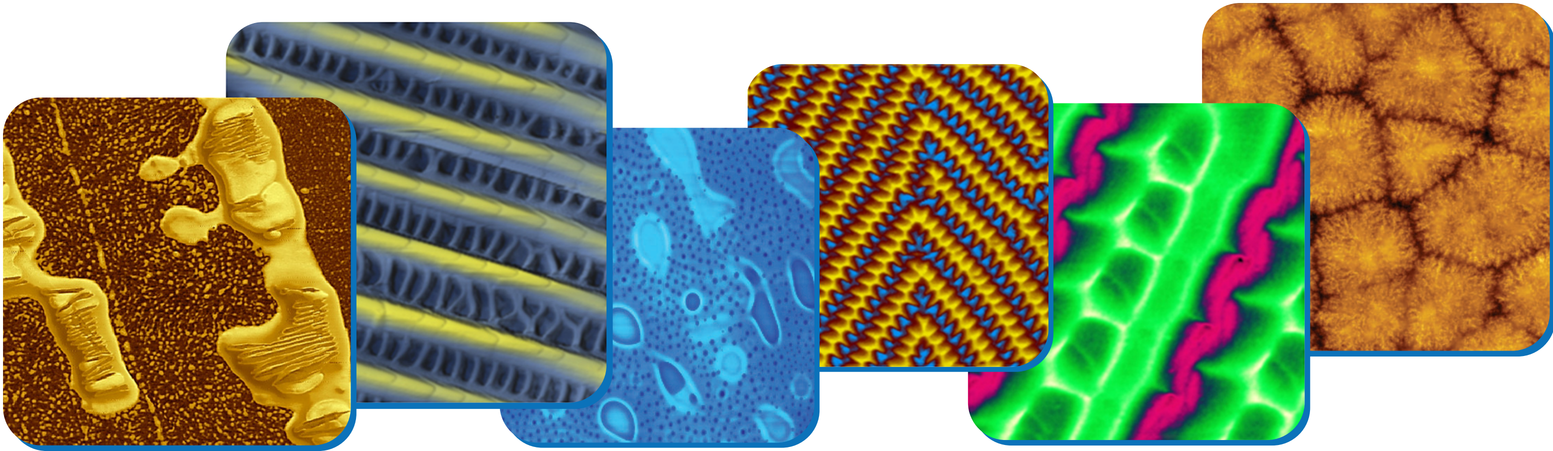
NT-MDT
Spectrum Instruments



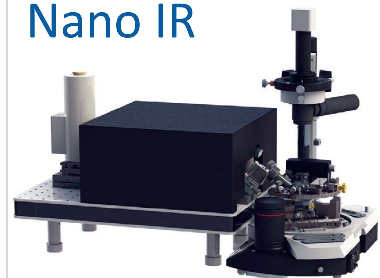
Leading the way in nanoscale analysis

VEGA

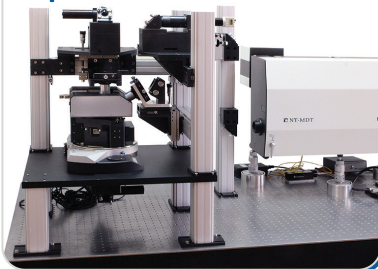
NTEGRA Prima

SOLVER Nano

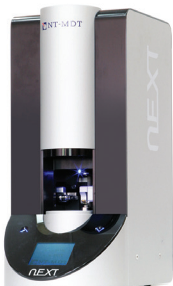
NTEGRA Nano IR



NTEGRA Spectra II



NEXT II



www.ntmdt-si.com

NTMDT: Customer, Technology, Integrity

Our primary goal is customer success in exploring the nanoworld with our innovative microscopes. We combine our strong motivation, fundamental knowledge, multi-year experience, hard-working ethics, and full integrity to make this possible.

The NT-MDT Way

NT-MDT has been involved in the development, production, and support of research instrumentation, primarily, scanning probe microscopes for nanotechnology and its applications. Our pathway has been marked by a creation of a few thousand different devices, whose functions and capabilities cover the broad range of customer needs in different areas: university education, academic and industrial research. NT-MDT pioneering efforts led to the impressive combination of scanning probe microscopy with Raman spectroscopy.

Our team of talented engineers and scientists is committed to provide an excellent service to all of our customers in industry and academia worldwide. We cherish our stakeholders, work globally as a team to share ideas, technologies and talents, and constantly improve what we do.

Prof. Victor Bykov - the founder of NT-MDT, Honorary President of NT-MDT Spectrum Instruments Group

Our vision is to be a second-to-none global manufacturer of microscopes for nanotechnology research, while upholding an unparalleled standard of excellence.

2016 NTEGRA Nano IR

2017 VEGA

2018

2015 Spectra II

2011 SOLVER Nano

2009 NEXT

2006 NTEGRA Spectra

1989 NT-MDT is born

1990 STM MDT-1

1997 SOLVER-P47

2004 NTEGRA Prima

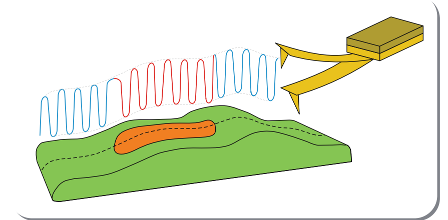
Unique NT-MDT SI SPM Features

We are now proud to provide NT-MDT SI microscopes with the most advanced features, which include but not limited to the following:

- An expanded set of resonance oscillatory AFM modes:

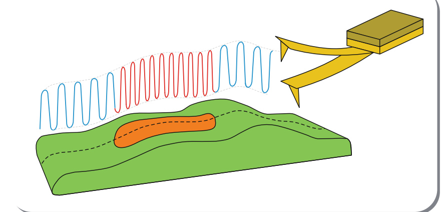
  - Amplitude modulation with Phase Imaging

    The surface profile and probe phase changes are detected and mapped while the probe frequency and amplitude are fixed.



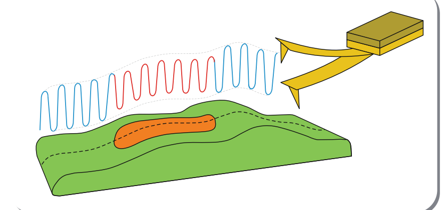
  - Amplitude modulation with Frequency Imaging

    The surface profile and probe frequency are detected and mapped while the probe amplitude and phase are fixed.

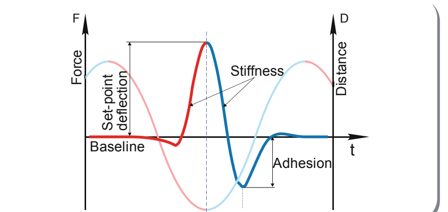


  - Frequency modulation

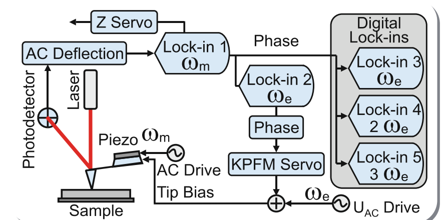
    The surface profile and probe amplitude are detected and mapped while the probe frequency shift and phase are fixed.



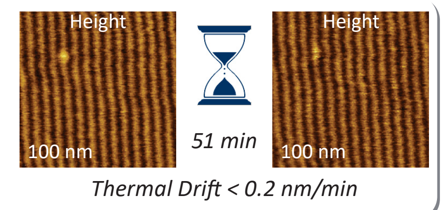
- A non-resonant oscillatory HybriD mode allowing direct and fast force detection for quantitative and high-resolution mapping of local sample properties



- A suite of AFM-based electric modes that includes single and double pass techniques for measuring surface potential and capacitance gradients and unique thermoelectric imaging

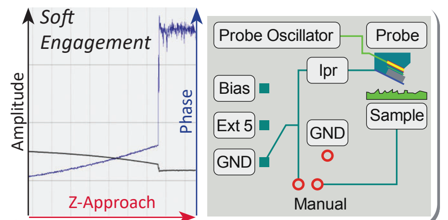


- The exceptional low-noise and low thermal drift enclosure for stable imaging for a variety of applications

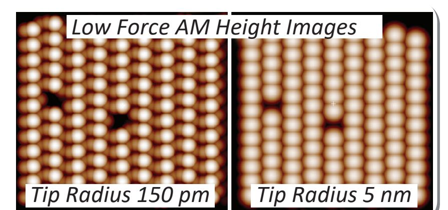


Thermal Drift < 0.2 nm/min

- An open architecture software with multiple ways for controlling and monitoring the electronic signals during experiments starting with soft probe engagement

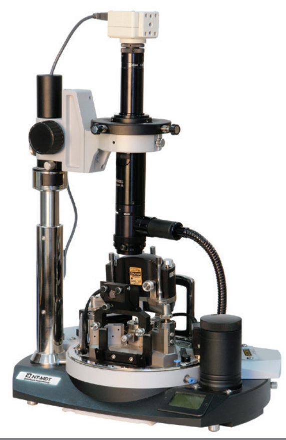


- Computer simulation tools for theoretical evaluations of tip-sample interactions and their manifestation in most experimental AFM modes



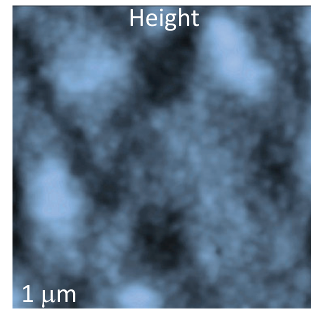
NT-MDT SI microscopes are equipped with closed loop scanners and are compatible with a wide range of accessories and a temperature stable enclosure providing exceptional noise protection.

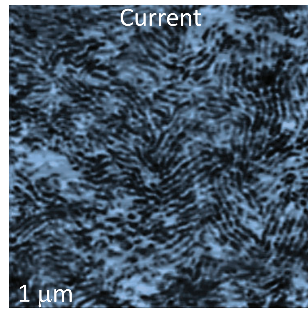
NTEGRA Prima - Flexible Device for Routine and Advanced Applications



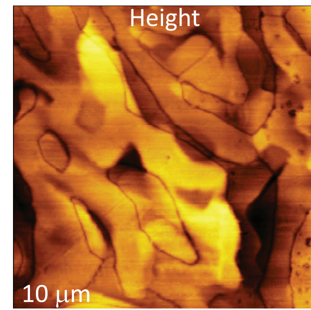
- **Open architecture**
- **Tip/sample scanners**
- **Wide range of configurations/heads**
- **Broad temperature range**

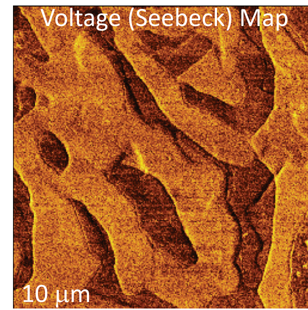
NTEGRA Prima – an Open-Architecture Modular Device for Advanced Research:
- Environmental and high-temperature measurements
- Specialized measurements with external magnetic fields
- Combination with Near-Field Optical Microscopy and Raman Spectroscopy
- Scanning in liquids with temperature control and flow-through capabilities
- Flexible scanning geometries and ranges





Polymer blend P3HT/PCBM



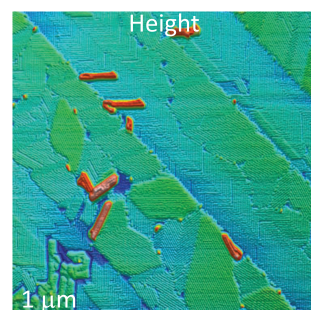


Metallic alloy Bi/Sn

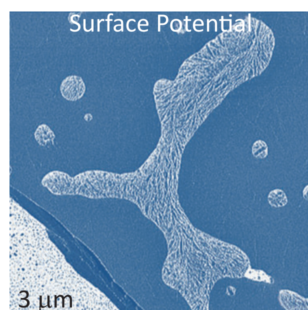
NEXT II – Prime Automated Microscope

- **Easy to use microscope with advanced capabilities**
- **Automated head exchange**
- **Automated laser/photodetector alignment**
- **Superscan and stitching capabilities**

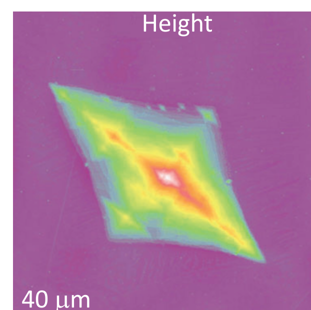
NEXT is a unique system that provides researchers with outstanding performance and a wide range of capabilities. Specifically, it removes gap between optics and SPM by offering the users surface imaging from mm range down to the atomic scale. The exceptional functioning and automation of the alignment routines of this microscope make it the best candidate for high throughput studies in multi-user environments.



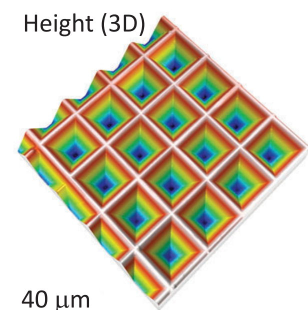
F14H20 fluoroalkane on HOPG



Polymer blend PVDF/PVAC



Crystal of $C_{242}H_{486}$



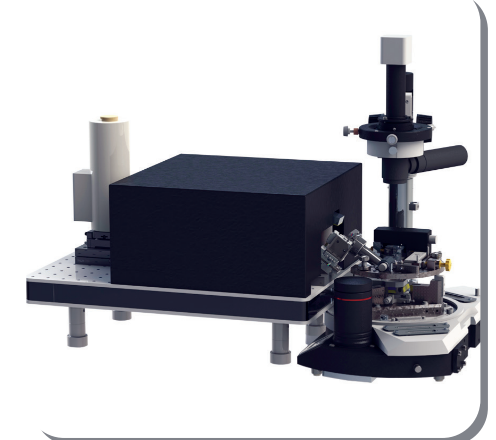
Etched Si

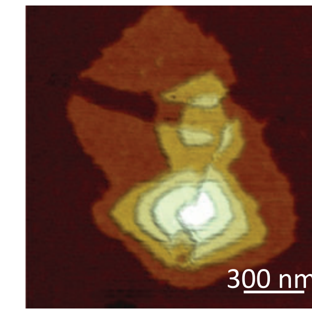
A powerful software package provides our users with flexibility to monitor and control a broad range of operational signals, starting with those used for “soft probe engagement”.

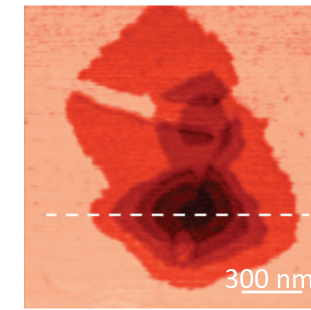
NTEGRA Nano IR - bringing the light into nanoscale

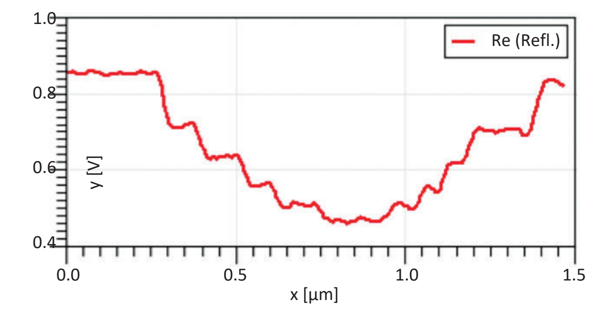
- **Wide spectral range of operation: 3-12 µm**
- **Incredibly low thermal drift and high signal stability**
- **Versatile AFM with advanced modes: EFM, KPFM, SCM, MFM, PFM**
- **HybriD ModeTM - quantitative nanomechanical mapping**

NTEGRA Nano IR is scattering SNOM designed for IR spectral range. AFM probe is located in the focus of optical system which excites sample structure by IR laser and collects the optical response. Collected light is directed to Michelson interferometer for optical analysis. Far-field component of the collected signal is suppressed by using lock-in techniques. NTEGRA IR system allows detection of near-field signal amplitude and phase. Spatial resolution of IR s-SNOM is about 10 nm and defined only by tip size.







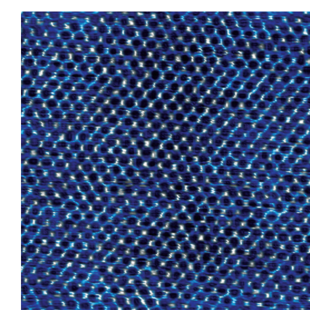


Topography (left), reflection for λ= 10.6 µm (center) and cross section of reflection signal (right).

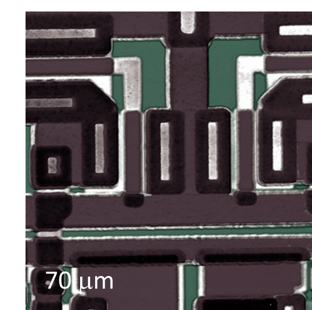
VEGA

- **Study of up to 200 mm samples using the widest set of AFM modes**
- **Industrial standards of automation**
- **A unique combination of precision and performance**

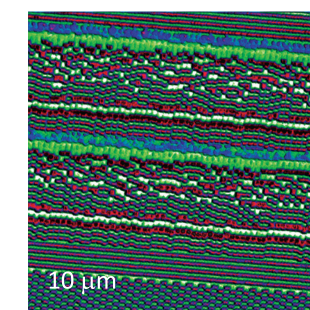
VEGA allows to inspect up to 200×200 mm samples with 50+ AFM modes, including HybriD mode, atany point with 1 µm positioning accuracy. Industry standards of automation, smart ScanTronic™ software for one-click optimization of scanning parameters and database image storage make routine AFM measurements with VEGA easy and time-effective.
Ultimate imaging quality is guaranteed by build-in acoustic and vibration isolation, active fan-free thermal stabilization, industry-lowest 25 fm/√Hz PBD sensor noise and unique design of scanning-by-tip system.



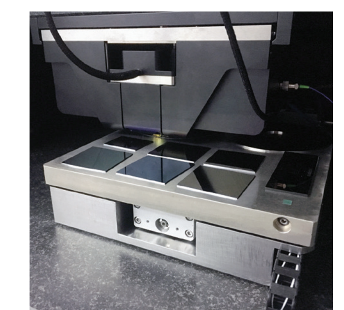
HOPG atomic resolution



Topography of microchip

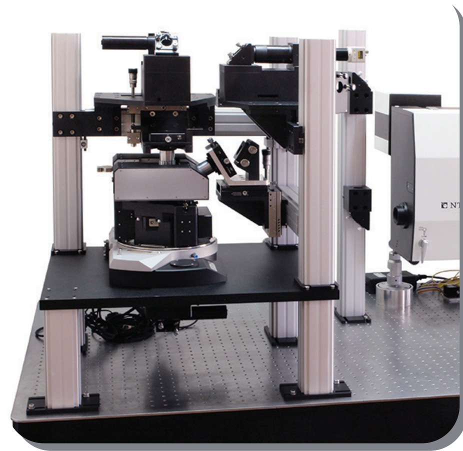


Magnetic domains of HDD



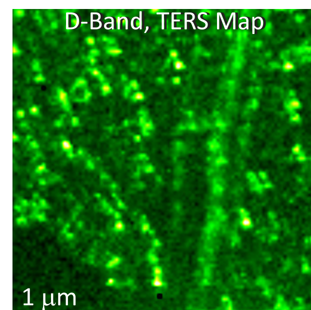
Multisample holder

NTEGRA Spectra II – Enables AFM/Optics Synergy

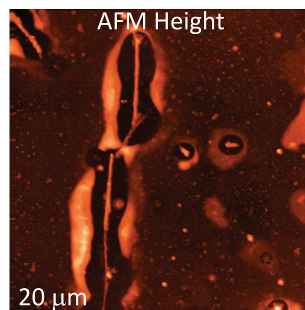


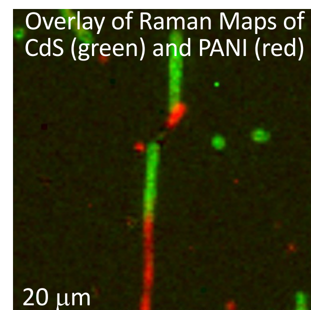
- **Co-localized AFM and optical measurements**
- **Near-field Optical Microscopy (SNOM/NSOM)**
- **Tip Enhanced Raman Scattering (TERS)**
- **With NT-MDT SI, Thermo Scientific, Renishaw and other spectrometers**
- **Focus track for optical measurements**

NTEGRA Spectra II is an integrated solution for simultaneous AFM and Confocal Raman, Fluorescence, SNOM, TERS measurements. The instrument supports multiple AFM/Optics geometries enabling studies both in air and liquid. Comprehensive characterization of materials is achieved in combined mapping of chemically specific Raman bands and local mechanical and electrical properties. Raman mapping with nanometer resolution can be obtained by means of TERS. Similar resolution can be achieved for studies of plasmonic materials.

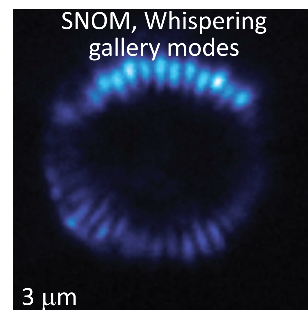


Graphene oxide



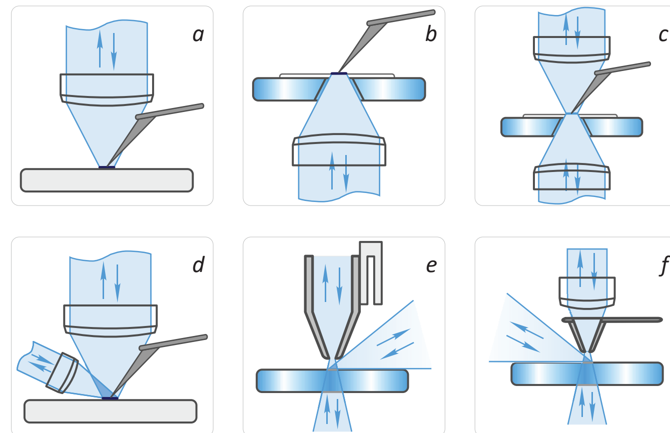


CdS & polymer nanowires



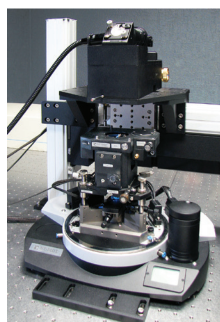
Semiconductor microdisk

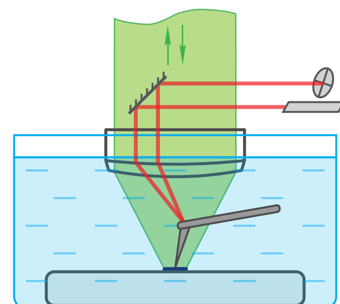
AFM/Optics Configurations for Illumination/Collection



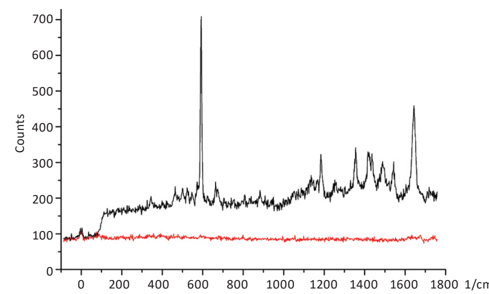
- **Upright (a)**
- **Inverted (b)**
- **Full transmission (“4-Pi”) (c)**
- **Side-Illumination (d)**
- **SNOM: Optical fibers (e) and “smart” probes (f)**

The open-design of NTEGRA Spectra II facilitates a broad spectrum of AFM/Optics applications for characterization of local chemical content, dielectric and plasmonic features in complex samples of various origins. They include polymers, carbon-based compounds, bio-materials, semiconductors etc. Spatial resolution of such measurements has approached the nanometer scale.





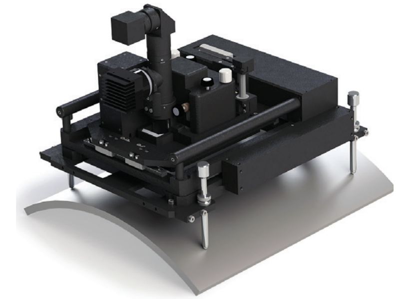
TERS in liquid, upright configuration



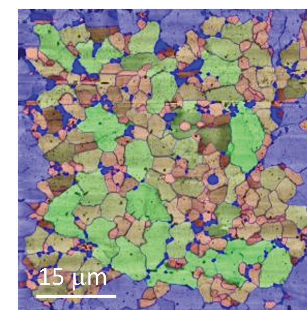
TERS (black) and microRaman (red) spectra

SOLVER Pipe II – Nondestructive in-field AFM diagnostics of structural and bulky objects

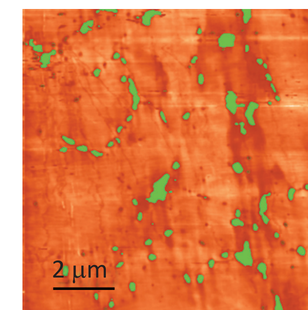
- **Unlimited object size – AFM can be fixed in-field at any bulky object from top, bottom or side**
- **Provides nanometer-level spatial resolution**
- **Automated defect analysis**



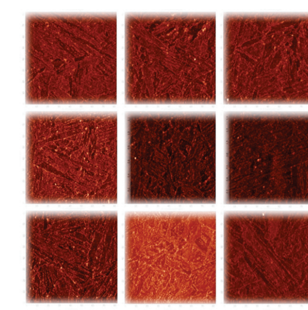
SOLVER Pipe II is an AFM which is designed especially for nondestructive in-field study of structural and bulky objects. High spatial resolution allows to diagnose corrosion and other destructive processes at early stages. This allows to forecast the future behavior of industrial and highly loaded objects such as: powerplant pipes, turbines, shafts, etc. below 50% of wear degree. Automated 50×50 mm XY mover coupled with high resolution optics and angle self-adjusting approach mechanism allow precise and accurate location of inspection area. Included software package of statistical and grain segmentation instruments allow to make the comprehensive defect analysis of measured data.

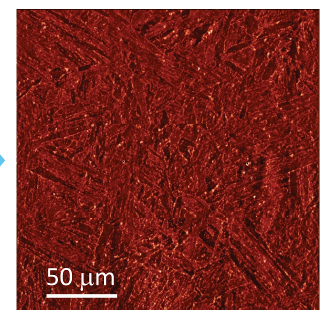


Automatic grain analysis



Automatic pore analysis



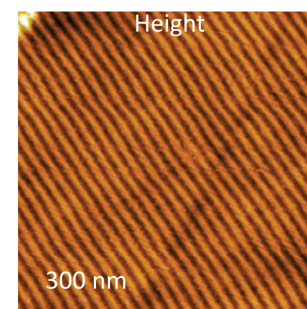


Inspection of large areas with AFM resolution. Size of stitched image: 220×220 µm

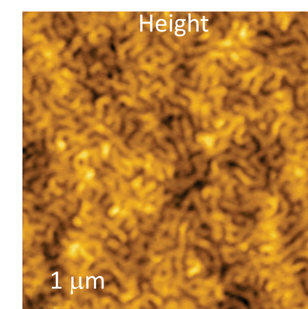
SOLVER Nano – Effective Solution for Education and Research

- **SPM heads for novice and expert users**
- **Apprentice toolkit**
- **Flexible choice of probes**
- **Compact design and affordable cost**

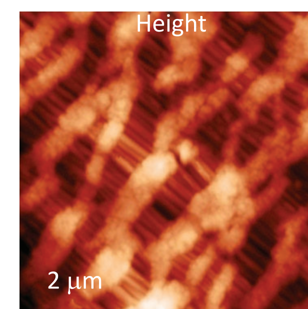
NT-MDT SI Nano is a robust, small footprint SPM with a wide range of features:
- Educational head for STM & AFM intermittent contact mode by user made tips.
- Student toolkit to etch probes.
- Research head for most common AFM modes with commercially available tips.
- Routine imaging of nanoscale structures.



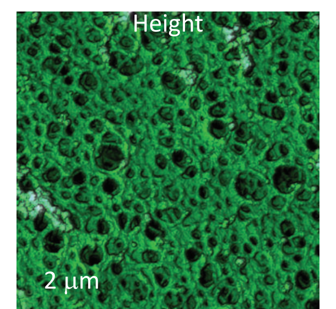
$C_{60}H_{122}$ alkane on HOPG



Block copolymer



Microporous membrane Celgard

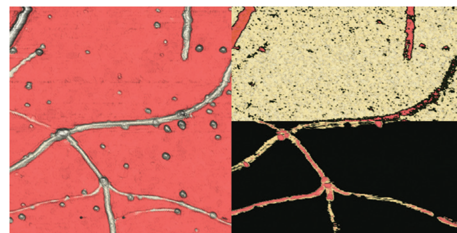


Nitrocellulose membrane

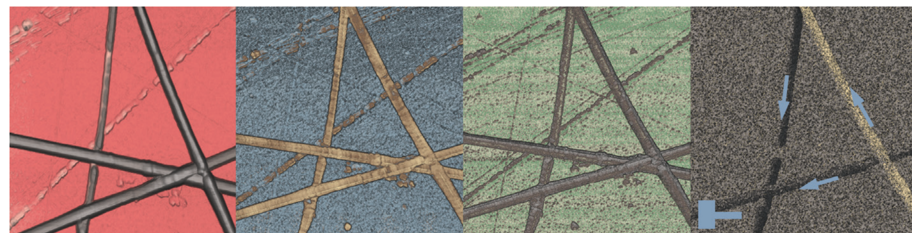
HybriD mode

- **Fast Quantitative Nanomechanical Measurements and Force Volume**
- **Simultaneous Electrostatic and Non-destructive Conductive, Piezoresponse, Thermoelectric and Thermal studies**
- **Advanced Cantilever-Type Tip-Enhanced Raman Scattering and Scanning Near-Field Optical Microscopy**

In HybriD mode tip-sample distance is modulated according to the quasi-harmonic law. Thus tip enters a force interaction with the sample thousands of times per second. Force-distance curve analysis enables maps mappingof topographical, nanomechanical, electrical, thermal, thermoelectric and piezoelectric properties of the sample to be extracted with high spatial resolution and eliminated lateral forces. High-performance electronic components and unique algorithms implemented in the state-of-the-art HybriD 2.0 Control Electronics provide superb level of real-time signal processing and analysis.
Combination with cutting-edge optical microscopy and spectroscopy techniques opens-up novel opportunities of cantilever-base tip-enhanced Raman scattering (TERS) and scattering scanning near-field optical microscopy (s- SNOM).



HD PC-AFM study of carbon Nanotubes on Silicon: Topography (left), Elastic Modulus (top), Current (bottom)

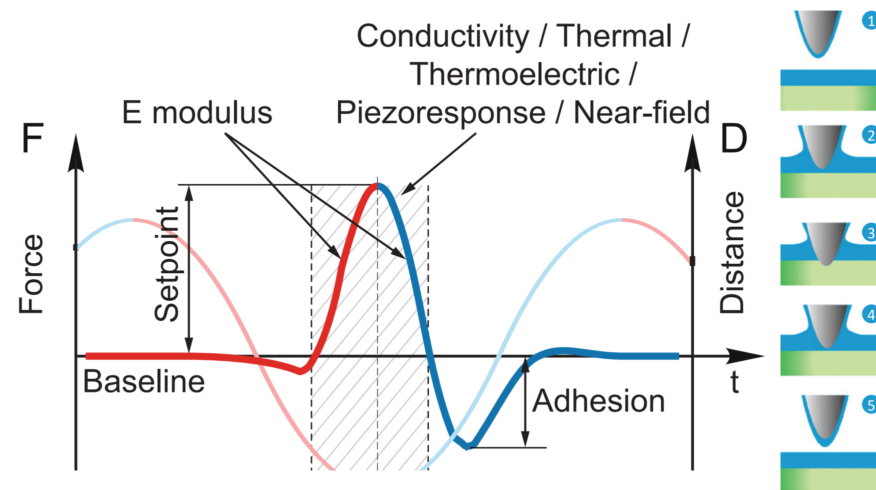


Non-destructive electromechanical study of diphenylalanine peptide nanotubes: topography, adhesion, deformation and in-plane piezoresponse phase (polarization direction and probe position are marked by light-blue)

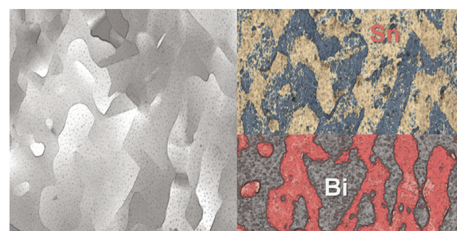
Full list of measured properties:

- Straight forward Topography studiesin in air, liquid and vacuum
- Young's Modulus and Force Volume
- Adhesion and Work of Adhesion
- Conductivity
- In-Plane and Out-of-Plane Piezoresponse
- Temperature and Thermal Conductivity
- Electrostatic: Kelvin Probe Force, Electrostatic Force and Scanning Capacitance Force Microscopy
- Near-Field Component of Optical Response
- Tip-Enhanced Raman Scattering

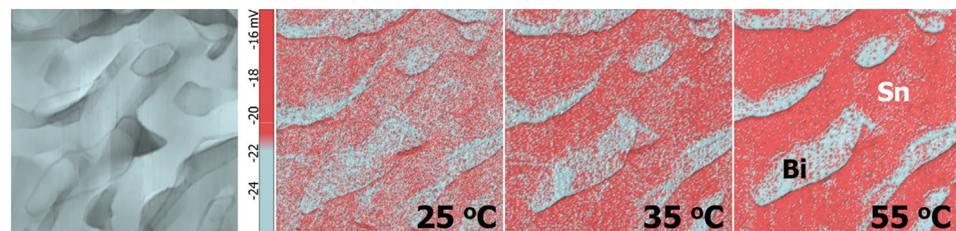
Conductivity / Thermal / Thermoelectric / Piezoresponse / Near-field



HybriD mode working principle



HD KPFM study of BiSn alloy. Left – topography, top – Young's modulus, bottom – surface potential

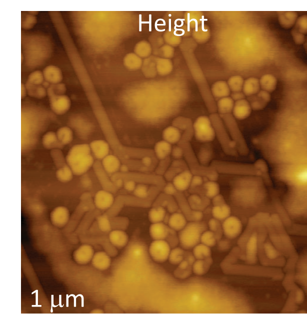


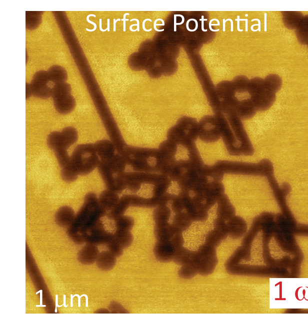
HD SThEM study of BiSn alloy. Left – topography, right – generated voltage at the specified sample temperature. Seebeck coefficient, S: Bi -72 mV/C, Sn -1.5 mV/C.

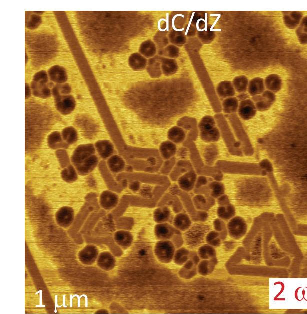
PX Controller – the Core for High-Quality & Advanced SPM

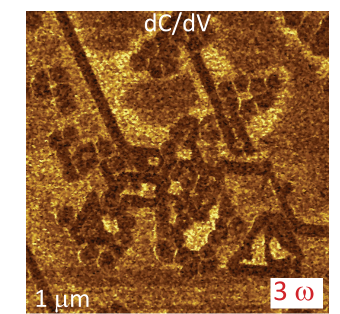
- **Built-in 5 lock-in amplifiers**
- **Detection channel up to 5 MHz**
- **Modular design**
- **Support all NT-MDT SI microscopes**

Our powerful PX digital controller incorporates a low-noise high voltage generator (< 1 mV/600 V), five lock-in amplifiers and sensitive detection electronics (up to 5 MHz) enabling measurements with negligible deflection noise (~25 fm/√Hz). The latter helps to make imaging in the atomic-scale as the routine procedure. The controller features provide a microscope user with a large spectrum of imaging and in single- and multi-frequency operations, which tremendously expand the research capabilities for visualization of surface structures and local quantitative studies of materials' properties down to the nanoscale.



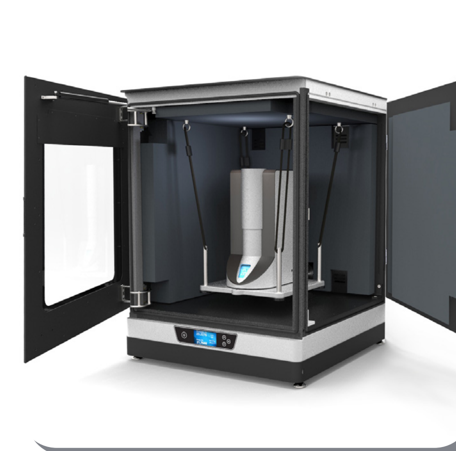






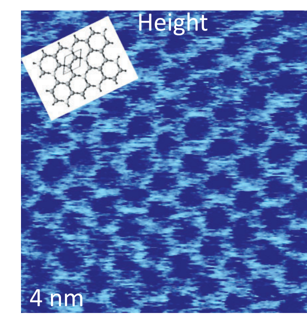
$F_{14}H_{20}$ fluoroalkanes on HOPG

Thermal Cabinet for NT-MDT SI Microscopes

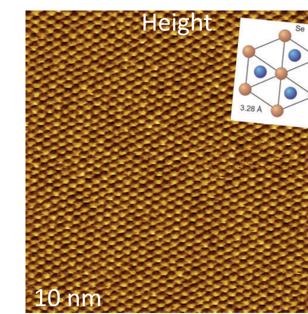


- **Unique solution for high-performance microscope environment**
- **Exceptional temperature stability**
- **Low-thermal drift medium**
- **Excellent acoustic and vibrational isolation**

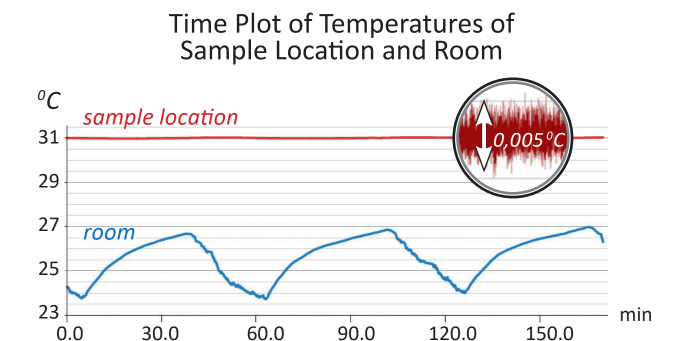
This new fan-free enclosure provides NT-MDT SI microscopes the capability to operate at conditions of extraordinary temperature stability within 5 millidegree ˚C. This guarantees the exceptionally low thermal drift of less than 0.2 nm/min. The cabinet also protects the positioned microscope from external acoustic and vibrational noises with passive and active means of damping.

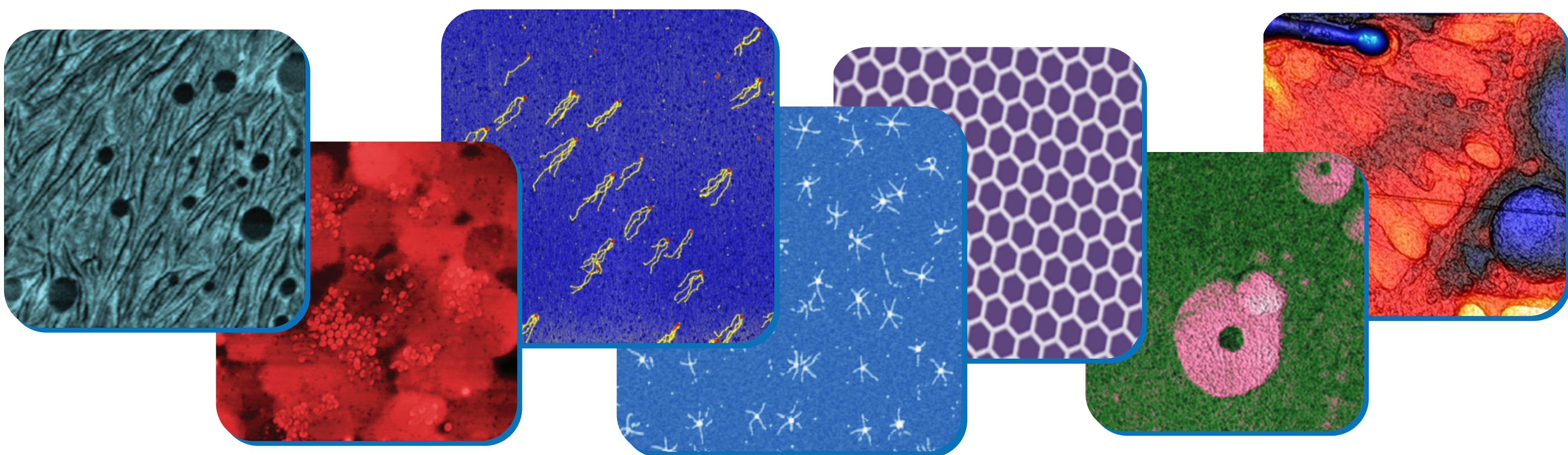


Mica



$MoSe_2$





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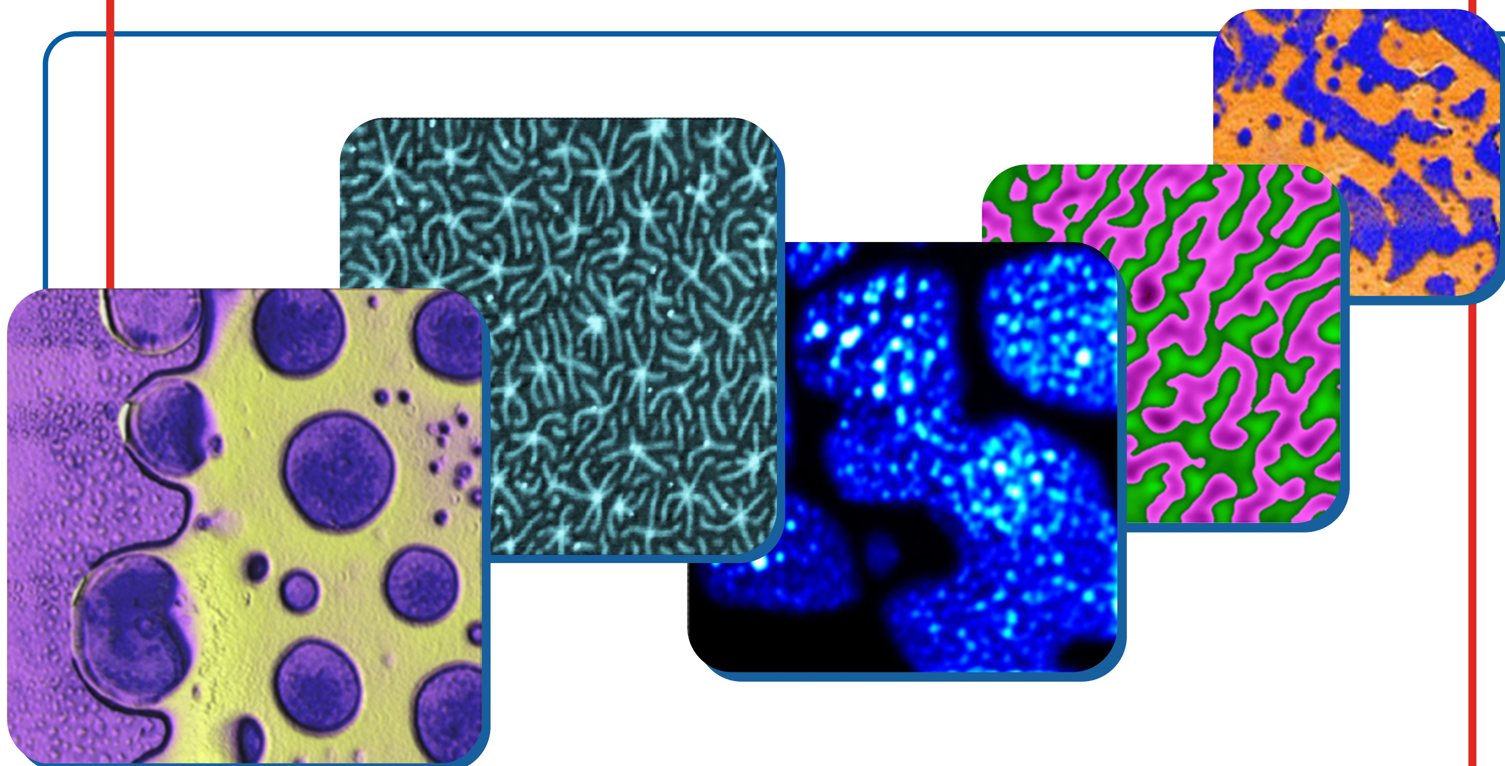

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