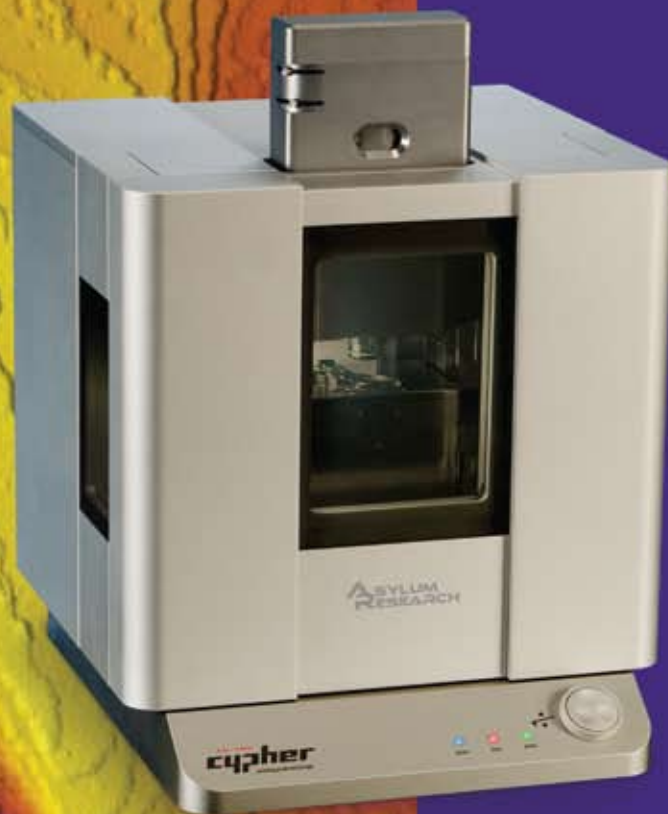# ASYLUM RESEARCH

Decoding the Nanoworld

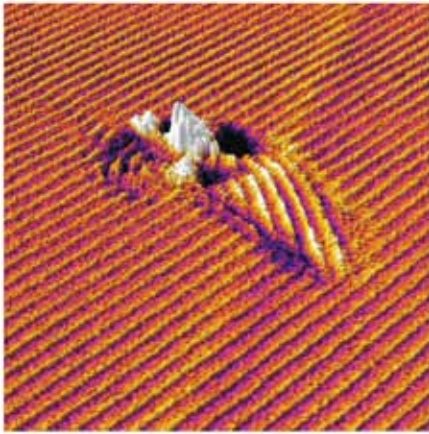# cypher
scanning probe microscope

Break the Nanocode with the Next Generation of AFM

The World's Fastest _and_ Highest Resolution AFM

You've been expecting something genuinely new from the AFM/SPM industry, but for many years you've only seen tweaks to old technology.


Closed loop image of domains of surfactant hemi-micelles surrounding a defect on graphite, 200nm scan.

Now Asylum Research introduces the Cypher™ AFM, the first totally new small sample AFM/SPM in over a decade. More capability, more control, more functionality, more modularity, and more resolution – all with >20X faster scanning and striking ease of use.

Closed loop atomic resolution using sensors in all three axes ensures the highest resolution and most accurate images possible today. With the Cypher AFM, you no longer have to choose between the accuracy and control of closed loop and the low noise of open loop. Asylum's third generation NanoPositioning System (NPS™) sensors are the quietest in the world today. With positioning accuracies better than 60 picometers in X, Y and Z, you not only achieve atomic resolution in closed loop, you also get the most accurate measurements, positioning and nanomanipulation possible.

SpotOn™ automated laser alignment provides extraordinary ease of use. With Cypher's fully motorized laser and photodiode positioning, a mouse click aligns the laser spot on your cantilever and centers your photodetector.
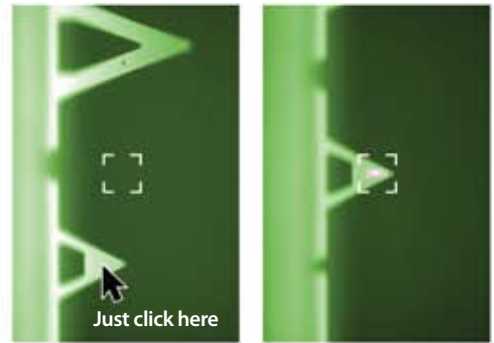
Just click here

SpotOn Alignment Just click on the desired spot location and the motorized stages automatically align the laser spot. The photodiode signals are also automatically centered.

Laser spot sizes as small as 3μm enable high-speed AC imaging with small cantilevers. Cypher provides the industry's smallest spot size, allowing you to use cantilevers smaller than 10μm for fast imaging and sub-picoNewton force measurements.

10μm

50μm
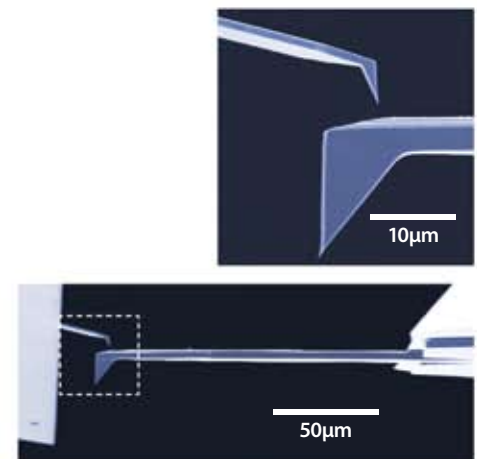
>20X Faster Scanning
Small cantilevers provide much higher resonant frequencies than conventional cantilevers without an increase in stiffness.

Designed from the Ground Up for Superior System-Wide Performance

Cypher's proprietary system-level mechanical design is inherently immune to normal environmental vibration, eliminating the need for additional isolation add-ons for most labs. The integrated system enclosure allows for thermal control and provides additional acoustic isolation for noisy environments. This system-level design creates images of atomically flat samples that are free of periodic noise. Cypher also features unimpeded 180 degree optical/mechanical access to your samples and a small 40x42cm footprint that conserves lab space.

Interchangeable modules broaden your options for applications and scanning modes. MultiLux™ source modules are available with laser diodes and low-coherence SLDs in a variety of spot sizes to provide optimal signal-to-noise over a wide range of cantilever lengths. Module exchange takes only a minute.
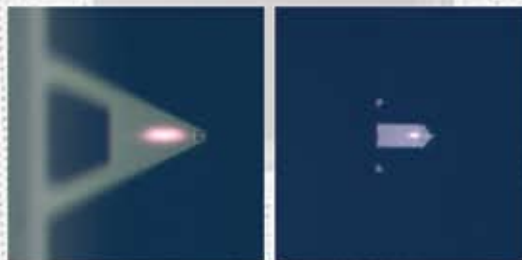
MultiLux Optics The focused spot size can easily be changed to fit the size of the cantilever being used. Here, two different spot sizes are shown on two different cantilevers. The small spot has dimensions of 3x9µm.

High resolution top-view optics with Köhler illumination provide crystal clear viewing of your sample and tip. Cypher's custom optics with 20X objective are limited only by physical diffraction. You'll see sub-micron resolution over a 690x920µm field of view with digital zoom and pan.

Digital Zoom

20µm

Diffraction-limited Optics 3.1 megapixel top view image shows AFM calibration grating (20µm pitch) with inset of 8X digital zoom.

100µm
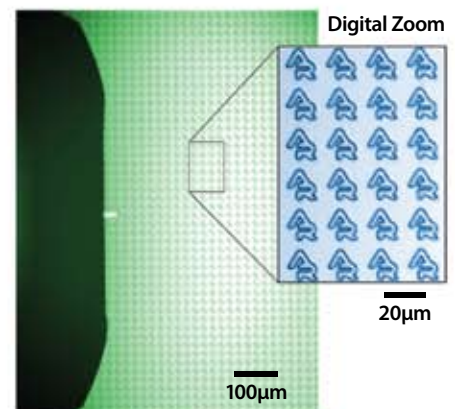
Cypher's integrated enclosure allows for thermal control and acoustic isolation to optimize imaging and measurement stability. Achieve >10X improvement in thermal drift compared to older, less advanced SPMs.

Scanning Modes

Standard

- **Contact:** Uses feedback on deflection. Height, deflection, and lateral force (LFM) signals available.

- **AC:** Uses feedback on amplitude. Signals available include height, amplitude/phase, I/Q, deflection, lateral; digital Q-control included.

- **Force:** Force curve acquisition and mapping in contact or AC mode. Triggering/feedback allow for a wide variety of force curve modes.

- **Dual AC™:** Provides multiple frequency drives and analyses for bimodal and harmonic measurements and imaging.

- **Piezoresponse Force Microscopy (PFM):** Enables high sensitivity, high bias and crosstalk free measurements of piezo materials.

- **Electric Force Microscopy (EFM)**

- **Magnetic Force Microscopy (MFM)**

- **Surface Potential**

- **Nanolithography**

- **Nanomanipulation**

- **Frequency Modulation (FM)**

- **Operation in fluid**

Optional

- **Conductive AFM with ORCA™ Module:** Provides low-current measurements at constant applied voltage for electrical characterization.

- **Scanning Tunneling Microscopy (STM)**

- **iDrive™ magnetic actuated drive for imaging of soft samples in fluid.**

- **Band Excitation for measurement of materials properties.**
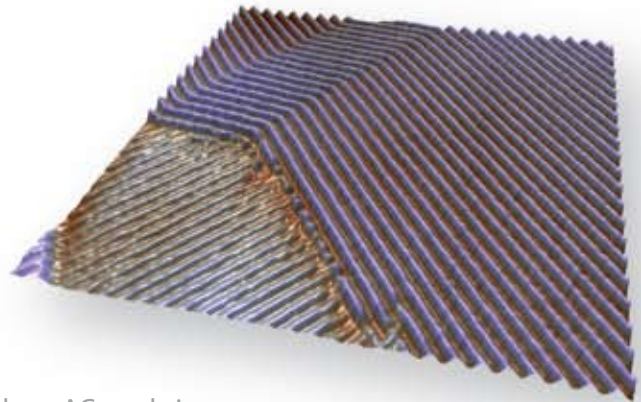
The World's Highest Resolution AFM

With the Cypher AFM, you can do things that are simply not possible with other AFMs. Here are some examples of how the Cypher AFM can help you decode the nanoworld.
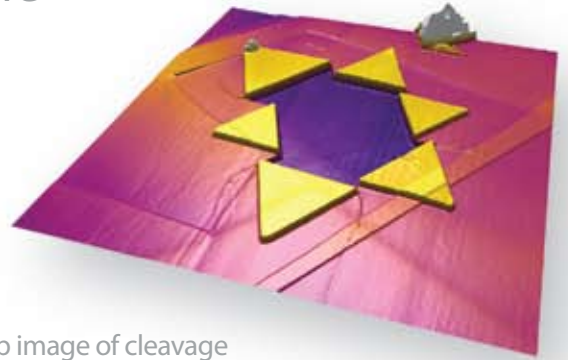
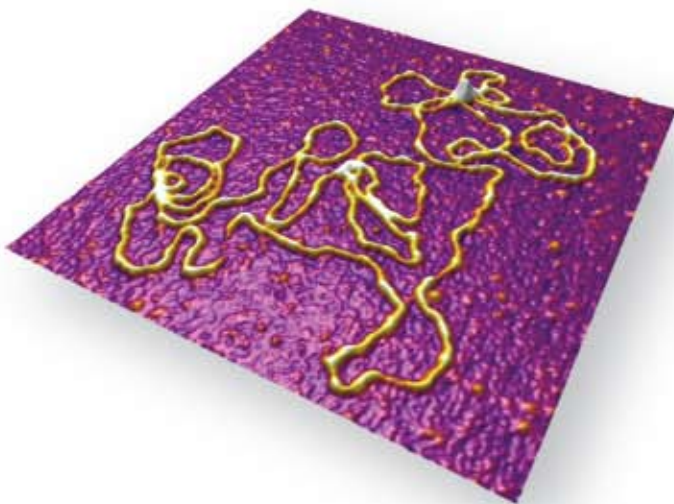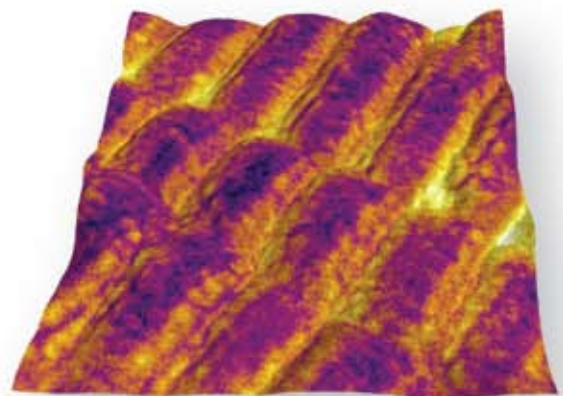Closed loop image of cleavage defects on graphite surface, 1.7µm scan.
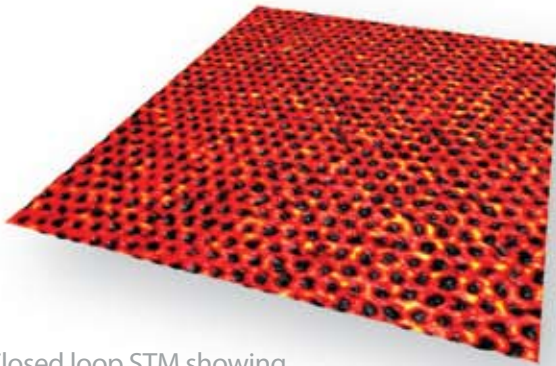
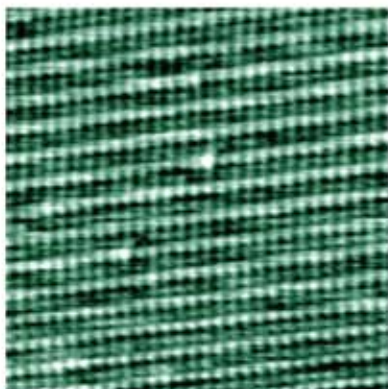Closed loop STM showing graphite atoms, 6nm scan.

Closed loop AC mode image showing the molecular level ordering of cetyl palmitate adsorbed onto HOPG, 150nm scan.
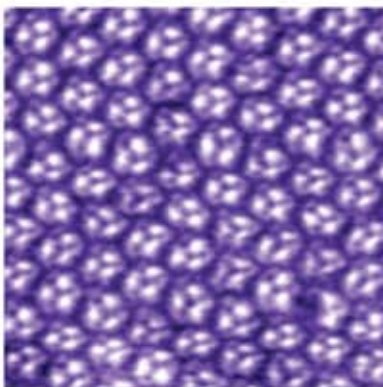

Closed loop image of Lambda digest DNA imaged in buffer, 530nm scan.

Closed loop Dual AC Mode image of collagen. Second mode amplitude is overlaid as color on topography, 300nm scan.

Open loop AC mode image of calcite in water, 15nm scan, 1Å height scale. The point defects remained visible through several images demonstrating true atomic resolution.

Closed loop AC mode image of extracellular face of bacteriorhodopsin in buffer, 50nm scan, 5Å height scale. G.M. King Lab, University of Missouri-Columbia.

Unbreakable Nanocode? Crack It with the Cypher AFM and the Asylum Research Team

You need the new Cypher AFM to make tomorrow's discoveries and to keep your facility first in science. With capabilities far beyond those of older SPMs – and modularity and expandability for the future – the Cypher AFM can help you be a leader in decoding the nanoworld.

The Asylum Research team will support you every step of the way.

Asylum's legendary product and applications support ensures you get up and running quickly and achieve optimum results. Asylum is the clear leader in customer satisfaction. If you're not already an Asylum user, just ask one (or ask us for a reference).

And Asylum's Exclusive Five-Year Warranty and Six-Month Money-Back Guarantee ensure your satisfaction. Our quality and support are unrivaled – but just in case, you're covered.

Seek Asylum for the most advanced AFM/SPM technology and tools

Choose the Cypher AFM for:

- Closed loop imaging from tens of microns down to atomic scales
- Small cantilevers for high-speed scanning
- High-speed, low-noise force measurements
- High-bandwidth data acquisition
- Diffraction-limited optical sample viewing/imaging
- Automated laser alignment

Choose MFP-3D™ AFM for:

- Large closed loop scan area
- Compatibility with inverted optical microscopes
- Sample viewing from top and bottom
- Long-range, low-noise force measurements
- Widest range of accessories
- Flexible mounting for various sample shapes and sizes
- Quantitative nanoindentation

Specifications

Head/Optical Lever

DC Detector Noise*: <5pm

AC Detector Noise: <25fm/$\sqrt{\text{Hz}}$ above 100kHz

Photodiode Bandwidth: DC to 7MHz

Light Source: User selectable/exchangeable. Options include superluminescent diodes and laser diodes. Wavelength is fixed at 850nm.

Spot Size: User selectable/exchangeable. Focused spots range in size from 10x30μm down to 3x9μm.

Controls: Focused spot positioning and photodiode centering controls are motorized and fully controllable from the software.

Scanner

A variety of scanner modules are available depending on application. All scanner modules include XYZ actuation as well as a motorized cantilever engage stage. The standard scanner module specs are listed below:

Scan Range: XY range is 30/40μm (closed/open loop). Z range is 5/7μm.

XYZ Sensor Noise*: NPS™ Digital LVDT sensors. XY noise is <60pm. Z noise is <50pm. Closed loop scan performance achieves lattice resolution (<10nm scans) with feedback gains equivalent to large scan (>1μm) values.

XYZ Open Loop Noise

XY: <8pm Adev in a 1Hz to 10kHz BW

Z: <4pm Adev in a 1Hz to 10kHz BW

Vibration Immunity: <10pm coupling into deflection for 1mm/s^2 floor acceleration.

XY Drift: <20/200nm/°C (with/without temperature control module).

Out-of-Plane Motion: <3nm over closed loop scan range

Sample Dimensions: 15/7mm (diameter/thickness)

Sample Environment: Standard environments are ambient, droplet, or low evaporation/perfusion chamber.

System

DC Height Noise*: <15pm (<5pm in quiet environments)

AC Height Noise*: <15pm

View Module

A variety of view modules providing top-down optical view of the sample/cantilever are possible depending on the application. The standard view module specifications are listed below:

Configuration: Bright field/reflected light

Illumination: LED based Köhler illumination with manual controls for the aperture and field diaphragms. Intensity is software controlled.

Resolution: Diffraction limited performance (<1μm) with apochromatic correction. NA = 0.45.

Field of View: 690x920μm

Camera: 3.1 megapixel CMOS camera with FireWire interface. Digital zoom/pan/capture; software controlled white balance, shutter speed, and binning.

Electronics

ADCs	Two 16-bit, 80MHz One 16-bit, 5MHz Six 18-bit, 2MHz Five 16-bit, 100kHz
Capture Buffer	512MB
DACs	Four 16-bit, 40MHz One 16-bit, 10MHz Four 24-bit, 1.25MHz One 24-bit, 400kHz Five 24-bit, 100kHz
Firmware Devices	Firmware upgradable devices that run real-time SPM specific operations. Modules included are: lock-in amplifiers, Q-control, IIR filters, and feedback loops.
FPGAs	Four Field Programmable Gate Arrays running at up to 667MHz.
Processors	Floating point DSP running at 80MHz Dual-core NIOS in FPGA.
Dual-Frequency Digital Lock-in Amplifiers	Two dual-frequency quadrature lock-ins, 20MHz. One dual-frequency quadrature lock-in, 5MHz.
Frequency Synthesizer	Two dual-frequency synthesizers output at 40MHz. Frequency range DC to 15MHz in 9mHz steps. One dual-frequency synthesizer output at 10MHz. Frequency range DC to 2MHz in 2mHz steps.
Dual Quadrature Outputs	$R_{1,2}/\theta_{1,2}$ (amplitude/phase) $I_{1,2}/Q_{1,2}$ (Rcosθ/Rsinθ) for each lock-in
Digital Q-control	2kHz – 20MHz
Feedback loops	Multiple proportional-integral gain controllers and more advanced controllers (such as H$_\infty$). At a minimum there are: Six loops running at 100kHz Ten loops running at 2MHz
IIR Filters	Infinite Impulse Response (IIR) filters running at 2MHz and 100kHz. There are four types of software controllable IIR filters (DC to 50kHz): low pass, high pass, band pass, and band stop.
Crosspoint Switches	One 32 by 32 digitally controlled switch. One 16 by 16 digitally controlled switch.
Power Supplies	Low voltage: $\pm$15, $\pm$7, 3.3V High voltage: 150V Optional: $\pm$150V for PFM
Software Controlled Relays	XY high voltage Z high voltage Laser power
USB Computer to Controller Communication	Compatible with most computers running WinXP or Windows 7 (including laptops)
High Voltage Noise	<70uV Adev in 1Hz to 10kHz bandwidth (50uV typ.) in all three axes.

Data Acquisition

Data size is limited only by the memory on the PC (10 million point and 8k x 8k images are possible). Additionally, a continuously running circular fast capture buffer allows high speed data to be sent to the computer at any time.

Computer

Minimum: Dell Precision T3500 mini-tower, 2.80GHz Quad Core, 6GB RAM, dual 320GB RAID 1 hard drives, 16x DVD writer, dual 20" LCD panels (30" optional), 1GB video card, 8 USB ports, 2 Fire Wire ports, Windows 7 64bit (WinXP optional).

Software

The software is based in IGOR Pro by WaveMetrics, a powerful scientific data acquisition and analysis environment. The software is user programmable.

Features include:

- Nonlinear curve fitting to arbitrary user-defined functions.
- Extensive image analysis including 2D FFTs, wavelet transformations, convolutions, line profiles, particle analysis, edge detection (eight methods, including Sobel), and thresholding (five methods, including fuzzy entropy).
- Automatic spectral fitting and calibration of cantilever spring constants using thermal noise and Sader method.
- Easy generation of scientific publication-quality graphs and page layouts.

ARgyle™: OpenGL® 3D rendering technology for advanced image display.

- Generate, display, and visualize 3D images in real-time while scanning or doing off-line processing.
- Overlay alternate channel data with primary to view feature correlation.
- Independent scaling of axes for true 1:1 aspect ratio.
- Mouse-driven rotating, panning, scaling, and lighting control of images.
- Export 3D images to clipboard, JPEG, TIFF, BMP, PNG.
- Stereo anaglyph creation from 3D images.

Instrument Isolation

Vibration: Includes passive vibration isolation with f$_o$=7Hz, Q~1. The Cypher AFM exhibits exceptional vibration immunity, and even for high resolution work no further isolation is necessary in typical lab environments. Additional isolation may be needed for unusually noisy environments.

Acoustic: Included acoustic enclosure provides 20dB of isolation.

Temperature: Included enclosure allows for 0.1°C temperature stabilization with optional temperature control module.

*Noise measurements are quoted as average deviation (Adev) in a 0.1Hz to 1kHz bandwidth unless otherwise noted.

Cypher is a Class 1 Laser Product

Cover Image: Closed loop AC mode image of HF-etched mica showing atomic steps, 6μm scan. 5-2012