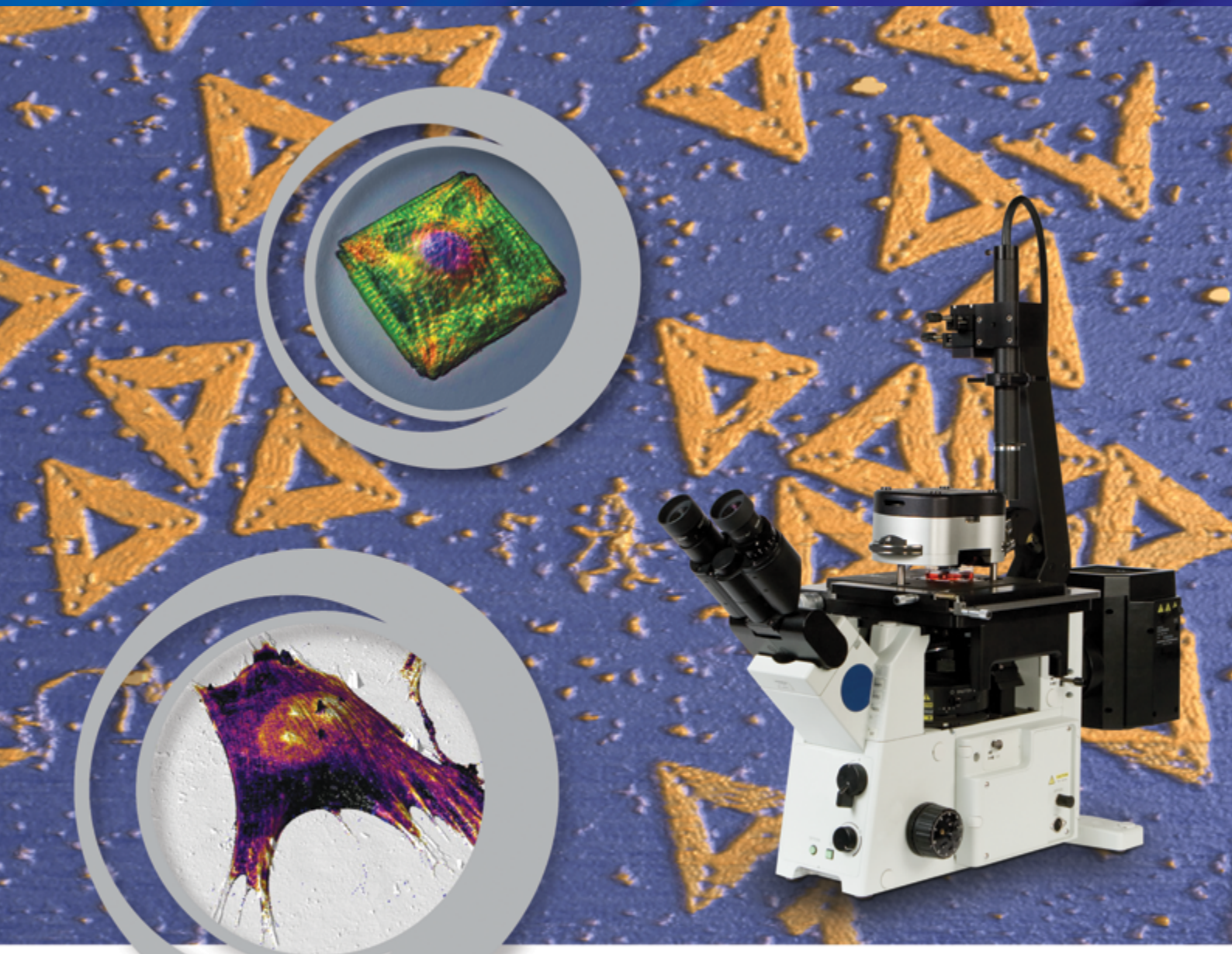
AFM

Asylum Research

MFP-3D-BIO

The only full-capability AFM on an inverted optical microscope



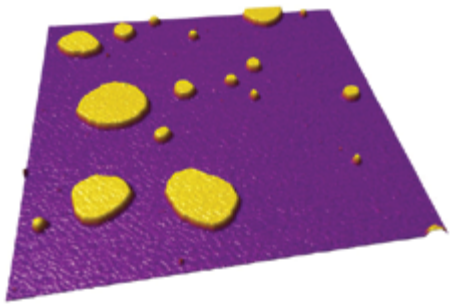
OXFORD INSTRUMENTS

ASYLUM RESEARCH

MFP-3D-BIO

Full-capability AFM integrated with optical microscopy

The Asylum Research **MFP-3D-BIO**™ sets the standard for integrating AFM and optical microscopy for bioscience research. It is the only bioAFM that makes no compromises to AFM imaging resolution, force measurement performance, or application versatility while seamlessly integrating with a full range of optical techniques. This, along with unmatched support from Asylum experts, make it the best, most productive bioAFM to achieve your research objectives.



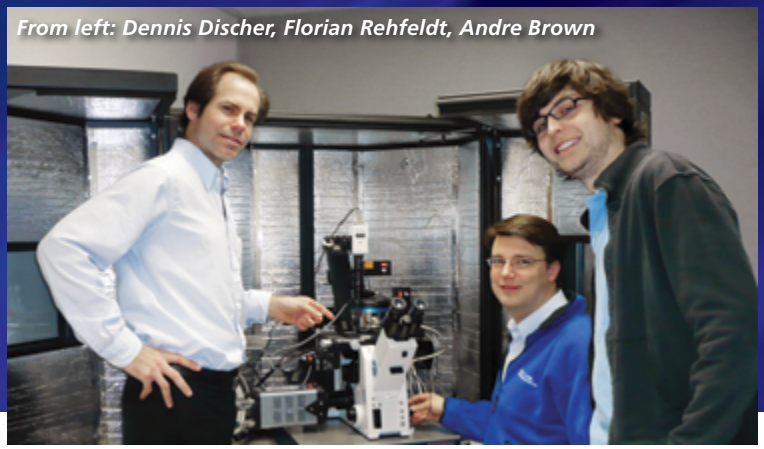
2.5 µm scan of supported lipid bilayers (5 nm tall) adsorbed onto mica and imaged in buffer.

The Performance and Versatility to Get the Results You Need

- Uncompromised AFM performance integrated with optical microscopy
- Simple, high-resolution imaging in liquid for soft biological samples
- Performance leadership in force spectroscopy and force mechanics
- Unmatched versatility to satisfy the diverse needs of multiple users
- Unrivaled support from bioAFM experts to get the results you need

"We chose Asylum's MFP-3D-BIO AFM because it has the most powerful AFM capabilities of the inverted optical integrated systems. It excels in all aspects, from optical integration to high-resolution imaging and dimensional measurements to force spectroscopy and elasticity measurements of soft tissue matrices. Asylum's quality and reliability allow us to focus on the science."

– Prof. Dennis Discher, University of Pennsylvania

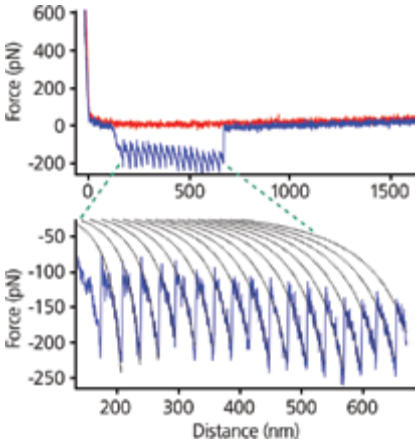


From left: Dennis Discher, Florian Rehfeldt, Andre Brown

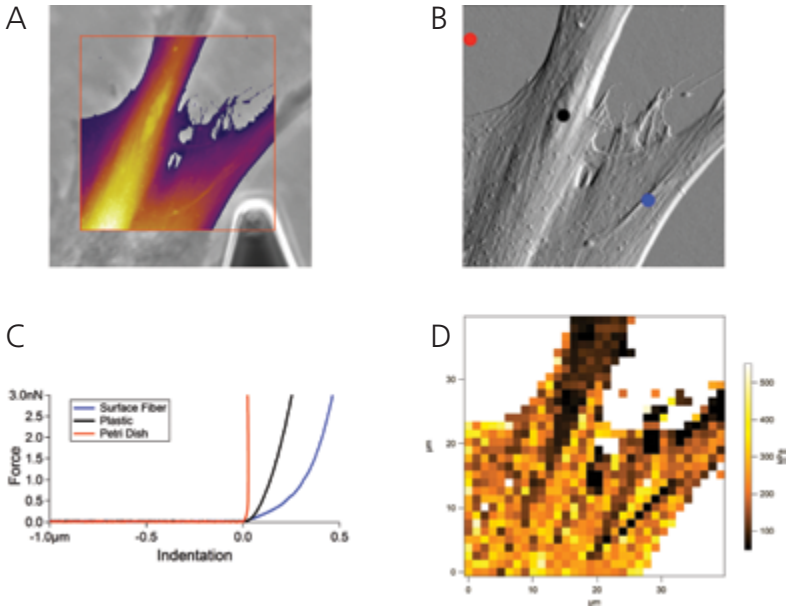
Performance Matters in a BioAFM

"Performance matters" might sound like an obvious statement, but some companies make all sorts of compromises to performance in their bioAFMs. Some literally have a hole through the middle of their AFM head. While that permits the use of some standard optical condensers, it also degrades imaging resolution and interferes with quantitative force measurements.

In contrast, the stability of the MFP-3D-BIO allows it to measure picoNewton forces and resolve the smallest features of your samples. The flexure-mounted optical lever mechanism moves as a single robust unit, virtually eliminating non-linearities, off-axis motion and interference fringes. Our custom-designed condenser optics provide unobstructed top-down sample viewing and enable standard optical microscopy modes, including phase contrast.



The unfolding of fibril amyloid beta-sheets in algal adhesive reveals a distinct sawtooth pattern. The force curve was fitted to the worm-like chain (WLC) model (dotted lines) and a persistence length of 0.22 nm was calculated. Data from Mostaert et al., J. Biol. Phys. ***32****(5):393 (2006).*



The MFP-3D-BIO includes powerful features for investigating cell mechanics. A) Here, a MRC-5 fibroblast cell was located using phase contrast optics and a scan box was drawn to define a region for AFM imaging. The resulting AFM topography data was overlaid on the optical image using thresholding to remove the portion of the image corresponding to the bare petri dish. B) The same optical image was then used to guide the location of three individual force curves. C) The force curves clearly show the stiff petri dish substrate (red), the much softer cell body (black), and a yet softer fiber (blue). D) Finally, a 32x32 point force map was measured over the entire area and built-in indentation model analysis was used to calculate the modulus at each point.

LIGHT

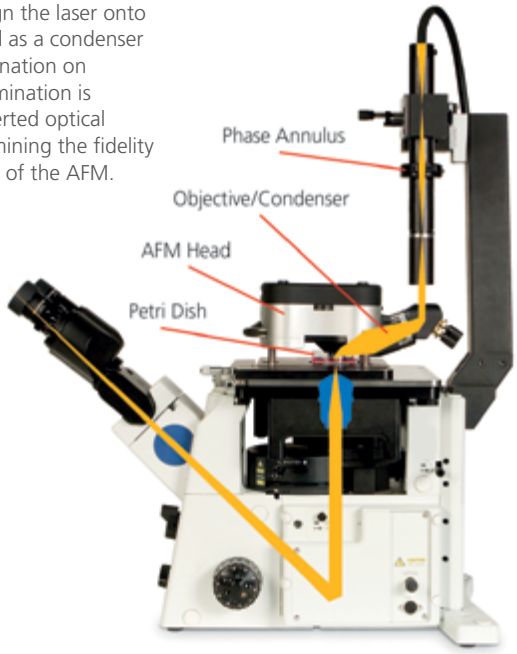
Seamless Optical and AFM Integration

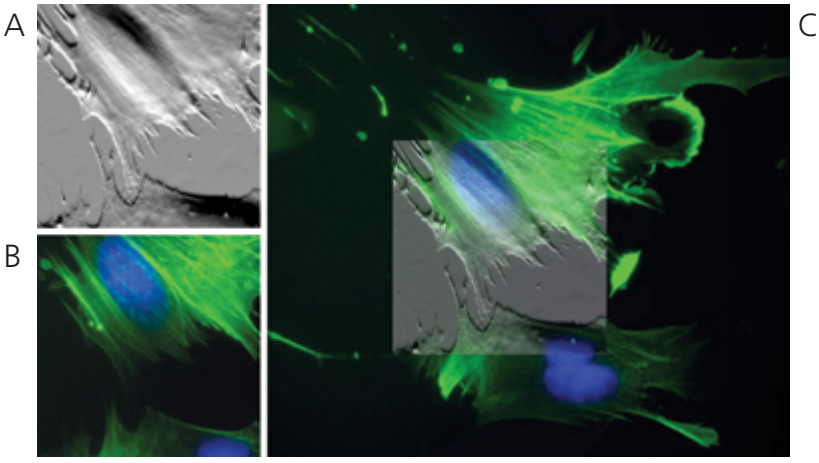
Light up your AFM without compromising performance

The MFP-3D-BIO sets the industry standard for combining optical and atomic force microscopies in a single integrated tool specifically designed for biologists. Our team of biologists and optical engineers have optimized the MFP-3D AFM for use with the leading inverted optical microscopes to ensure that you get the maximum benefit and productivity from the combination of these powerful techniques. High numerical aperture, water immersion, and TIRF objectives are all accommodated. All of the following optical techniques are supported:

- Brightfield
- Phase Contrast
- Epifluorescence
- Confocal Microscopy
- TIRF
- FRET
- FCS
- FRAP
- Ion Indicators (e.g. Ca^{2+} response)

The optical path through the head of the MFP-3D-BIO utilizes a high-quality objective that can be used to view the top of opaque samples and to align the laser onto the tip. The objective can also be used as a condenser for brightfield or phase contrast illumination on transparent samples. High-quality illumination is achieved for observation with the inverted optical microscope objectives without undermining the fidelity of the optical lever or Z-flexure design of the AFM.





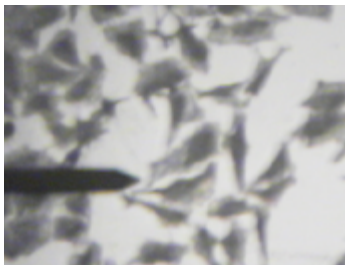
Multiply-labeled fibroblasts imaged in buffer using contact mode AFM (A), and fluorescence microscopy (B). The MFP-3D's standard overlay feature produced the composite image (C). Our proprietary IR filter blocks the AFM laser, enabling clean, full-spectrum fluorescence imaging – including far-red fluorophores.

"The MFP-3D-BIO is a research instrument through and through and designed for the scientist. The optical integration is exceptional, and the flexibility of the platform offers almost endless possibilities."

– Prof. Jan Hoh, Johns Hopkins University

Illuminate or View with Built-in Top-Down Optics

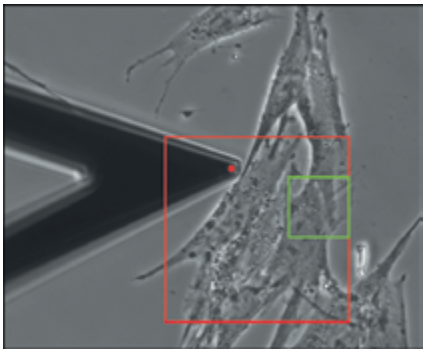
The MFP-3D-BIO extends the capability of the inverted optical microscope by allowing you to view transparent and opaque samples from above while scanning with the AFM. The integrated top-view optics enable *in situ* laser alignment and tip positioning without removing the AFM head and without ancillary equipment. Our unique design also allows the top-view objective lens to double as a high-quality condenser for phase contrast illumination.



Top-view optical images: (top) HeLa cells on silicon, (bottom) pollen grains.

Real-time Optical Navigation

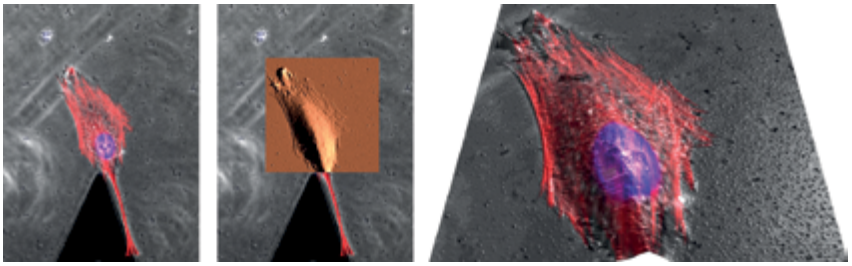
Top or bottom-view optical images can be used to navigate the tip to any feature on the sample and then scan that area at the nanoscale with the AFM or select specific locations for force curves – easily and seamlessly.



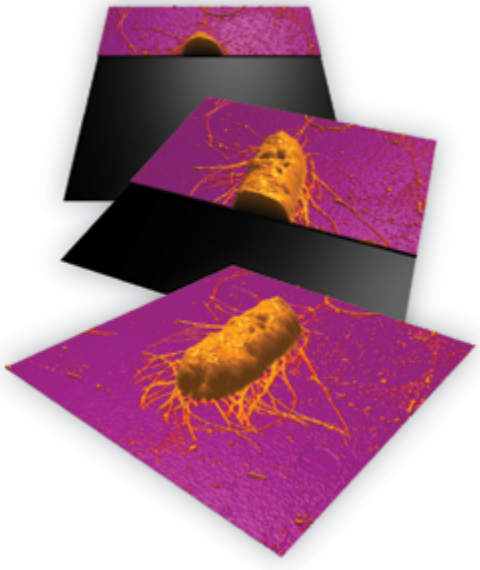
40X phase contrast image of MRC-5 fibroblasts on a Petri dish. With a single click, you can direct the tip (red dot) to any point, or select a new scan area (green box) within the scan range (red box).

Powerful Real-time and Offline Rendering Options

Both AFM and optical images can be rendered and viewed together in both real-time and offline. Optical images can be overlaid on AFM data to assist interpretation. Stunning 3D renderings combine AFM topography with the capabilities of light microscopy.



Locate a cell with phase contrast (gray) or fluorescence and examine features such as cytoskeletal structures (red) or the nucleus (purple), then zoom in for high-resolution topography or force measurements with AFM (copper). Overlay optical data on AFM topography for 3D analysis and presentation (right).



Sequence of real-time 3D renderings of E. coli on glass showing structure and fimbriae, 5 µm scan.

VERSATILE & SIMPLE

Full capability and ease of use

A bioAFM that satisfies the needs of beginners and experts alike

Not all AFM users are AFM experts and even the experts appreciate keeping operation as simple as possible. At Asylum Research, we develop ease of use improvements that offer genuine advantages to both groups without compromising capability or flexibility.

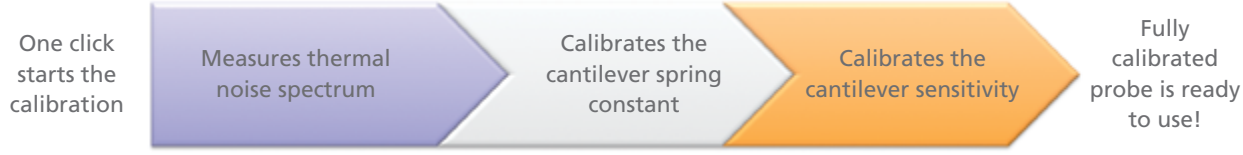
ModeMaster™

- Automatically configures the software for the selected mode
- Supports both basic and advanced imaging techniques
- Makes getting started quick and easy

ModeMaster enables one-click configuration for more than thirty different modes.

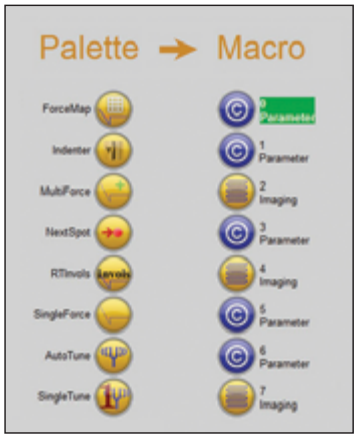
GetReal™

- One click calibrates the cantilever sensitivity and spring constant
- Tip never touches the sample, so there's no need for a hard surface
- Process is fast, simple and accurate with no risk of damaging the tip



Automation? Advanced needs? No problem.

- MacroBuilder™ allows you to easily implement custom routines by simply dragging "modules" together to form macros, no coding required
- Even greater customization potential is possible with the lower-level IGOR Pro scripting language



"Our MFP-3D is a highly reliable and key tool in our NanoImaging Core Facility. In addition to 'traditional' imaging in air, it has outstanding capabilities for imaging in liquid and performing reliable and accurate force measurements. The simplicity of the software allows us to easily train students, yet the open setup of the instrument makes it flexible and powerful for very high-end projects, including nanolithography and nanomanipulation."

– Prof. Yuri Lyubchenko, University of Nebraska Medical Center

Yuri Lyubchenko with Luda Shlyakhtenko

Leadership in Force Spectroscopy and Force Mechanics

- Thermally-limited force resolution (<8 pm deflection noise typical, <20 pm guaranteed)
- Large Z range (15 µm standard, 40 µm extended Z option) accommodates demanding applications such as cell-cell and cell-substrate adhesion measurements
- Users can choose between open loop force curves with sensored Z for the ultimate in low noise performance or closed loop Z for the most accurate velocity control
- Force Mapping measures force-distance curves at a grid of points with automated fitting of indentation models for estimation of elastic modulus and automated adhesion / rupture force analysis
- Analysis software helps by suggesting the most appropriate indentation model among many built-in options, including Hertz / Sneddon, Johnson-Kendall-Roberts (JKR), Derjaguin-Müller-Toporov (DMT), and Oliver-Pharr, or customers may also freely enter their own customized models
- Force Clamping for single-molecule and bond-rupture force spectroscopy measures unfolding or rupture kinetics under constant force, allowing direct comparison to theoretical models

Great for Biology, but Also Ready for Much More

The MFP-3D-BIO is based on the powerful MFP-3D Origin+ standalone AFM, so it is compatible with Asylum's full range of accessories, modes, and options. That means it can be ready to successfully do its job for any application, whether it's in biophysics, biology, photonics or far outside the realm of ordinary bioAFMs in materials science, microelectronics, and functional materials. It will continue to support your goals no matter what direction you take your research.

Effective, Easy to Use Accessories for Biological Applications

Petri Dish Holder
Specially designed sample plate for imaging cultured cells and other biological samples in Petri dishes.

Petri Dish Heater
Petri Dish Holder supporting heating from ambient to 45˚C.

Closed Fluid Cell
Sealed chamber with inlet / outlet ports for liquid or gas media.

BioHeater™
Closed Fluid Cell for imaging in liquid between ambient and 80˚C.

Fluid Cell Lite
Economical portless fluid cell. Ideal for individual users at multi-user facilities.

CoolerHeater
Heats and cools samples with a Peltier element. Continuous temperature control from -30˚C to +120˚C.

Humidity Sensing Cell
Measures humidity within a sealed cell.

MicroFlow Cell
Small volume fluid exchange cell.

Specifications

High Precision 3D Motion

Closed loop sensors on all three axes:
X & Y range 120 µm, **X & Y sensors** <0.6 nm noise
Z range >15 µm, **Z sensor** <0.25 nm noise
Optional Extended Z Head with range >40 µm
DC height noise <50 pm

Lowest Noise Single Molecule or Cellular Force Measurements

Cantilever deflection noise <15 pm (typical 8 pm)
Low coherence source Superluminescent diode (SLD) for ripple-free baseline.
Cantilever spring constant calibration by the thermal noise and Sader methods or GetReal automated cantilever calibration.
Flexible interface allows recording or triggering from any channel during a force curve, including amplitude/phase from AC or Dual AC™ mode; user-supplied input voltages; and photon count rate (with optional Digital Access Module).
Force mapping including automated adhesion and elastic modulus analysis.

Optical Microscope Integration

Includes stage unit for mounting on inverted optical microscope: Olympus IX73, IX81, IX83; Nikon Ti-E/U/S, Ti2-E/A/U; or Zeiss Axio Observer models. Inquire regarding other models.
All standard objective lenses including high NA oil- and water-immersion and TIRF objectives are supported.
Infrared source 860 nm SLD for compatibility with far-red fluorophores. Matched interference filters in AFM head and optical microscope completely block the SLD beam from fluorescence detectors and cameras.
Software overlay of optical images on AFM data in both 2D (variable alpha) and 3D (topographic rendering).
Optically guided region of interest (ROI) selection for imaging and force curves/maps.
Top view optics with 10x / 0.28 NA objective lens, for SLD spot alignment and positioning tip on opaque samples.
Phase contrast enabled with included condenser and annuli for Ph2, Ph1, and Ph0/C/L objectives (purchased separately).
Compatible optical techniques See page 4 and inquire regarding other techniques.

Superior Usability

Included modes Contact mode; Dual AC™, DART™ PFM; Dual AC Resonance Tracking (DART); Electric force microscopy (EFM); Fluid imaging; Force modulation; Frequency modulation; Kelvin probe force microscopy (KPFM); Lateral force mode; Loss tangent imaging; Magnetic force microscopy (MFM); Nanolithography / nanomanipulation; Piezoresponse force microscopy (PFM); Phase imaging; Switching spectroscopy PFM; Tapping mode (AC mode); Tapping mode (AC mode) with Q control; Vector PFM
Optional modes AM-FM Viscoelastic Mapping Mode; Conductive AFM (CAFM) with Eclipse™ mode; Contact Resonance Viscoelastic Mapping Mode; Electrochemical Strain Microscopy (ESM); Force modulation; High voltage PFM; Scanning Thermal Microscopy (SThM); Scanning Tunneling Microscopy (STM);
Sample format 75x25 mm typical. Maximum 80 mm diam. x 5 mm high. Up to 22 mm high with optional leg extenders.
Sample adapters included for coverslips (12 or 25 mm diam. or 22x22 mm) and Petri dishes (plastic and coverglass-bottom). See the MFP-3D AFM Options and Accessories brochure for heating, flow-through, and humidity sensing sample holders.

Service and Support

Warranty One-year comprehensive warranty.

Support Ask about service and support agreements that extend the original warranty and offer additional training and support services.

(All noise measurements are quoted as the average deviation measured with a 1 kHz bandwidth over a full 10 seconds at the center of the scanner range. Specifications assume required vibration and acoustic isolation in an appropriate laboratory environment.)

Visit **AFM.oxinst.com/mfp-3d-bio** to learn more and get a quote

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Class 1 laser product

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