Keysight Technologies
5500 AFM Controller Upgrade

Data Sheet

Upgrade Overview

The Keysight 5500 AFM Controller Upgrade offers a tremendously convenient and cost-effective pathway to a more versatile, easier-to-use AFM. Upgrading your 5500 for use with a high-bandwidth digital controller and new NanoNavigator software greatly simplifies the complete control of all scanning parameters while providing the flexibility needed to conduct more complex experiments associated with materials science, life science, polymer science, and electrical characterization.

For electrochemistry applications, NanoNavigator provides precise control of potentials and cyclic voltammetry. And to facilitate the investigation of surface reactivity and interfacial processes, the software supports Keysight's powerful AFM-SECM (scanning electrochemical microscopy) technique. Furthermore, NanoNavigator enables easy-to-use Quick Sense, a new imaging mode from Keysight that permits quantitative mapping of nanomechanical properties. It now supports Scanning Microwave Microscopy Mode and TREC.

Just trade in your present controller and head electronics box and we will send you the revolutionary NanoNavigator software package, a new digital controller, a new head electronics box, a new computer, a new monitor, new cables, and an installation guide.

The self-install process is quick and easy, so you can start using your upgraded 5500 AFM right away. You can also arrange for a remote support session if you would like one.

Features and Benefits

– High-bandwidth, FPGA-based digital controller improves high-speed precision

– New NanoNavigator software:
  – Workflow-based GUI makes 5500 AFM system noticeably easier to use
  – Auto Drive automatically and optimally sets all parameters within seconds
  – Quick Sense mode for quantitative mapping of nanomechanical properties
  – Controls potentials as well as cyclic voltammetry for electrochemistry studies
  – AFM-SECM technique for studying surface reactivity and interfacial processes
  – Scanning Microwave Microscopy Mode
  – TREC Mode

– New head electronics box, computer, monitor, cables, guide for quick self-install

– Immediate ability to utilize more than a half-dozen popular AFM imaging modes

– Achieves higher 5500 system scan rates

New NanoNavigator Software

Even true AFM novices in your lab will find it easy to operate the upgraded 5500 system thanks to Keysight NanoNavigator. After loading a cantilever, the user simply enters the cantilever type into the software and the Auto Drive feature does the rest, automatically and optimally setting parameters within a matter of seconds.

If a particular experiment requires the use of non-default settings, NanoNavigator is still exceptionally helpful. AFM beginners and experts alike will appreciate the new software's workflow-based GUI as it guides users step-by-step through system setup and operation via intuitive and attractive visuals. For ultimate convenience, the NanoNavigator mobile app for smartphones and tablets allows remote monitoring of AFM experiments while they are being performed by the 5500.

Upgrading with NanoNavigator and a digital controller immediately gives your 5500 system the ability to utilize all the popular imaging modes, including contact mode, acoustic AC (AAC) mode, lateral force mode (LFM), MAC mode, STM, current-sensing AFM (CS-AFM), electric force microscopy (EFM), Kelvin force microscopy (KFM), and magnetic force microscopy (MFM). Your 5500's scan rates will also improve.

NanoNavigator also supports volume spectroscopy and FlexGrid spectroscopy, as well as math plug-ins to facilitate quantitative analysis. Additional and extensive interactive post-processing capabilities are provided by Keysight's easy-to-use Pico Image, an imaging and analysis software package built into NanoNavigator. Pico Image provides all of the features and functions required to build a surface analysis report on multilayer measurement data.

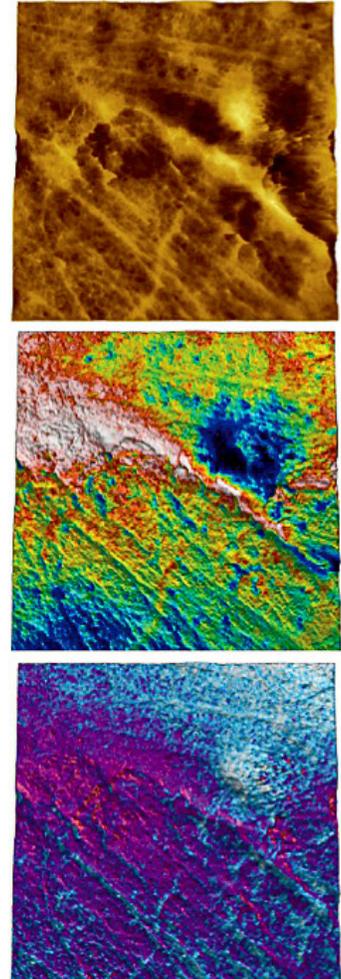Figure 1. NanoNavigator 1.8.2 launching window

Figure 2. Quick Sense image of fixed cells. Adhesion image (middle) is overlaid on topography image (top) where blue shows higher adhesion force. Stiffness (bottom) is overlaid on topography where the blue/white shows higher stiffness.The adhesion map gives a clearer picture on the position of a cell nucleus versus flat areas of the cell, whereas the stiffness map shows a better picture of the mechanical properties, like the position of the cytoskeleton structure (actin filaments showing higher stiffness for instance). In addition different cells (there are two cells shown, the intersection in the middle of the image running from higher left to lower right) might exhibit different levels of stiffness (overall higher stiffness levels being observed for the top cell).

1.   Some modes may require a specialized nose cone and sample plate.

Quick Sense

NanoNavigator software enables Quick Sense, a new Keysight imaging mode that permits quantitative mapping of nanomechanical properties on a wide range of samples. Via NanoNavigator's simple GUI, Quick Sense lets you quickly and easily set modulation amplitudes and frequencies, acquire individual force-distance curves, and measure adhesion, stiffness and elasticity. All of the data is collected while the 5500 AFM simultaneously images the sample's topography, resulting in both precise and accurate characterization of local mechanical property variations at the nanoscale.

Scanning Microwave Microscopy

Scanning microwave microscopy (SMM) mode combines the exceptional electrical measurement capabilities of a vector network analyzer (VNA) with the outstanding spatial resolution of an atomic force microscope (AFM). This unique mode outperforms traditional AFM-based scanning capacitance microscopy techniques, offering far greater application versatility, the ability to acquire calibrated quantitative results, and the highest sensitivity and dynamic range in the industry.

In SMM mode, a VNA sends an incident microwave signal through a diplexer to the sub-7-nm conductive tip of a platinum-iridium cantilever. The signal is reflected from the tip and measured by the VNA. The magnitude and phase of the ratio between the incident and reflected signals are calculated and a model is then applied in order to calculate the electrical properties of the sample. The AFM scans the sample and moves the tip to specific locations to perform point probing. Operation frequencies up to 20 GHz are supported.

SMM mode offers unprecedented utility for a diverse set of applications. SMM mode's ability to provide calibrated, high-sensitivity, compound electrical and spatial measurements is particularly useful for semiconductor test and characterization. In addition to enabling complex impedance (resistance and reactance) measurements, SMM can be used to acquire calibrated capacitance and dopant density measurements when studying sidewall diffusion. SMM mode works on all semiconductors: Si, Ge, III-V (e.g., GaAs, InAs, GaN), and II-VI (e.g., CdTe, ZnSe). Unlike scanning-probe capacitive techniques, SMM mode does not require an oxide layer.

TREC

Keysight's exclusive TREC molecular recognition toolkit is designed for use with AAC mode, preferably with MAC mode using MACLevers modified with specific biochemistries. It provides the ability to detect and map the molecular binding events while simultaneously generating topographic images in real time. With TREC, researchers can quickly distinguish between species that are engaged in molecular binding events and those that are not specific binding, thus eliminating the need to perform slow and tedious force-volume spectroscopy experiments to get the same results.

Scientists can use TREC 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.

Specifications

Scanner type		Multipurpose scanner
Scan mechanism		Tip
XY scan range		Small: 9 µm x 9 µm
		Large: 90 µm x 90 µm
Z range		Small: 2 µm
		Large: 7 µm
		Noise Level: ≤0.3Å (RMS) in Z
Scanner type		STM scanner
XY scan range		Small: 1 µm x 1 µm
		Large: 10 µm x 10 µm
Z Range		Small: 0.7 µm
		Large: 1.6 µm
Standard modes		Contact, LFM, AAC, Phase, MFM, EFM, KFM, Quick Sense, Lift, Force Spectroscopy, Volume Spectroscopy, FlexGrid, Force Plug-ins, PFM, Auto Drive, Scripting, Thermal Tuning
Optional modes		MAC, CS-AFM, STM, Electrochemistry, SECM, SMM, TREC
Controller	FPGA	@ 200 MHz
	XY PID update rate	1 MHz
	Z PID update rate	10 MHz
Inputs Control Loops	Photodiodes	100 MS/s – 14 bit
	XYZ sensors	1 MS/s – 18 bit
Supplemental IO	AUX In	1 MS/s, 18 bit, 100 KHz, ± 10 V
	VEC, IEC, Itip (fast)	10 MS/s, 16 bit, 2 MHz, ± 1 V
Itip (slow)		1 MS/s, 18 bit, 150 KHz, ± 1 V
AUX Out		1 MS/s, 20 bit, 500 KHz, ± 10 V
MAC		100 MS/s, 16 bit, 1 MHZ, ± 100 mA
AAC		100 MS/s, 16 bit, 12 MHz, ± 10 V
Sample bias, Tip bias, Ref set		1 MS/s, 20 bit, 150 KHz, ± 10 V
EIS (Sample bias, Tip bias, Ref set)		100 MS/s, 16 bit, 2.1 MHz, ± 8 V
High Frequency modulation output for Electrochemical Impedance Spectroscopy(EIS).		
3 Lock-ins		@ 25 MHz
Camera mounting		Top
Environmental control		Yes (with all electrical components outside environment)

AFM Instrumentation from Keysight Technologies

Keysight 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. Keysight's leading-edge R&D laboratories are dedicated to the timely introduction and optimization of innovative, easy-to-use AFM technologies.

www.keysight.com/find/nano

KEYSIGHT
TECHNOLOGIES