular requirements of the research to be undertaken.

Available options for the MultiView 1000™

- Liquid Cell - perform NSOM/AFM measurements on samples in liquid.
- Closed Loop Scanner - closed loop operation for scanning and positioning.
- Environmental Chamber - control your measurement environment.
- Nanochemical Delivery - deliver chemicals with nanometer precision to your sample surface.
- 3D Nanolithography - software for lithography applications.
- For more options and additional details see backcover.

Other Systems Available

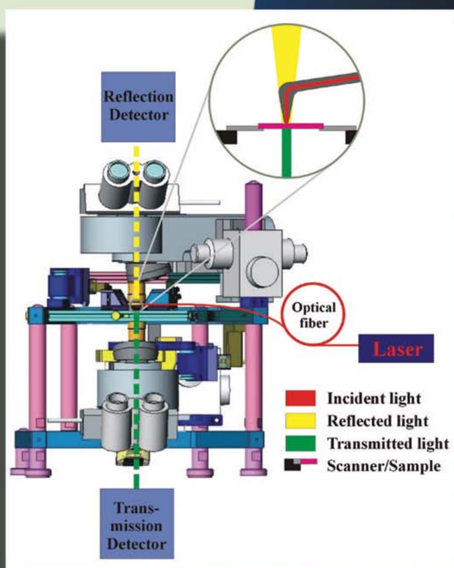
The following systems are also available from Nanonics:

- MultiView 2000™ – a tip scanning NSOM/SPM system.
- Low Temperature – perform SPM measurements at temperatures down to 25 K or 10 K.
- Beam Scanning Confocal – beam scanning or combined beam and sample scanning systems.

Overall, the MultiView 1000™ is a robust and versatile SPM system which allows the user to zoom, with overlapping fields of view, from the lowest resolutions of conventional far-field imaging to the higher resolutions of confocal microscopy, and finally, to the ultimate resolutions of AFM and NSOM.

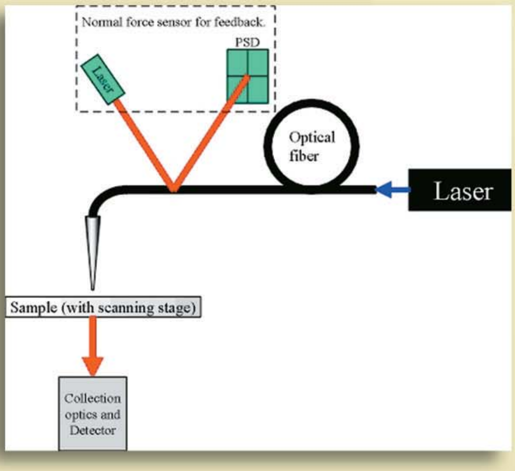
▲ *Dual Microscope System*

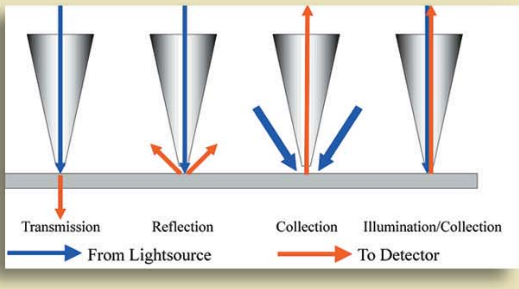
▲ *MultiView 1000™ Head integrated with a standard microscope*



◀ *Complete MultiView 1000™ system with a dual microscope providing optics for the collection of transmitted/reflected light and for viewing the sample before and during the AFM scan. The system is also available with either an upright or an inverted microscope. A cantilevered optical fiber is used to illuminate the sample.*

WHY NSOM?





NSOM (SNOM) is the only way to get sub-wavelength optical information from a sample, and as it is usually combined with AFM, the optical information can easily be correlated to topographical information.

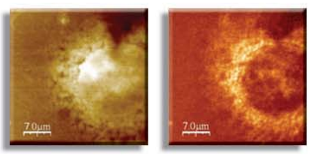
NSOM is able to provide information about the following sample properties:

- Changes in reflectivity
- Changes in transparency
- Changes in index-of-refraction/polarization/sample material
- Stress at certain points of the sample which changes its optical properties
- Magnetic properties which change the optical properties
- Fluorescent molecules
- Molecules excited through a Raman shift, SHG, or other effects

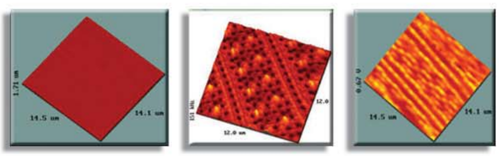
The Basic Setup of NSOM
In order to make an NSOM experiment, a point light source (1) must be brought near (nm distances) the surface to be imaged. The point light source is then scanned over the surface (2), and the optical signal from the surface is collected and detected (3) (see diagram on the left for a schematic view of a basic setup).

1) To achieve a point light source, it is possible to use tapered optical fibers (pulled optical fibers) that are coated with metal except for an aperture at the fiber's tip. The light is coupled into the fiber and is then emitted at the sub-wavelength (30 nm or larger) aperture of the fiber.
The resolution of an NSOM measurement is defined by the size of the point light source used (typically 50-100 nm).

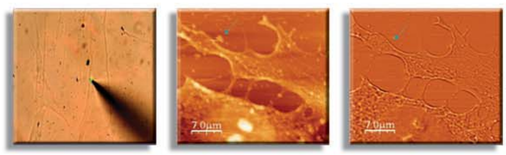
MultiView 1000™ GALLERY



Murine Stem Cells imaged with AFM (left) and simultaneously recorded pixel by pixel near-field optical fluorescence imaging of the cell membrane, stained with indocyanine green (ICG).

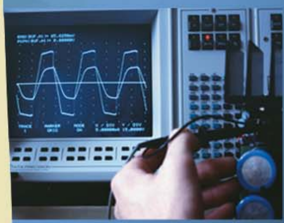


Images of SRAM after chemical mechanical polishing (CMP). The left image shows the AFM of the highly polished surface. The middle image demonstrates excellent reflection NSOM capabilities showing the region underlying the polished surface. The right image displays the superior capabilities of thermal conductivity imaging with Nanonics' specialized probes.



Cellular imaging fully integrated with optical microscopy. An NSOM probe readily placed on specific cellular structures, using the clearly visible subwavelength point of light at the exposed tip of the cantilevered optical fiber probe (left). This probe images the cellular topography with the AFM sensitivity of the probe (middle) and simultaneously, pixel by pixel, images the cellular refractive index changes in this unstained fibroblast cell. Notice the fine definition of the cell membrane in the NSOM image indicated by the arrow while the AFM in the same location has imaged a piece of cellular debris.

tiView 1000™



2) The distance between the point light source and the sample surface is usually controlled through a feedback mechanism that is unrelated to the NSOM signal.
The easiest method to use is a normal force feedback (the standard feedback mode used in AFM), which enables one to perform experiments in contact, intermittent contact and non-contact mode.

3) There are four possible NSOM modes of operation:

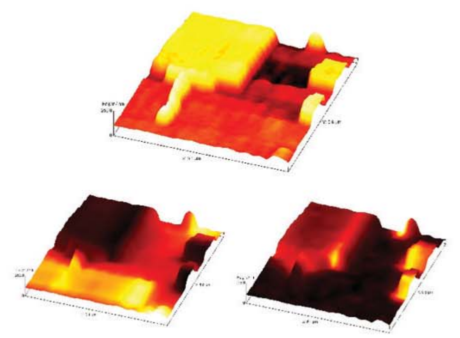
Transmission mode imaging.
The sample is illuminated through the probe, and the light passing through and interacting with the sample is collected and detected.

Reflection mode imaging.
The sample is illuminated through the probe, and the light reflected from the sample surface is collected and detected.

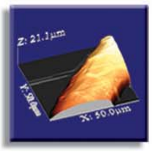
Collection mode imaging.
The sample is illuminated with a macroscopic light source from the top or bottom, and the probe is used to collect the light from the sample surface.

Illumination/collection mode imaging.
The probe is used for both the illumination of the sample and for the collection of the reflected signal.

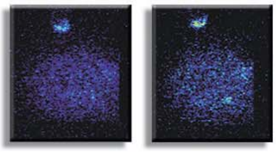
Detection of the collected light can be achieved with a wide variety of instruments: an Avalanche Photo Diode (APD), a Photomultiplier Tube (PMT), an InGaAs Detector, a CCD, or a spectrometer. The signal obtained by these detectors is then used to create an NSOM image of the surface.
In addition, Nanonics' unique cantilevered glass probes have no Raman background - as opposed to silicon probes - and have completely transparent, exposed AFM tips.



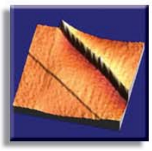
3D AFM topography (top) of a state of the art transistor with on-line pixel by pixel correlation of the Raman spectral distribution of silicon (bottom left) and strained silicon (bottom right). The images represent true chemical distribution since the on-line AFM acts as the finest auto-focus mechanism known to date while providing detailed structural correlation.



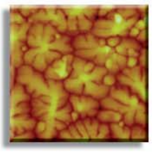
AFM of a wool fiber, that is uniquely imaged with the MV 1000 system which is capable of such imaging as a result of a Z range (100 microns) 5 times larger than any other AFM system.



The MV 1000 SPM/NSOM system allows for full integration with beam scanning confocal microscopes. Shown is a neuronal cell filled with a calcium sensitive dye that is also held in the tip of an ion sensing glass sensor. The sensor is held above the cellular membrane with AFM control. Images are before (left) and after caffeine activation. Nature Biotechnology 21, 1378 (2003)

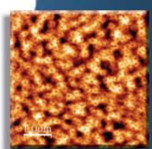


The Nanonics SPM/NSOM system integrated with a dual microscope allows for the imaging of a single atomic step of highly oriented pyrolytic graphite as is seen in the lower left of this image.



*Nanonics SPM/ NSOM systems can use any probe and can image with any mode presently known to AFM or NSOM.
Seen in this image is a dendritic structure of pentacene imaged with a standard Si cantilevered probe.*

AFM topography of single and multiple walled carbon nanotubes imaged with a super thin cantilevered optical fiber probe.



Topographic image of aggregated insulin.

Plasmonic waveguide investigated with the MV 1000 system. Nature Materials 2, 4 (April 2003)

MultiView 1000™ Technical Specifications

Available Modes of Operation	
AFM	AC Mode, Contact Mode and All Standard AFM modes of operation
Near-field Optical Imaging & Illumination	Transmission, Reflection, Collection, Illumination
Differential Interference Contrast and Phase Imaging	Reflection and Transmission
On-line Far-field Confocal with Raman and Fluorescence Spectral Imaging	Reflection and Transmission
Liquid Cell Operation	For AFM, NSOM and other SPM measurements in liquids with a completely free optical axis allowing for all modes of optical imaging including phase imaging. In addition to all standard silicon cantilevers, cylindrical glass cantilevers for AFM and NSOM operation are provided. Such cylindrical cantilevers are not damped by the liquid environment and permit AFM operation without Q control allowing for higher fidelity in AFM and NSOM liquid imaging.
Thermal Conductivity and Spreading Resistance Profiling	Contact or AC mode No Feedback Laser Induced Extraneous Carriers in Semiconductors (using optional tuning fork feedback module) The probes also can act as a nanoheater for heat induced point alterations up to 700°C which can be used for the induction of phase transitions or thermally induced chemistry.
NanoLithography	Software and hardware for correlation of the position of the AFM sensor for writing nanolithographic patterns. This includes patterning with Nanonics exclusive nanofountain pen nanochemical lithography package. The hardware and software also permit external triggers for either electrical pulses or optical pulses or other external sources in concert with the patterning operation.
NanoFountain Pen NanoChemistry	Components for nanofountain pen nanochemical nanolithography liquid delivery for use with the Nanonics 3D lithography package and NanoChemwrite™ Software Package. The only System allowing for gas writing with a controlled environment chamber fully integrated into optical microscopy. Environmental chamber also permits controlled environments of gases or humidity for chemical or other writing tasks. Nanoheaters available for thermally induced chemical writing and near-field optical point light sources for optically induced chemical writing.
NanoIndentation	Application of MegaPascals of force, allowing exact positioning and controlled application of force with on-line analysis. Scripting of the nanoindentation pattern.
NanoManipulation	Placement and movement of sample for controlled placement of particles and other nano-manipulation task.
Environmental Control	Controlled environment chamber with full integration into an optical microscope. Also permits 100x0.7NA viewing from below. Monitored humidity capabilities: 5% - 95% with error of 0.2% Inlets for other substances for environmental controls, including additional gas inlet for the environmental control. Cooling to 4°C – Heating to 40°C of the chamber. Ideal for Biological samples.
Sample cooling/heating	Ability to heat solid state samples up to 350 degrees centigrade and cool samples to -20 degrees centigrade using evacuated environmental chamber as above.
Other Modes of Operation	Refractive-Index Profiling in Reflection and Transmission

SPM Scan Head Specifications

Sample Scanner	Piezoelectric Based Flat Scanner (3D Flat Scanner™) Height 7 mm
SPM Scan Range	Up to 100 microns (X,Yand Z) sample scanning
Scanner Resolution	< 0.005 nm (Z) < 0.015 nm (XY) < 0.002 nm (XY) low voltage mode
Rough Positioning	Sample rough positioning: 6mm rough positioning of sample via piezo electric 3D Flat Scanner
Feedback Mechanism	Beam bounce Attachment (Standard) Tuning fork (Optional)
Sample Geometries	Sample size: Standard and unconventional geometries, including hanging samples for edge profiling and other unconventional geometries possible per customer requirements.
Probes	Specialized glass probes with exposed tip geometry and all forms of silicon cantilever probes can be used.

Imaging Resolution

Far-field	Diffraction Limited
Optical	Optics providing 500 nm diffraction limited non-confocal operation
Confocal	200 nm
NSOM	100 nm on installation; 50 nm probes available
Topographic	Z noise 0.05 nm rms X.Y lateral resolution: convolution of tip diameter & sample
Thermal	From 100 nm
Resistance	From 25 nm

Thermal & Resistance Imaging

Temperature	350ºC or greater, depending on sample to be investigated
Thermal	Unique exposed tip dual platinum nanowire probes fully insulated with glass coating: Thermal Sensitivity 0.01°C Measured Resistance Change per degree; 0.38 Ω/ºC
Resistance	Unique exposed tip platinum nanowire probes fully insulated with glass coating and allowing for coax geometry structures: Ultra high electro potential resolution Few tens of ohms contact resistance for probes <100nm Electrically stable & free from oxidation

MultiView 1000™ Technical Specifications

Electronics & Software

Control System	**Integra Controller** Specifications: Supports various imaging modes including AFM (contact and non-contact) phase, error signal and NSOM. Up to 8 data channels for external signals which can be read and imaged simultaneously. All ADCs are 16 bit and DACs have 16-bit resolution. Image size continuously variable from 2x2 to 1024x1024 Inbuilt lock-in amplifier
	There are two alternative software packages available: **Quartz Software Package Specifications:** User-friendly 32-bit Windows application available for Windows 95/98, NT and XP. Intuitive scan parameter setup Image and line profiles displayed in real time 2-D and 3-D image rendering Extensive image processing options Comprehensive image analysis features including: cross section, particle analysis, fractal analysis and z-data histogram. Import data as Windows bitmaps and ACSII. Export data as TIFF and Windows bitmaps and ACSII.
	LabView Software Package Specifications: User-friendly LabView SPM based software with the following specifications: AUX Data acquisition Image and line profiles displayed in real time Intuitive scan parameter setup Open Design enabling Customization by User and interfacing to other LabView modules. Nanonics Controller and software package based on Windows XP and Windows XP LabView based software package. Real time image display, image acquisition up to 8 channels. Full access to all signals and readily integrated with external signals from other sources. Analysis software including all standard image processing routines and 3D rendering including collages of multiple signals. Software modules available for spectral acquisition and analysis including Raman and fluorescence spectra, nanoindentation, nanolithography including NanoChemwrite™ Fountain Pen NanoChemistry™ software suite.
Data Acquisition	From 2x2 to 1024x1024 and multiple Z acquisition
Analog Lock-in	Provides quadrature output. Information is readily available on R/Θ and I/Q in output bandwidths of 15kHz (depending on DT card in use, the controller can give up to 100 kHz).
Frequency Synthesizer	Direct Digital Synthesizer (DDS) system for frequency and phase adjustment with 32-bit frequency determination and 20-bit phase determination. This system uses three independent generators. Two of these generators provide quadrature for lock-in processing and the third generator is used for exciting with an autophase algorithm. The system uses a clock frequency of 20 MHz with a stability of 5 ppm and provides frequency resolution of <5 mHz.
Amplitude	0 to 5 V p-p and maximum resolution of up to 0.2 mV. Amplitude, Phase and Frequency of the oscillator can be controlled with 100 kHz updates.
X, Y and Z High Voltage Outputs	-145V to +145V

On-line Optical and Electron/Ion Optical Integration

Type	Far-field, Confocal, micro-Raman; Scanning Electron Microscope (SEM) or Focused Ion Beam (FIB).
Integration	Free optical axis from above and below the sample for on-line optical or electron/ion optical characterization.
	Integration with all forms of optical microscopes including upright microscopes and upright microscope probe stations.
	Integration with all confocal microscopy including micro-Raman 180 degree backscattering geometry configurations, inverted microscopes and state of the art dual (4Pi) microscopes such as Nanonics' unique dual microscope.
	All conventional far-field optical modes of operation are available, including phase imaging and differential interference contrast.
	NSOM with any optical microscope including: upright, inverted and dual.
	The completely free optical axis from above and below in all Nanonics MultiView Systems also allows for integration with (4Pi) dual microscopes for non-linear optical techniques including second harmonic and sum frequency generation microscopes, third harmonic imaging, coherent anti-Stokes Raman microscopes and stimulated emission depletion microscopy.
Minimum Working Distance (WD) with High Numerical Aperture (NA) Optical Microscope Lenses	*Upright Microscope or SEM or FIB:* Optical Objective: 100 X with 0.75NA Objective WD: 6.5 mm *Inverted Microscope:* Most available objectives including oil immersion optical objectives
Detectors	Photomultiplier Tube, Avalanche Photo Diode or InGaAs Detectors
Lasers	Variety of lasers can be used from deep UV to near-IR
Video system	On Line CCD video imaging

Integration Options

	Raman Spectroscopy Packages for on-line pixel by pixel integration of AFM and Raman from a variety of Raman suppliers
	On-line Spectroscopy options
	In addition to complete and transparent integration with beam scanning confocal microscopes, the MV 1000 provides stage scanning confocal microscopy with on-line AFM auto-focus and pixel by pixel structural correlation. With such advantages, resolution below 200 nm is achieved.

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