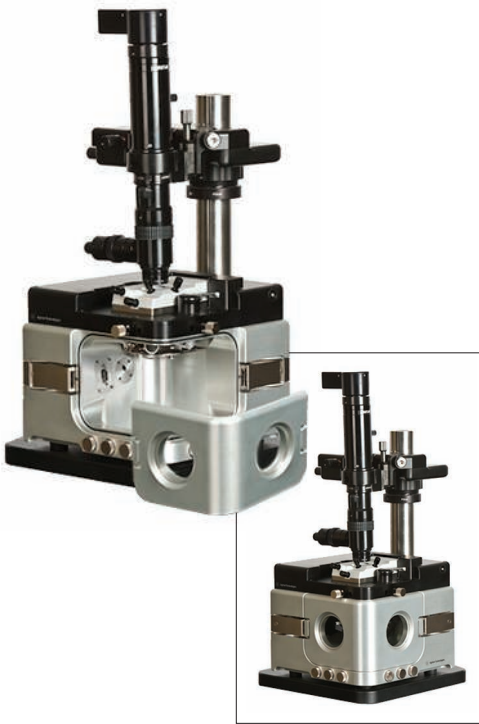


Agilent 7500 AFM

Data Sheet



The Agilent 7500 AFM System.

Features and Benefits

- Atomic resolution imaging with closed loop 90 μ m scanner
- Exceptional environmental and temperature control
- Standard nose cone supports expanded set of imaging modes
- Superior scanning in fluids, gases, and ambient conditions
- Single-pass nanoscale electrical characterization
- Unprecedented electrochemistry (EC) capabilities

Applications

- Materials science
- Life science
- Polymer science
- Electrochemistry
- Electrical characterization
- Nanolithography

System Overview

The Agilent 7500 AFM establishes new performance, functionality, and ease-of-use benchmarks for nanoscale measurement, characterization, and manipulation. This next-generation system extends the forefront of atomic force microscopy, offering a large closed

loop scanner with atomic resolution, industry-leading environmental control, ultra-high-precision temperature control, an unrivaled range of electrochemistry capabilities, and much more.

The clever, compact design of the 7500 gives researchers quick, convenient access to their samples. A half-dozen most used AFM imaging modes are supported by the system's standard nose cone, which can easily be interchanged with specialized nose cones as needed, extending capability effortlessly.

Whether serving academia or industry, the Agilent 7500 is the new gold standard for advanced AFM applications in the fields of electrochemistry, life science, materials science, polymer science, electrical characterization, and nanolithography.

New AFM Design

The 7500 offers stable AFM imaging combined with exceptionally flat, easily reproducible displacement over the entire scan range to deliver high resolution and very low distortion. Agilent's patented top-down tip scanner technology is ideal for imaging in fluids and in air as well as under controlled temperature and environmental conditions.

The scanner's standard nose cone enables the use of contact mode, AAC mode, current-sensing AFM (CS-AFM), EFM, KFM, MFM, and MAC Mode in



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fluids and in air. Easy-to-load nose cones for additional AFM techniques can be interchanged quickly and conveniently. These nose cones are made from PEEK polymers, have low chemical reactivity, and can be utilized in a wide range of solvents.

The system's video optics include a color camera and can resolve details to less than 1.7 μ m. Open access to the scanner and easy alignment of the optics help simplify use of the 7500. The user friendly scanner has a built-in detector, no cables to plug-in and is easy to calibrate.

Environmental and Temperature Control

The 7500 AFM system includes a built-in environmental chamber engineered to meet the many requirements of intricate, demanding nanoscience applications. The chamber provides an easily accessible, sealed sample compartment that is completely isolated from the rest of the system. Six inlet/outlet ports permit the flow of different gases into or out of the sample area.

The system's scanner resides outside the environmental chamber, so it is protected from contamination, harsh gases, solvents, caustic liquids, and other potentially damaging environments. Humidity levels are monitored by sensors built into the chamber. Oxygen and reactive gases can be introduced into and purged from the sample chamber.



The 7500 scanner.

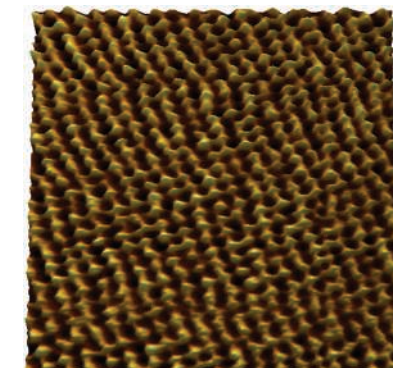


Figure 3. Closed-loop contact mode, topography images of atoms on mica. Scan size: 10 nm.

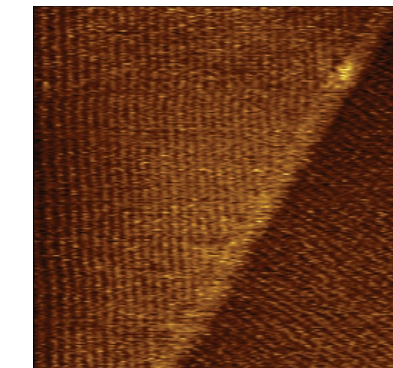


Figure 4. Closed-loop topography image of C₃₆H₇₄. Scan size: 162 nm.

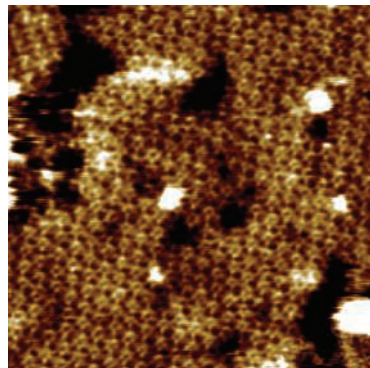


Figure 2. High resolution closed-loop MAC mode image of bacteriorhodopsin, revealing the donut-like structure of bacteriorhodopsin trimers, and the connecting fibrous arms in between. Scan size: 120 nm.

Robust, easy-to-handle sample plates designed specifically for use with the 7500 are offered to facilitate studies in air, in fluids, or with electrochemistry.

Agilent's temperature control system employs a patented thermal insulation and compensation design to deliver the industry's most precise temperature control. This highly versatile option allows imaging during temperature changes and is fully compatible with all imaging modes, including those utilized in fluids. The temperature controller's unique system's design isolates the sample plate from the rest of the system,

improving stability and performance. Temperatures can be controlled from -30°C up to 250°C, with suitable resolution and control to match any experimental requirements.

MAC Mode

Agilent's patented MAC Mode is a gentle, nondestructive AFM imaging technique that employs a magnetic field to drive a paramagnetically coated cantilever, yielding precise control over oscillation amplitude (thus providing excellent force regulation). Since only the tip is driven, the signal-to-noise ratio is greatly enhanced, yielding a significant improvement while imaging in fluids.

MAC Mode has allowed researchers to resolve sub-molecular structures that could not be resolved with any other AFM technique. It is particularly useful for imaging delicate samples

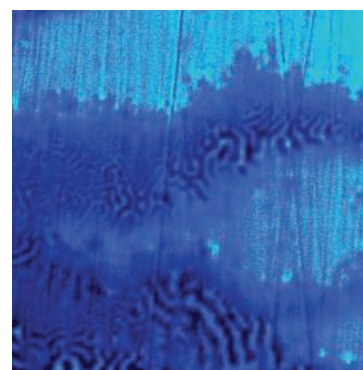
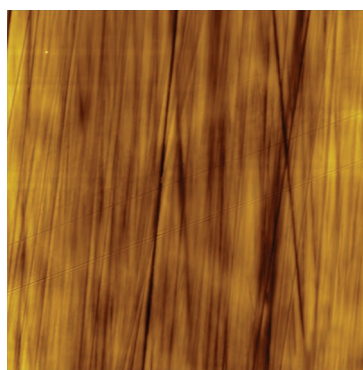


Figure 1. Topography image (left) of polished duplex stainless steel. MFM image (right) showing ferrite and Austenite domains of the duplex stainless steel. Scan size: 10 μ m.

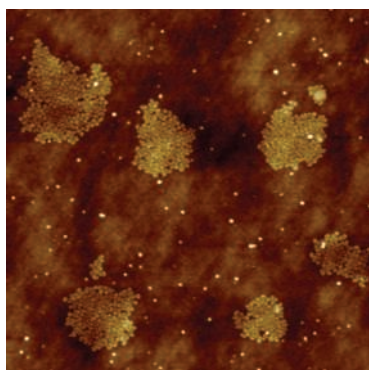


Figure 5. KFM topography (left) and surface potential (right) images of fluoroalkane $F_{14}H_{20}$ self-assembly on Si. Scan size: $4\mu\text{m}$.

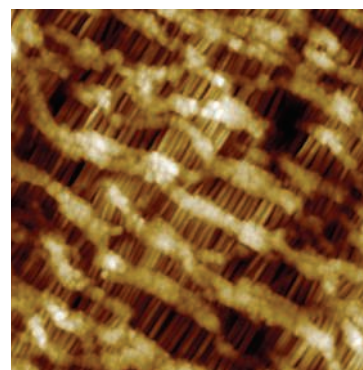
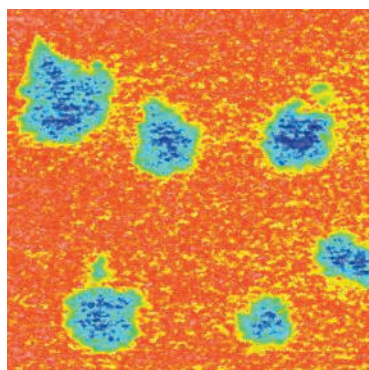


Figure 6. Closed-loop topographic image of polymer isotactic polypropylene. Scan size: $2\mu\text{m}$.

in application areas that require high resolution and force sensitivity, such as life science, polymer science, and surface science. AAC mode is included with MAC Mode.

The MAC Mode III controller is optimized for single-pass Kelvin force microscopy (KFM) and electrostatic force Microscopy (EFM), a technique that enables simultaneous collection of topography and surface potential data by using a servo-on-height cantilever approach that is insensitive to scanner drift. These modes are especially useful for measuring dielectric films, metal surfaces, piezoelectric materials, and conductor-insulator transitions. In addition to KFM/EFM and piezo force microscopy (PFM), it allows the use of higher resonance modes of the cantilever. This technique can be utilized to collect additional information about mechanical properties of the sample surface.

Electrochemistry

The Agilent 7500 can be equipped with electrochemistry accessories that include a fluid cell, a salt bridge, improved software, and a built-in, low-noise potentiostat/galvanostat for *in situ* EC-AFM studies. When combined with precise temperature control, it is possible to obtain information about electrochemical processes that would otherwise be inaccessible. Furthermore, the 7500 AFM system's environmental control allows imaging with no dissolved

oxygen in either aqueous or non-aqueous solutions. The optional EC glove box features a smaller chamber that allows the glove box and AFM to be placed inside the Pico IC isolation chamber for uncompromising results.

PicoTREC

Agilent's exclusive PicoTREC molecular recognition toolkit is designed for use with MAC Mode. With PicoTREC, researchers can quickly distinguish between species that are engaged in molecular binding events and those that are not binding events, thus eliminating the need to perform slow and tedious force-volume spectroscopy experiments to get the same results.

Scientists can use PicoTREC with the 7500 AFM to explore dynamic properties of biological systems (antibody-antigen, ligand-receptor, drug-receptor, DNA-

protein, DNA-DNA, and so forth) by imaging patterns of molecular binding and adhesion on surfaces.

Software

The 7500 AFM system utilizes Agilent's PicoView, an imaging and analysis software package that allows complete control of all scanning parameters and provides the flexibility required for more complex experiments.

For additional interactive post-processing capabilities, Agilent's easy-to-use Pico Image imaging and analysis software package provides all of the features and functions required to build a surface analysis report on multi-layer measurement data.

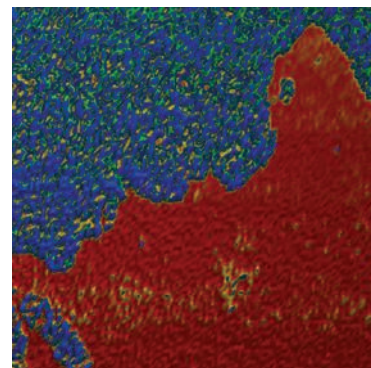
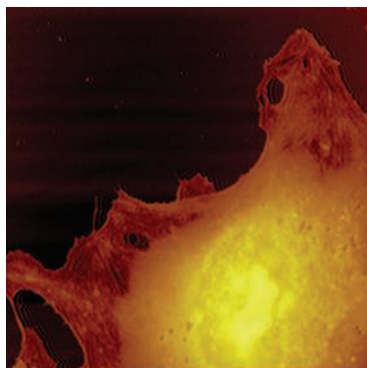


Figure 7. Contact mode, topography image (left) of a cell were made to characterize cell morphology including nucleus lower right. Scan size $50\mu\text{m}$. Elasticity map (right) of a fixed cell. An array of force distance curves were measured at the same position as shown in figure left. A map of elasticity modulus was constructed by analyzing the individual force distance curves.

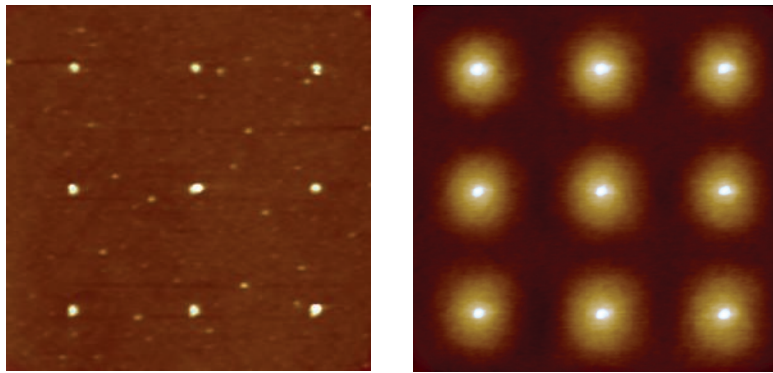


Figure 8. Humidity-dependent anodic oxidation of a silicon surface. Side-by-side AFM topographic images of the resulting surface after the tip-directed oxidation under a RH of 20% (left) and a RH of 90% (right), respectively. Scan size: 6 μm .

7500 System Specifications

Scanner	
Scan range	90 μm x 90 μm
Z range	> 12 μm
X/Y Positioning noise(CL)	< 0.15 nm typical
XY Linearity	< 0.5%
Z noise	< 0.03 nm
Out of plane travel	< 0.1% Full range
Laser	670 nm
System Controller	
PC	Quad core Xeon, 8G ram, 1TB disk, Win7 x74 2ea 23" FPD, 1920x1080pix resolution
Video Microscope	
Top down video microscope	
Manual focus and zoom	
2 Mpixel color USB camera	
1.7 μm resolution	
Sample Size	
Manual X/Y stage	~ 10 mm travel
Motorized Z stage	~ 10 mm travel
Max sample diameter	~ 25 mm
Max sample height	~ 8 mm
Standard Modes	
Contact, LFM, AAC, Phase, CS-AFM, MFM, EFM, KFM, Liftmode, F-d Spectroscopy, F-V Spectroscopy, Force Plugins, Force Modulation (FMM), Q-Control, LV PFM	
Optional Modes	
MAC, STM, PicoTREC, DLFM, Nanolithography, Electrochemistry, Heating/Cooling, Thermal K, PicoScript	
Microscope Dimensions	
L x W x H	191x191x201 mm
Weight	7.5 Kg
Potentiostat (Option)	
Scan rate	0.1 mV/s – 10V/s
Current range	5 pA – 100 mA
Current sensitivity	0.01, 0.1, 1, 100, 10,000 $\mu\text{A/V}$
Max. sample rate	16 bit @ 25 kHz

AFM Instrumentation from Agilent Technologies

Agilent Technologies offers high-precision, modular AFM solutions for research, industry, and education. Exceptional worldwide support is provided by experienced application scientists and technical service personnel. Agilent's leading-edge R&D laboratories are dedicated to the timely introduction and optimization of innovative and easy-to-use AFM technologies.

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