

# Cypher VRS1250

Capture nanoscale dynamics with the world's most powerful video-rate AFM



# Cypher VRS1250 Video-Rate AFM

## Capture dynamics at the highest spatial and temporal resolution

Oxford Instruments Asylum Research expands the capabilities of high-speed atomic force microscopy with the Cypher VRS1250. Cypher VRS1250 is twice as fast as the first-generation Cypher VRS, scanning at up to 1250 lines/second. This enables either higher temporal resolution with frame rates up to 45 frames/second or increased spatial resolution by collecting more image pixels at lower frame rates. Combined with ultra-stable imaging, an easy-to-use fully sealed sample cell with perfusion capability, and a full range of modes and accessories, the Cypher VRS1250 is ready to help you achieve your most ambitious research goals.

### Designed for ultra-high speed and spatial resolution

High-speed AFM experiments require a balance of high temporal resolution *and* high spatial resolution. The Cypher VRS1250 uniquely balances your experimental demands, from ultra-high spatial resolution of atomic or molecular structure to ultra-high frame rates up to 45 frames/second to capture fast dynamic events.

### Stable imaging keeps the “focus” on your sample

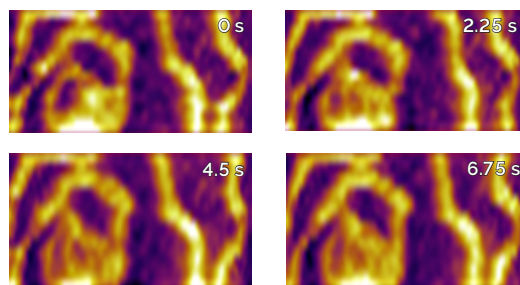
Observing nanoscale dynamics requires continuous imaging for long durations. The Cypher’s advanced design virtually eliminates thermal drift and blueDrive photothermal excitation technology and a sealed sample cell keep imaging stable such that even delicate biomolecules can be observed without damage.

### Ease of use features make it easier to get great results

The Cypher VRS1250 is designed with the same ease-of-use features as other Cypher AFMs, including motorized laser and detector alignment, simple probe loading, and a sealed cell that eliminates worries over leakage. Its software includes features to easily process and export video-rate AFM movies for presentations and publications.

### All the flexibility and capabilities of Cypher AFMs

The Cypher VRS1250 supports all the functionality and associated benefits of the Cypher ES environmental AFM, including sample heating and cooling and a complete range of operating modes. It is much more than just a video-rate AFM. The platform is the ideal AFM for interdisciplinary research groups and shared imaging facilities.

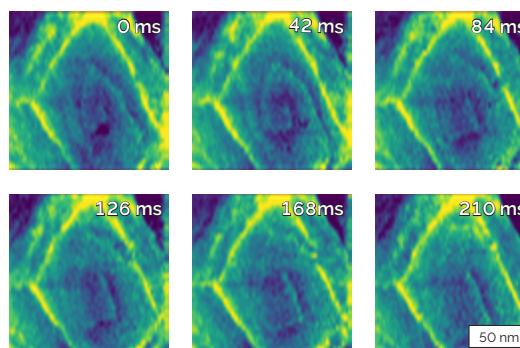


#### DNA imaged at 45 frames/s

DNA was imaged at 1250 lines/second and 160x16 pixels for a frame rate of 45 fps. The DNA was loosely bound, allowing the strands to randomly move about. Here, the still images highlight motion in the two strands on the right. The full movie shows additional dynamics.

#### View the movies

[AFM.oxinst.com/VRS1250](http://AFM.oxinst.com/VRS1250)



#### Copper etching by ammonium persulfate

The etching of copper is commercially important in the manufacture of printed circuit boards but is also a common processing step in the deposition of large area graphene on copper. Here, an electropolished copper substrate was imaged in ammonium persulfate solution at 1250 lines/s and 160x40 pixels for a frame rate of 24 fps. The full movie shows a transition from unidirectional etching to a spiral etching process, apparently the result of a screw dislocation defect in the copper crystal. The frames here show a portion of the spiral etch process. Sample courtesy of Mitsubishi Materials Corporation.

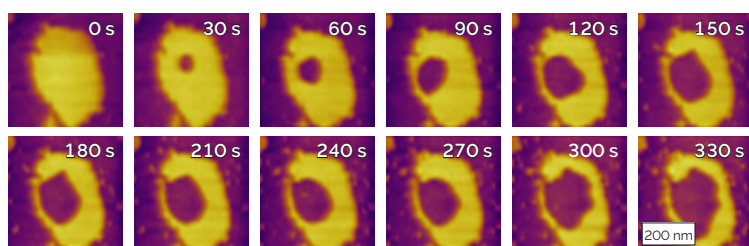


# Better resolve nanoscale dynamic events

## Faster scanning improves both spatial and temporal resolution

Video-rate AFM imaging can be optimized for temporal resolution (i.e. higher frame rates) by reducing the pixel count of the images. Alternatively, spatial resolution can be optimized (i.e. higher pixel count) by reducing the frame rate. This compromise is universal to all digital imaging techniques, from cameras to electron microscopes. However, by scanning twice as fast as previous high-speed AFMs, the Cypher VRS1250 better balances speed and resolution, enabling you to improve both. It reaches exceptional frames rates (up to 45 fps) at the same pixel counts as other high-speed AFMs, or it can achieve more modest frames rates (e.g. 5-15 fps) whilst maintaining much higher pixel counts than other commercial high-speed AFMs. With the Cypher VRS1250, you can achieve whatever degree of spatio-temporal resolution is most appropriate to your experiment.

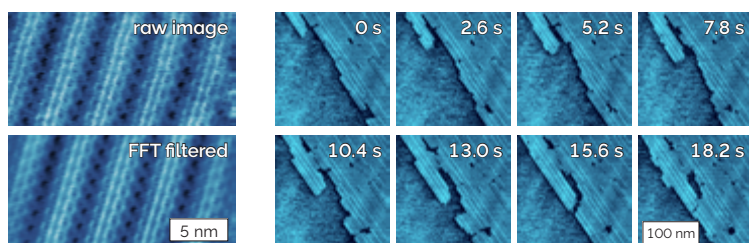
### True video-rate imaging at 28 fps



#### Degradation of lipid bilayer by antimicrobial peptide

The degradation of a lipid bilayer by an antimicrobial peptide, PG-1, was monitored by video-rate imaging at 28 fps, acquired at 1250 lines/second and 160×32 pixels. The lipid patch was imaged continuously for almost 7 minutes during which almost 12,000 image frames were acquired. Observation of similar patches in the absence of the peptide did not result in any degradation of the bilayer.

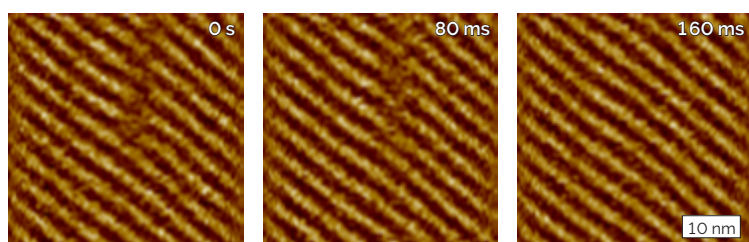
### Ultra-high spatial resolution and high-speed imaging



#### Crystallization of MoS<sub>2</sub>-binding peptide

Ultra-high resolution contact mode imaging (left) resolved the molecular structure of peptide crystals with sub-nm spatial resolution. High-speed tapping mode images (right) were captured at 2.6 seconds per frame, which allowed the nucleation dynamics to be measured with sufficient time resolution while also clearly resolving nucleated islands as small as 4×9 nm (only ~8 peptide dimers). Data courtesy of Prof. Jim De Yoreo, U. Washington and PNNL. Published in: Chen, J. et al. (2018) *Science* 362(6419): 1135-1139.

### High spatial and high temporal resolution at 13 fps



#### Cetyl palmitate adsorbed on HOPG

This waxy ester molecule self-assembles in a pattern that templates the underlying HOPG substrate. Here, the sample was imaged at 962 lines/second and 208×64 pixels for a frame rate of 13 fps. Shown here is a process whereby a defect in the pattern anneals out, leaving lamellae rows that run parallel across the 40 nm scan area.

Movies can be viewed at: <https://AFM.oxinst.com/VRS1250>



# Simpler workflow gets to results faster

Every step from setup to final data processing is made easier

## Fast and simple setup

- Probes are installed using a simple clamp mount in the probe holder
- Simply focus on the cantilever, then just point and click to align the laser
- One more click zeroes the photodetector

## Fast, stable, high-resolution tapping mode imaging

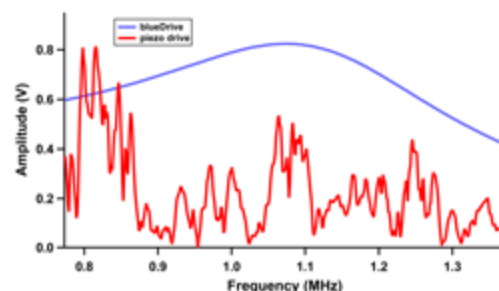
- Tapping mode is the fastest and highest resolution AFM imaging mode, ideal for all high-speed AFM projects
- blueDrive produces a clean tune in liquid, so it's easy to select the correct tapping resonance frequency
- Tapping amplitude is stable for hours, even during fluid exchange, which keeps imaging stable
- Stable imaging means no tweaking imaging settings, less sample damage, and higher resolution

## Safe and straightforward imaging in liquid

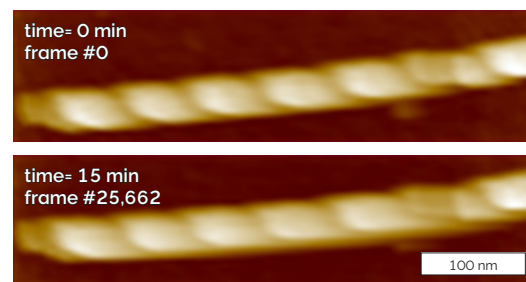
- Fully sealed liquid cell eliminates evaporation and the risk of fluid spilling onto the scanner
- Perfusion option allows the liquid on the sample to be exchanged, e.g., to add new reagents or buffers
- Accommodates samples up to 15 mm diameter

## Quickly process data and prepare for presentation

- Includes data analysis tools to process the whole video, so there's no need for frame by frame editing of single images for flattening and plane fitting operations
- Movies can be edited for length and playback speed can be adjusted relative to the original acquisition rate
- Final movies can be exported as WMV or MP4 videos and individual frames can be exported as single images

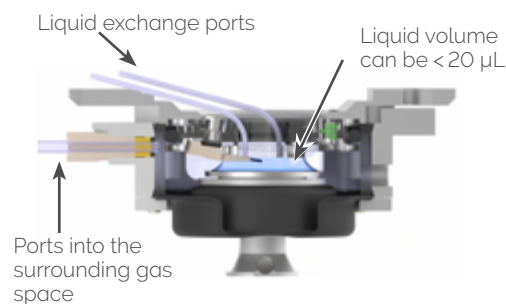


Tune of a small, fast Nanoworld USC-F1.5-k0.6 cantilever driven with blueDrive in water closely matches the theoretical response, while the piezo-driven response has multiple peaks.



### Insulin fiber—stable at 28 fps for 15 minutes

An insulin fiber was imaged at 1250 lines/second and 160×32 pixels for a frame rate of 28 fps. Over 25,000 image frames were captured over a period of 15 minutes with no intervention by the operator to adjust imaging parameters. Imaging remained stable with no sample degradation and with very little lateral drift, demonstrating remarkable stability even at video-rate imaging speeds.



Movies can be viewed at: <https://AFM.oxinst.com/VRS1250>



# All the flexibility of a Cypher AFM

Cypher VRS1250 supports a full range of modes and accessories

## Not just a video-rate AFM—provides the full versatility of a research AFM

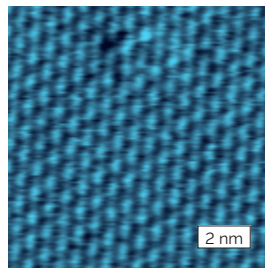
Buying an AFM that can only be used on certain projects can be difficult to justify. The Cypher VRS1250 was designed and built with unprecedented versatility. It can be used by your whole lab and fully satisfy the diverse needs of large research groups.

## Capabilities at video-rate scan speeds

- Video-rate imaging at up to 1250 lines/s in tapping mode (including phase) and contact mode.
- Image under ambient conditions in air or liquids.
- Operate in a fully sealed sample chamber or use the optional perfusion probe holder.

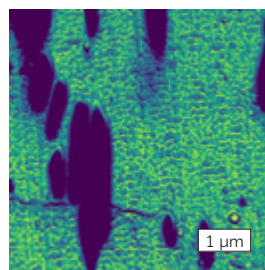
## Full-featured research AFM

- Imaging at up to 156 lines/s with the ES scanner.
- Comes standard with all of the modes included on the Cypher ES with blueDrive (see below).
- Supports all of the optional modes available on the Cypher ES (see below).
- Compatible with all of the Cypher ES accessories (see below).



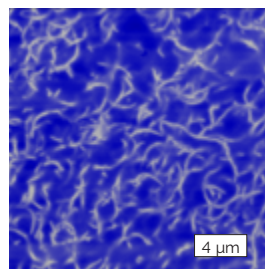
## Ultra-high resolution

Molecular packing of terephthalic acid (TPhA) on HOPG imaged with tapping mode. Image includes a point defect in the otherwise regular lattice structure.



## Fast, quantitative nanomechanical measurements

Modulus image of a polymer blend used in car bumpers, composed of isotactic polypropylene ( $E' \sim 1.2$  GPa) with rubber inclusions ( $E' \sim 150$  MPa).



## High sensitivity nanoelectrical measurements

Electrostatic force microscopy (EFM) image of single-walled carbon nanotubes embedded in a polymer matrix.

## Included Operating Modes

AM-FM Viscoelastic Mapping Mode; Contact mode; Contact Resonance Viscoelastic Mapping Mode; Dual AC™; Dual AC Resonance Tracking (DART); DART PFM; Electric force microscopy (EFM); Force curves; Force mapping mode (force volume); Force modulation; Frequency modulation; Kelvin probe force microscopy (KPFM); Lateral force mode (LFM); Loss tangent imaging; Magnetic force microscopy (MFM); Nanolithography and nanomanipulation; Phase imaging; Piezoresponse force microscopy (PFM); Switching spectroscopy PFM; Tapping mode (AC mode); Tapping mode with digital Q control; Vector PFM

## Optional Operating Modes

Fast Force Mapping Mode; Conductive AFM (CAFM) with ORCA™ and Eclipse™; Current mapping with Fast Force Mapping; Electrochemical Strain Microscopy (ESM); High voltage PFM; Nanoscale Time Dependent Dielectric Breakdown (nanoTDDB); Scanning Capacitance Microscopy (SCM); Scanning Microwave Impedance Microscopy (sMIM); Scanning Tunneling Microscopy (STM)

## Optional Accessories

- Heating and cooling: Maintain samples at temperatures between 0–120°C in gas or liquid environments.
- Heating: Heat samples at temperatures up to 250°C. Fully sealed chamber can control the gas environment.
- Humidity sensing: Fully sealed chamber with an integrated humidity sensor.
- Liquid perfusion probe holder: Ports allow exchange or perfusion of liquid. Small diameter tubing and short lengths limit waste and help conserve precious reagents.
- Electrochemistry cell: Sealed cell with integrated electrodes and potentiostat interface for electrochemical studies.

Want to see more examples?

Check out the main  
Cypher brochure



[AFM.oxinst.com/VRS1250](http://AFM.oxinst.com/VRS1250)

# Cypher VRS1250 Specifications

## Video-Rate Scanning Performance

**Maximum line scan rate** Up to 1250 lines/s

**Maximum frame rate** Varies with the selected line scan rate and the pixel size of the image, with a maximum of 45 frames/s.

**X&Y maximum scan size** Varies with line scan rate, scaling from 30  $\mu\text{m}$  for rates <640 Hz to 500 nm for rates >1000 Hz.

**X&Y offset range** Scan area can be located anywhere in the overall 30  $\mu\text{m}$  XY scanner range

**X&Y sensor noise** <60 pm

**Z range** >2  $\mu\text{m}$

**Sample size** Up to 15 mm diameter

**DC height noise** <15 pm (<5 pm typical in quiet lab)

**AC height noise** <15 pm

**Supported modes** Tapping (with phase) or contact mode

**Supported options** Liquid perfusion probe holder

## Cantilever Deflection Sensing

*Four modules are available (purchased separately):*

**Standard Laser Diode Module:** Modulated laser diode source with nominal 10 $\times$ 30  $\mu\text{m}$  spot size. Recommended for most imaging applications because of its superior low-noise performance:

DC detector noise <10 pm

AC detector noise <25 fm/Hz<sup>1/2</sup> above 100 kHz

**Standard SLD Module:** Superluminescent diode (SLD) source with nominal 10 $\times$ 30  $\mu\text{m}$  spot size. Suggested for contact mode and force curves due to reduced optical interference effects.

**Laser Diode Small Spot Module:** Modulated laser diode source with nominal 3 $\times$ 9  $\mu\text{m}$  spot size. Required for most imaging applications with small cantilevers.

**SLD Small Spot Module:** Superluminescent Diode source with nominal 3 $\times$ 9  $\mu\text{m}$  spot size. Recommended for contact mode and force curves when using small cantilevers.

*All four modules share these specifications:*

Wavelength 850 nm

Detector bandwidth DC to 7 MHz

Spot positioning and detector adjustment are fully motorized and software controlled.

### Cover image: Trimesic acid monolayer on HOPG

Trimesic acid (1,3,5-benzenetricarboxylic acid, TMA) forms a highly ordered monolayer upon adsorption to highly oriented pyrolytic graphite (HOPG) surfaces from aqueous solution at room temperature. The monolayer exhibits a "chicken wire"-like structure with an average pore size of  $11 \pm 1 \text{ \AA}$ . Here, a 35 nm scan area was imaged at 100 Hz line rate and 2000 $\times$ 2048 pixels. The entire image was captured in only 20 seconds.

*(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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Class 1  
laser product

## Normal-Rate Scanning Performance

**Maximum line scan rate** Up to 156 lines/s

**X&Y range** 30  $\mu\text{m}$  (closed-loop scanning)

**X&Y sensor noise** <60 pm

**Z range** >5  $\mu\text{m}$

**Z sensor noise** <50 pm

**Sample size** Up to 15 mm diameter

**DC height noise** <15 pm (<5 pm typical in quiet lab)

**AC height noise** <15 pm

**Supported modes** See the website for a comprehensive list of the many available modes at: <https://AFM.oxinst.com/VRS1250>

**Supported options** All Cypher ES accessories are compatible with the Cypher VRS1250. See the complete list of options at: <https://AFM.oxinst.com/VRS1250>

(Some modes and accessories require a quick swap of the video-rate sample stage for a different stage.)

## Top-view Bright-Field Optics

**Resolution** Diffraction limited (<1  $\mu\text{m}$ ), NA=0.45

**Field of view** 690 $\times$ 920  $\mu\text{m}$

**Illumination** Intensity is software controlled. Manual controls for the aperture and field diaphragms.

## blueDrive Photothermal Excitation

Included with all Cypher VRS1250 systems.

blueDrive replaces the conventional "shake piezo" with a second laser source that drives the cantilever photothermally at its resonance for tapping mode techniques. The resulting response is very stable over time. This enables unattended imaging, preserves tip sharpness, and maintains gentle, high resolution imaging.

**Drive frequency** Up to 8 MHz

## Instrument Isolation

**Vibration** <10 pm coupling into deflection for 1 mm/s<sup>2</sup> floor acceleration when using built-in passive isolation. No further isolation is necessary for typical laboratories.

**Acoustic** Included enclosure provides 20 dB isolation.

## 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.

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