

# AFM

Asylum Research

## Jupiter XR Atomic Force Microscope

Large-Sample AFM with Superior Resolution, Speed, Ease of Use, and Flexibility



OXFORD  
INSTRUMENTS  
ASYLUM RESEARCH



# DISCOVER

## Jupiter XR Eclipses Every Other Large-Sample AFM

Jupiter™ Offers Superior Resolution, Speed, Ease of Use, and Flexibility

The Asylum Research **Jupiter XR** Atomic Force Microscope from Oxford Instruments is the first and only large-sample AFM to offer both high-speed imaging and extended range in a single scanner. Jupiter provides complete 200 mm sample access and delivers higher resolution, faster results, a simpler user experience, and the versatility to excel in both academic research and industrial R&D laboratories.

### Highest Performance

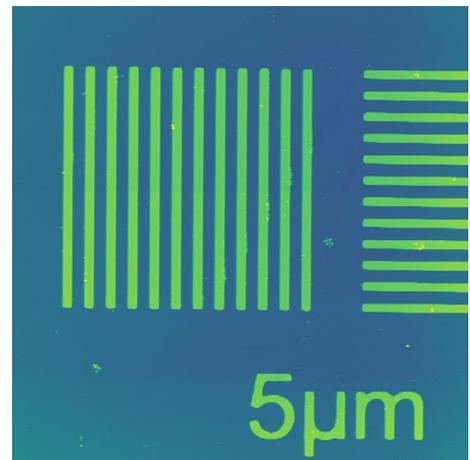
- Higher resolution than any other large-sample AFM
- Extended-range scanner is 5-20× faster than most AFMs and features large 100 μm X-Y & 12 μm Z range
- Exclusive blueDrive™ Tapping Mode gives more reproducible results and simplifies operation

### Simpler User Experience

- Fully-motorized laser and detector setup eliminates manual adjustment of knobs
- Fully-addressable, high-speed stage rapidly reaches any point on 200 mm samples
- Sharp top-view optics help you easily locate your precise region of interest
- Go from atoms to large 100-μm scans and use any imaging mode, all with the single XR scanner

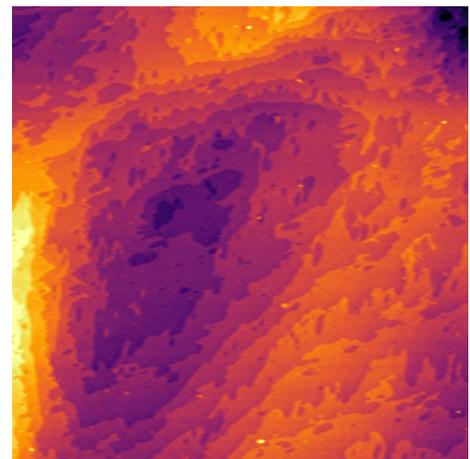
### Versatility for Diverse Research Needs

- Support for a full range of imaging modes
- Modular design makes it fast and simple to add accessories and future upgrades
- Flexible software makes routine measurements easy while enabling advanced research



#### **Optical standard, 100 μm scan**

The large scan range on Jupiter XR allows it to scan from atomic-level to microscale features, all with a single scanner. This image was acquired with 512 lines in ~4.5 min at 2 Hz line rate.



#### **HF-etched mica, 2 μm scan imaged in 26 s**

The atomic layers in mica are a useful scan speed challenge sample—to track the steps accurately, a higher imaging bandwidth is necessary. This image was acquired with 512 lines in 26 s at 20 Hz line rate.

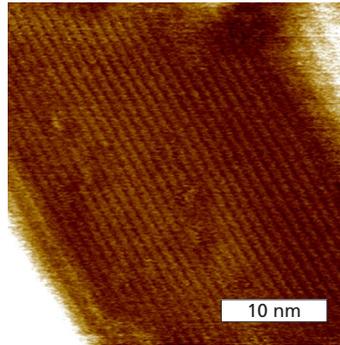
# OUTPERFORMS

## A New Performance Standard for Large-Sample AFM

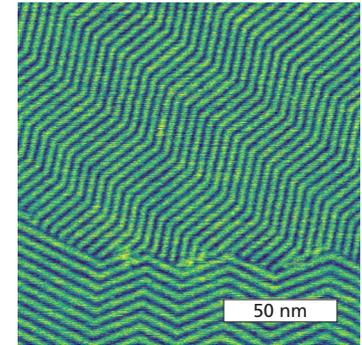
### Higher Resolution and Higher Speed, Powered by blueDrive Tapping Mode

## Higher Resolution

- Resolve smaller features and more accurately measure ultra-flat samples
- Jupiter has the lowest noise floor (<25 pm) of any large-sample AFM



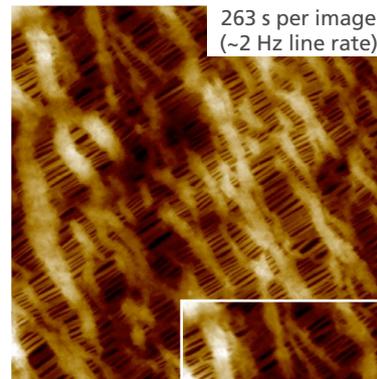
**Lamellae in polyethylene**  
Crystalline regions consist of tightly packed polymer chains with 0.89 nm periodic spacing. The larger features on the sides are disordered regions.



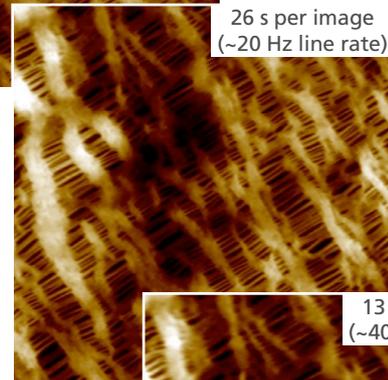
**Cetyl palmitate layer on HOPG**  
This waxy ester compound forms self-assembled structures on HOPG with periodic spacing of 4.3 nm and height of ~100 pm.

## Faster Imaging

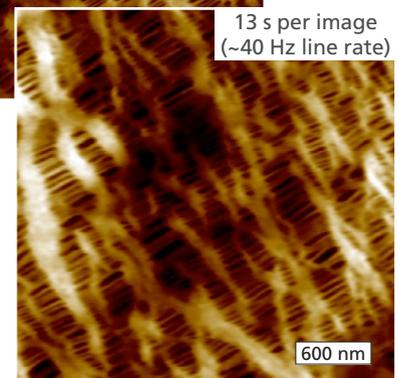
- Routinely capture images in <1 minute, at least 5× faster than most other AFMs
- Many samples can be imaged at ≥20 Hz line rate for typical scan sizes of <10 μm



263 s per image  
(~2 Hz line rate)



26 s per image  
(~20 Hz line rate)



13 s per image  
(~40 Hz line rate)

**Battery separator membrane**  
This polypropylene film has been widely used for AFM imaging speed comparisons because it features challenging topography and is relatively delicate. Here, there are no obvious differences in scan quality going from 2 Hz to 20 Hz scan rate and only very subtle changes at 40 Hz.

## blueDrive Tapping Mode

- Asylum exclusive blueDrive makes tapping mode simpler and more stable
- Improved stability results in longer tip lifetimes, even with fast scanning
- Every Jupiter includes blueDrive for maximum performance and productivity

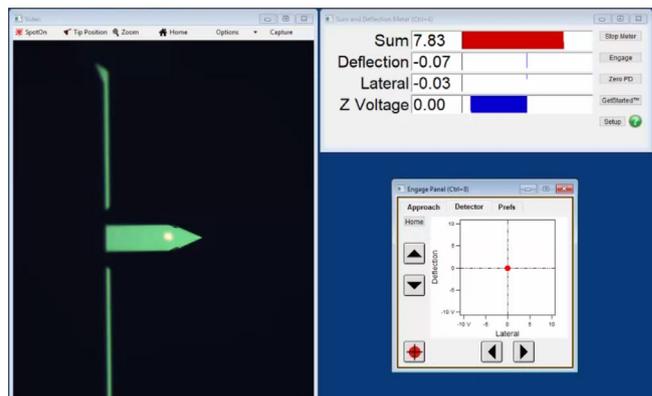
# DELIGHTS

## Jupiter XR Makes It Easier to Get Your Job Done

From Setup to Results, Jupiter Makes Using AFM a Better Experience

### Fast and Simple Setup

- Probes are easily exchanged on the removable Z scanner
- Samples can be held magnetically or by vacuum to the 210 mm chuck
- SpotOn™ feature enables point-and-click alignment of the laser and detector



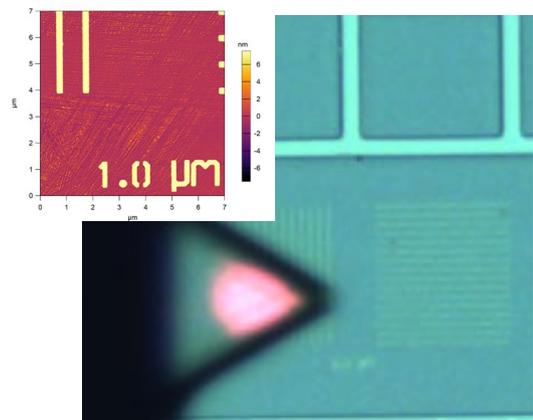
### Quickly Find Your Region of Interest

- Fully-addressable stage reaches any point on 200-mm samples without repositioning the sample
- High-speed stage allows navigation across the entire stage in just five seconds *and* precise micron-scale positioning via software or joystick
- Top-view optics are fully adjustable in software for the sharpest, highest-resolution (<1.5  $\mu\text{m}$ ) view of your samples



### Jupiter XR Can Do It All

- Extended-range 100  $\mu\text{m}$  X-Y and 12  $\mu\text{m}$  Z scanners deliver great performance, from ultra-high resolution imaging all the way up to the biggest scans
- The Jupiter XR scanners are compatible with all modes and optional accessories
- Modular design allows Jupiter to readily accept future upgrades to any of its components



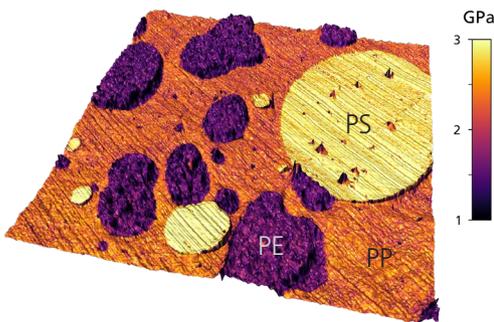
## All the Capabilities of a Top-Quality Research AFM

### Flexibility to Excel at Both Routine Measurements and Advanced Research

**Jupiter XR** makes even routine measurements better with higher resolution, speed, and ease of use. For advanced research, users will find that Jupiter also offers a complete set of imaging modes and accessories. This makes Jupiter ideal for multiuser facilities or any lab with a diverse range of needs.

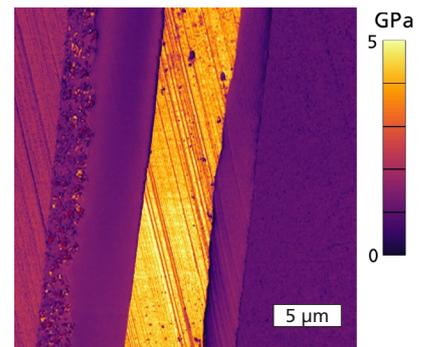
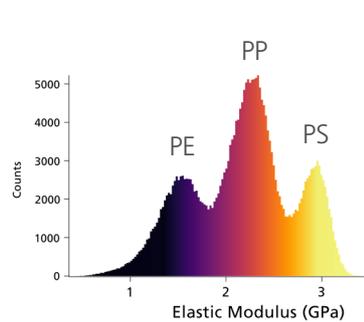
### Quantitative Nanomechanical Measurements

- Asylum offers several techniques for quantitative mapping of storage and loss moduli



#### **Ternary rubber blend**

Polymer blend containing polystyrene, polypropylene, and polyethylene imaged with AM-FM Viscoelastic Mapping Mode. Image shows topography overlaid with modulus, 15  $\mu\text{m}$  scan.

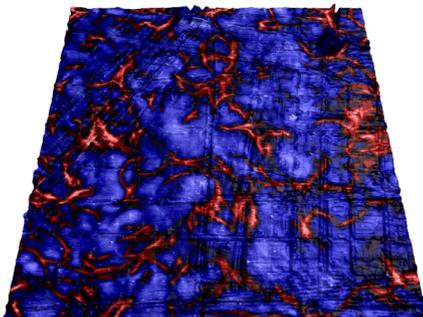


#### **Multilayer polymer film**

AM-FM modulus image shows the components of a food packaging film.

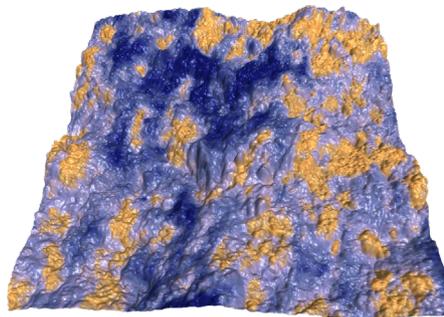
### Highest Sensitivity Nanoelectrical Measurements

- Evaluate properties including current, surface charge, and potential. Additional nanoelectrical characterization techniques are coming soon.



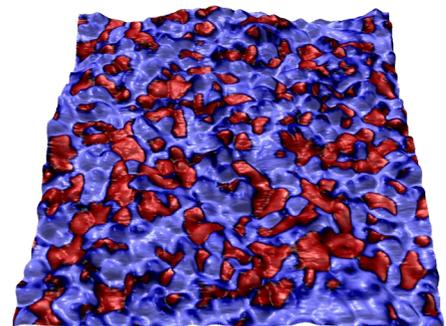
#### **Carbon nanotubes in polyimide**

EFM phase data is overlaid on topography, revealing the locations of carbon nanotubes in the polyimide matrix, 20  $\mu\text{m}$  scan.



#### **Carbon black-filled polymer film**

KPFM surface potential imaging was used to show carbon-rich regions of this static dissipative packaging film, 12  $\mu\text{m}$  scan.



#### **Sol-gel piezoelectric thin film**

PFM phase data is overlaid on topography, highlighting regions where the piezoelectric response is differently oriented, 2  $\mu\text{m}$  scan.

# MEASURES

## Jupiter—the Ultimate AFM for Industrial Metrology

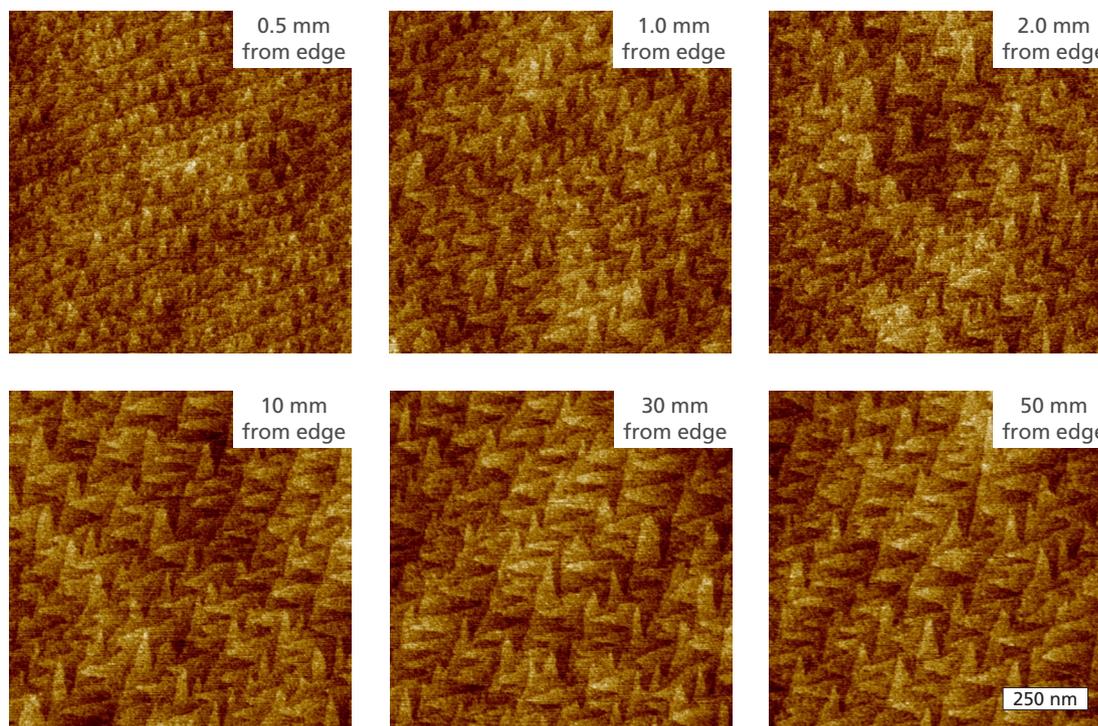
Faster, Simpler, More Accurate, and More Repeatable Measurements

### Faster at Every Step for Higher Throughput

- Setup time is minimized with easy probe loading and one-click laser and detector alignment
- Reach any point on your sample with the fully-addressable 210 mm vacuum chuck
- Move site-to-site quickly with a motorized stage that is >5× faster than any other AFM
- High-speed scanning comes standard—typical scans take 1 minute or less

### Automated Multi-Site Imaging and Analysis Simplifies Your Work

- MacroBuilder enables full automation of both realtime measurements and offline analysis
- Highly flexible interface can handle both simple automation and more complex workflows
- Typical automated measurements can be completed in about 1 minute per site



#### Automated inspection of epitaxial silicon grain structure

Non-uniform grain size can often be observed in epitaxial silicon layers, especially near the wafer edge where there can be greater variations in processing conditions. Here, an automated routine was used to inspect a series of points at different offsets from the wafer edge. The Jupiter software offers flexibility in defining these locations at any point on the 210 mm sample chuck. Roughness ( $R_q$ ) of each image is only 80-85 pm.

# CONFIRMS

## High Throughput Combined with High Performance

### Measure More Sites in Less Time with Complete Confidence in the Results

#### blueDrive Tapping Mode Improves Measurement Repeatability

- On less stable AFMs, tip wear over time causes roughness measurement values to change
- blueDrive keeps imaging exceptionally stable, so tip wear is reduced to negligible levels
- Measured roughness values are highly repeatable, even after 1000 images

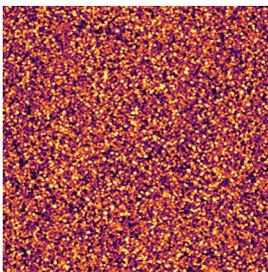


Image #1

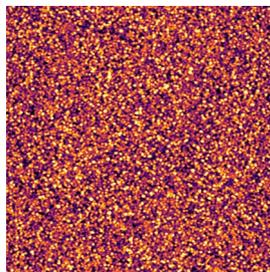
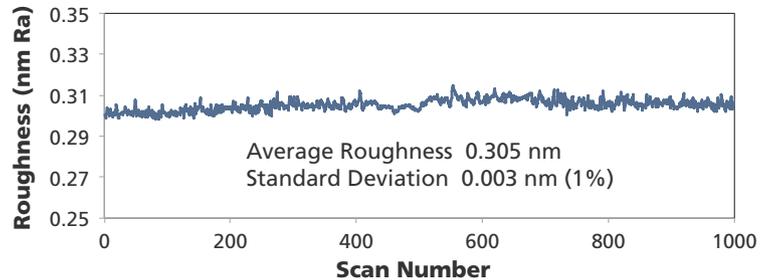


Image #1000

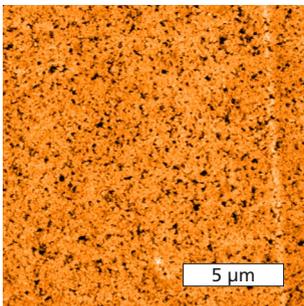


#### High-Accuracy Metrology Results You Can Trust

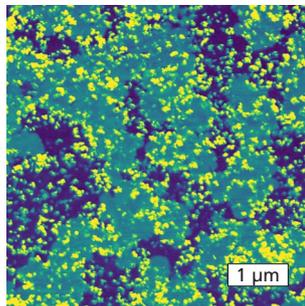
- Unique LVDT position sensors are inherently linear and never require recalibration
- Low-noise X-Y sensors (<150 pm noise) enable distortion-free closed-loop imaging
- Ultra-low-noise Z sensor (<35 pm noise) makes measurements more accurate and repeatable

#### Asylum AFMs Are Used Across Diverse Industries

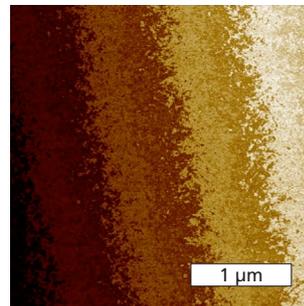
- Asylum Research has been the AFM technology leader for almost 20 years
- Asylum AFM performance and capabilities allow most any sample type to be investigated



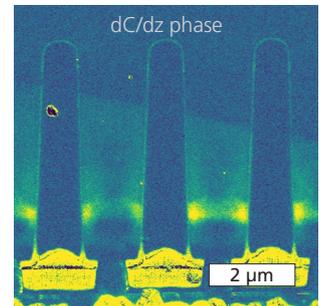
**Coated photo paper**  
AFM is a useful tool to investigate materials and processes for paper coatings and adhesives.



**Tire rubber blend**  
Bimodal imaging reveals the distribution of rubber compounds and carbon black.



**500 pm steps on SiC wafer**  
Silicon carbide is an important substrate for high-power microelectronic devices.



**Insulated-gate bipolar transistor**  
Single-pass KPFM reveals dopant variations in the emitter regions between trench gates.

# SPECIFICATIONS

## Jupiter XR Scanner

**X-Y range** 100  $\mu\text{m}$  (typical, closed-loop), 90  $\mu\text{m}$  guaranteed

**X-Y sensor noise** <150 pm

**Scan speed** depends on samples and scan conditions, but many samples can be imaged at line rates  $\geq 20$  Hz for scan sizes of  $\leq 10$   $\mu\text{m}$  with little or no degradation of image quality. Larger scans and rougher samples may require lower scan rates. In typical use, line rates between 5-20 Hz are routine.

**Z range** 12  $\mu\text{m}$

**Z sensor noise** <35 pm

*(The X-Y and Z scanners and chucks are fully modular and easily exchanged for future upgrades and accessory options.)*

## Cantilever Deflection Sensing

**Optical detection light source** Superluminescent diode (SLD) source. Spot size of  $\sim 10$   $\mu\text{m}$  is compatible with small levers such as the Asylum FS-1500, Nanoworld Arrow UHF, and Olympus AC55 in addition to all conventional probes.

**Wavelength** 670 nm (nominal)

**DC detector noise** <10 pm

**AC detector noise** <30  $\text{fm}\cdot\text{Hz}^{-1/2}$  above 100 kHz

**Detector bandwidth** DC to 7 MHz

Point-and-click spot positioning and detector adjustment are fully motorized and software controlled.

## blueDrive Tapping Mode

Asylum exclusive blueDrive Tapping Mode uses photothermal excitation at 640 nm to excite the cantilever resonance in all AC-based modes. It is included on all Jupiter XR systems. Point-and-click spot positioning and power adjustments are fully motorized and software controlled.

## Imaging Performance

**DC height noise** <25 pm

**AC height noise** <25 pm

## Top-view Bright-Field Optics

**Resolution** Diffraction limited ( $<1.5$   $\mu\text{m}$ ), NA=0.30

**Field of view** 930 $\times$ 1240  $\mu\text{m}$

**Illumination** Intensity, aperture diaphragm, and field diaphragm adjustable from software.

## Sample Chuck and Motorized Stage

**Sample chuck** accommodates samples up to 210 mm in diameter and up to 35 mm tall. Wafer locating pins and vacuum rings are provided for 2 in, 4 in, 5 in, 150 mm, and 200 mm wafers. Eight magnetic mounting points are provided for samples prepared on standard 10-15 mm diameter discs.

**Motor Stage** allows positioning of any point on a 200 mm wafer under the AFM probe (i.e. fully addressable). Maximum stage velocity is 40 mm/s.

## Instrument Isolation

**Acoustic** Included enclosure provides  $\sim 20$  dB of isolation.

**Vibration** Active vibration isolators offer superior performance in a wide range of laboratory environments (sold separately).

## Included Operating Modes

**Basic Modes** Contact mode; Force curves; Frequency modulation; Lateral force mode (LFM); Nanolithography and nanomanipulation; Phase imaging; Tapping mode (AC mode); Tapping mode with digital Q control

**Nanomechanical Modes** AM-FM Viscoelastic Mapping Mode; Bimodal Dual AC; Contact Resonance Viscoelastic Mapping Mode; Force mapping mode (force volume); Force modulation; Loss tangent imaging

## Nanoelectrical, Functional & Electromechanical Modes

Electric force microscopy (EFM); Kelvin probe force microscopy (KPFM); Magnetic force microscopy (MFM); Dual AC Resonance Tracking (DART) piezoresponse force microscopy (PFM); Switching spectroscopy PFM; Vector PFM

## Optional Operating Modes

Conductive AFM (CAFM) with ORCA™ and Eclipse™ Mode; Current mapping with Fast Force Mapping; Fast Force Mapping Mode. Other modes will be supported in future releases. Please inquire if needed.

## Optional Accessories

A full range of accessories similar to those available on the Asylum MFP-3D AFM family is planned. Please inquire if you have specific requirements.

## Warranty

**Standard warranty** One-year comprehensive warranty covering all parts and labor.

**Extended warranty** Asylum offers affordable extended warranties. Inquire for details.

*(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.)*

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6310 Hollister Avenue  
Santa Barbara, CA 93117  
Phone +1-805-696-6466  
AFM.oxinst.com  
afm.info@oxinst.com



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