

NANOMECHANICAL TEST SYSTEM

Hysitron TI 990 TribolIndenter

World's Most Comprehensive Nanomechanical Testing
with Unmatched Performance to Drive Materials Innovation

Hysitron TI 990 TriboIndenter

Accelerating Materials Understanding and Development

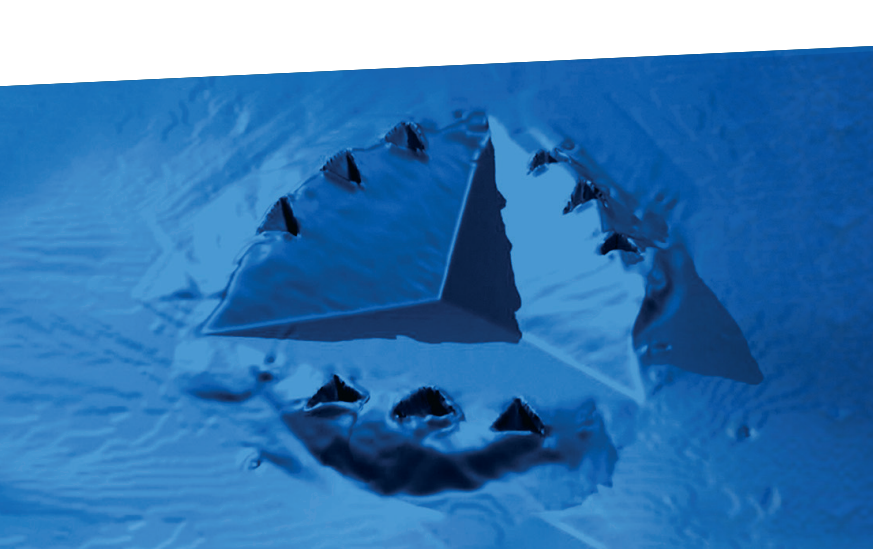
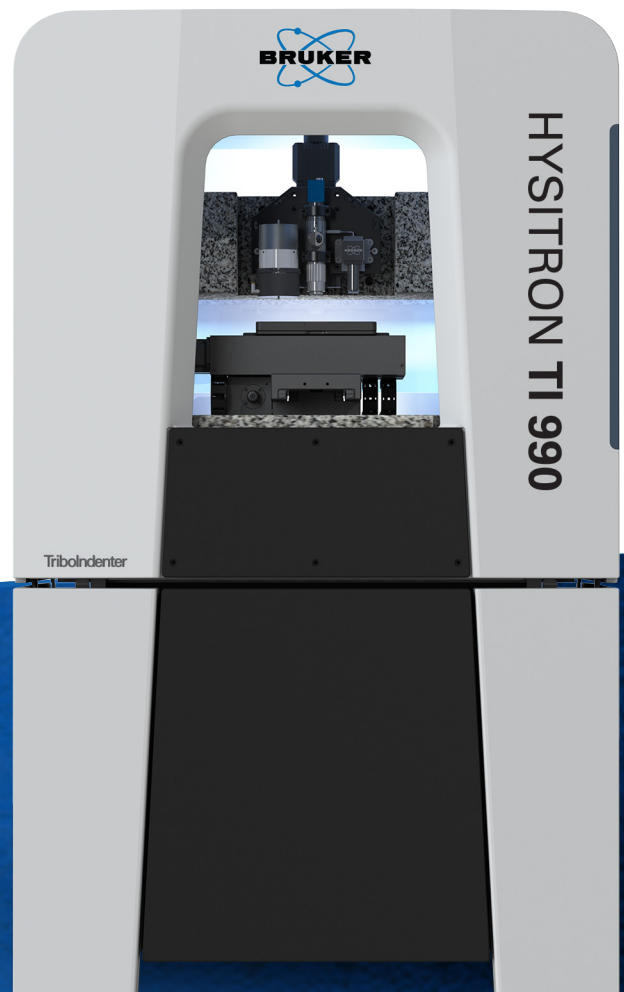
Bruker's next-generation TI 990 TriboIndenter® features new advanced measurement modes, faster testing throughput, and a larger testing area for ultimate versatility in nanomechanical characterization. Every aspect of the measurement and analysis process incorporates updated technology, including the new Performech® III controller, the latest TriboScan™ 12 software, next-generation nanoDMA® IV dynamic nanoindentation, and XPM™ II high-speed mechanical property mapping.

You Define What is Possible

TI 990 makes your nanomechanical testing process remarkably customizable. Mount your sample in your lab, without concern for restrictive stages or environmental noise. Program your experiment for any duration, without being confined to a single feedback mode or a data acquisition limit. Whether you need improved accuracy for polymer thin films, increased throughput for combinatorial materials science, or multi-measurement analysis of full 300-mm semiconductor wafers, TI 990 keeps up with your dynamic testing needs.

Only TI 990 delivers:

- **Unmatched performance for nanoindentation, nanoscratch, and nanowear testing**
Latest advances in Performech control technology with nanoDMA IV dynamic nanoindentation and XPM II ultrahigh-speed mechanical property mapping
- **Most streamlined system operation with superior control over the measurement process**
All-new TriboScan 12 operating software with simplified and assisted workflow
- **Unlimited potential for future developments in nanoscale characterization**
Modular system architecture, universal sample mounting options, and world's largest suite of advanced nanomechanical techniques



The New Standard for Nanoindentation

Exceptional Performance and Control

Industry-leading noise floors—Exclusive electrostatic actuation technology combined with ultralow-noise electronics, active antivibration system, rigid granite platform, and custom-engineered environmental enclosure delivers superior results in widest range of laboratory environments.

Performech III advanced control module—The latest Hysitron® control technology with parallel processing and dual lock-in amplifiers enables innovative new control modes, ultra-fast feedback control, and unlimited data acquisition and test function definition capabilities.

Unique Testing and Characterization

nanoDMA IV with CMX—Next-generation dynamic nanomechanical testing with displacement feedback control, automated displacement amplitude tuning, force amplitude control, and dual lock-in amplifiers for 2nd-harmonic measurements provides powerful characterization of mechanical properties as a function of depth, frequency, and time.

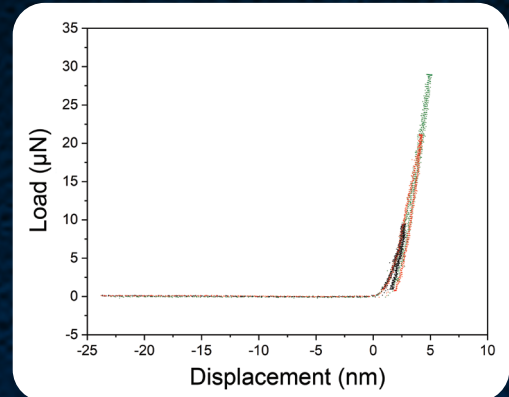
XPM II accelerated property mapping—High-resolution mechanical property mapping with an industry-leading throughput of 12 measurements/second, dynamic property mapping as a function of depth, and advanced machine-learning clustering algorithms for fast and reliable data analysis.

In-situ SPM imaging—Top-down scanning probe microscopy (SPM) enables improved measurement accuracy and repeatability, a ± 10 nm test positioning accuracy, the ability to correlate mechanical properties with sample morphology, and post-test observation of material deformation.

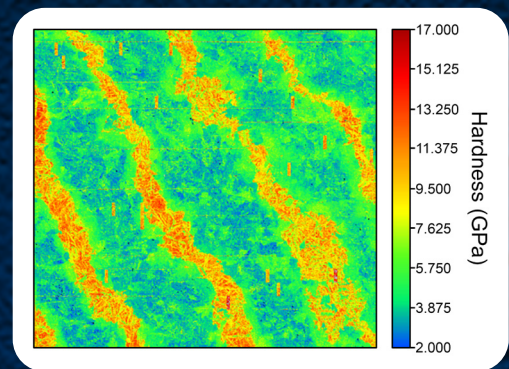
User-Focused Operation and Analysis

TriboScan 12 control software—Designed for ease of use and streamlined system operation, TriboScan 12 delivers the latest nanomechanical testing modes and simplifies system operation, from sample setup to results.

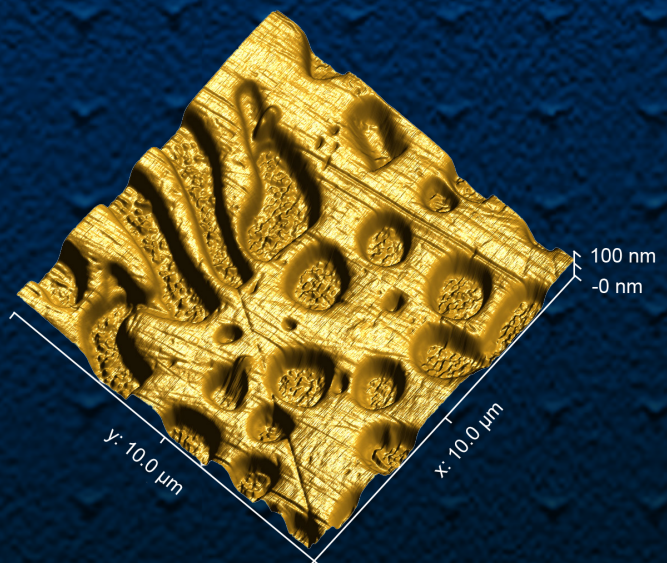
Tribo iQ™ data analysis software—Built on an advanced scientific software engine, Tribo iQ is a family of technique-specific data analysis, plotting, and reporting applications for comprehensive and flexible analysis.



Industry-leading noise floors enable quantitative measurement down to single-nanometer contact depths.



XPM II high-resolution, ultrahigh-speed property mapping up to 12 measurements/sec.



In-situ SPM imaging enables high-precision test placement to within ± 10 nm.

Powerful Base Configuration

Maximize Your Characterization Potential

In-Situ SPM Imaging

Dual piezo scanners deliver high-resolution sample surface topography imaging and nanometer-precision test placement accuracy.

Sample Imaging

High-resolution, color optics enable easy sample navigation and coarse test positioning.

2D Capacitive Transducer

Exclusive low-noise 2D capacitive transducer technology enables quasistatic nanoindentation, nanoscratch, and nanowear characterization.

Test Stability

Metrology-grade granite framing assures superior instrument rigidity and test stability.

Vibration Isolation

Integrated active anti-vibration system isolates the instrument from the environment.

Perfomech III

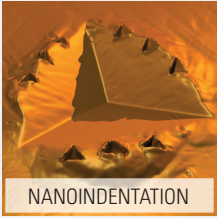
High-speed feedback, low noise, and fast data acquisition rates provide industry-leading control over the testing process.

Noise Immunity

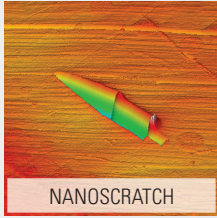
Vibration-dampening base delivers high-quality data in a broad range of environments.



Delivering the World's Best



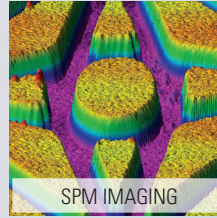
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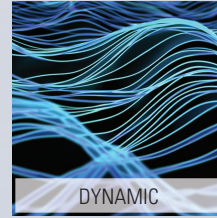
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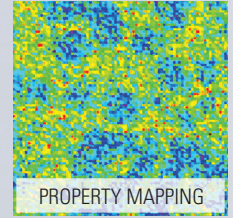
NANOWEAR



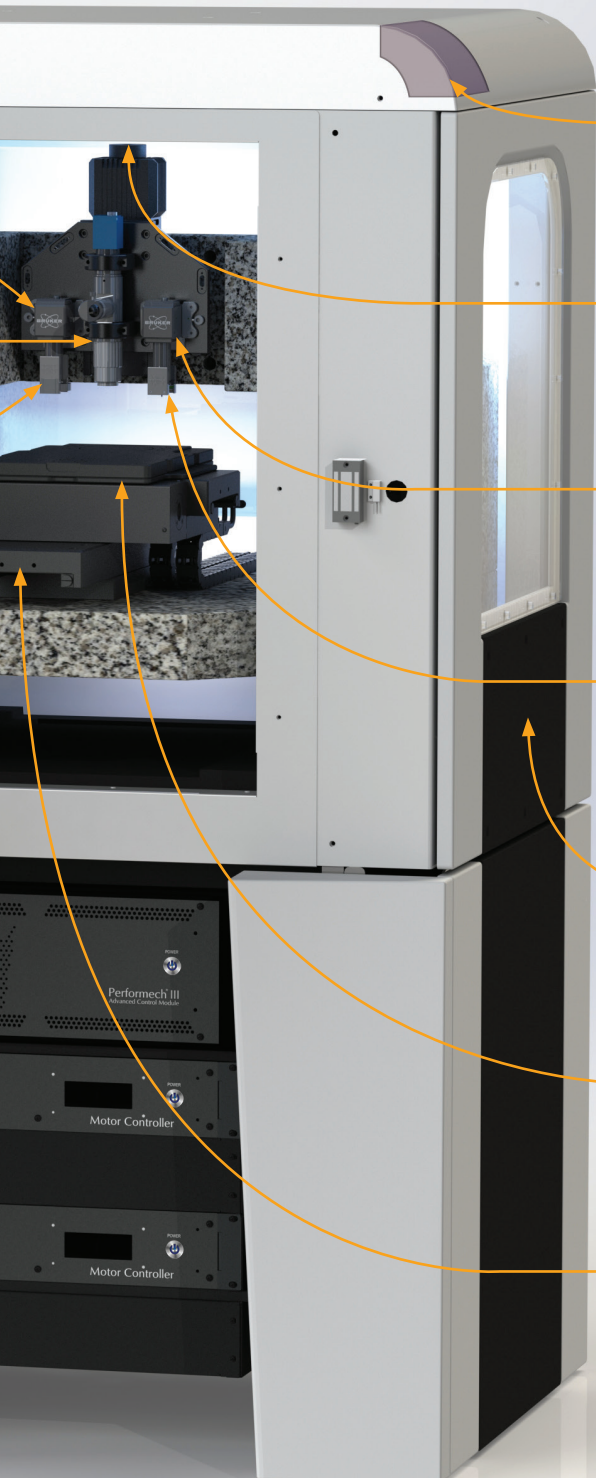
SPM IMAGING



DYNAMIC



PROPERTY MAPPING



■ **Environmental Isolation**

Multi-layered enclosure protects against thermal, acoustic, and air disturbances.

■ **Chuck Imaging**

Top-view sample chuck optics streamline sample navigation and system setup.

■ **Property Mapping**

XPM II ultrahigh-speed nanoindentation delivers high-resolution, quantitative mechanical property maps.

■ **Dynamic Nanoindentation**

nanoDMA IV enables viscoelastic characterization and a continuous measurement of properties as a function of depth, frequency, and time.

■ **System Modularity**

Customizable enclosure panels streamline system upgradability and technique integration.

■ **Versatile Sample Chuck**

Rapid and reliable sample mounting options: magnetic, mechanical, and vacuum.

■ **High-Precision Staging**

Encoded motorized staging provides a large accessible test region and automated multi-sample testing.

Next Nanomechanical Testing

Measure More, Measure Better

Keeping You at the Forefront of Materials Innovation

TI 990 is configurable to quantitatively measure over 6 orders of magnitude in force and 11 orders of magnitude in displacement, allowing the system to achieve your measurement needs of today and into the future.

A universal sample chuck incorporates magnetic, mechanical, and vacuum mounting options to accommodate a wide range of sample types and geometries. With a testable area 60% larger than previous TriboIndenter systems, larger surface areas can be analyzed and more samples can be tested in an automated workflow. An optional dual Z stage design provides independent control of any combination of two measurement heads for superior multi-technique characterization of samples with large or complex geometries.

In addition to the high degree of measurement mode configurability, TI 990 was designed for high-precision measurements in a broad range of laboratory environments and easy integration of future advanced techniques:

- Vibration-dampening base provides a 50x improvement in environmental noise immunity, allowing the system to operate at peak performance in a broad range of environments.
- Modular environmental enclosure with large internal volume provides exceptional versatility, empowering the system to be tailored for unique research needs.

TI 990 also features unparalleled Performech III technology with powerful, real-time control and signal processing using up to 16 channels of parallel data acquisition with a simultaneous data sampling rate of 1.25 MHz on all channels. Superior precision and control during the measurement process are ensured by industry-leading noise floors, dual lock-in amplifiers for 2nd-harmonic measurement, an ultrafast force and displacement control feedback loop rate, and unlimited data acquisition and test segment programmability.

Simple Operation and Comprehensive Analysis

System setup, data collection, and data analysis have never been easier than with the new TriboScan 12 control software and the Tribo iQ suite of analysis applications. The entire system setup and measurement process can also be operated remotely, allowing data to be collected from any operator location.

During system setup with TriboScan 12, multiple cameras within the environmental enclosure provide operators with real-time viewing of the location of transducers and staging, while a dedicated sample-chuck camera supports streamlined definition of sample location. Automated focus of the sample optics allows operators to quickly navigate to the desired testing region. Once data has been collected, the Tribo iQ suite of over 15 technique-specific applications provides unmatched data analysis, plotting, and reporting capabilities.



No System Has More Modes

A powerful suite of techniques come standard on TI 990, enabling comprehensive nanomechanical characterization of materials.

Nanoindentation

- Proprietary electrostatic actuation with capacitive displacement sensing delivers industry-leading noise floors with maximum measurement accuracy and repeatability
- Ultrafast 78 kHz feedback control loop rate delivers superior control over the testing process

Nanoscratch

- Electrostatic actuation in both the normal and lateral directions provides extreme sensitivity for nanoscale interfacial and tribological measurements
- High-precision normal and lateral force measurements enables quantitative thin-film adhesion and friction measurements

Nanowear

- Quantitatively measure material removal rate as a function of applied probe force, number of wear passes, and probe speed
- Calculate wear volumes on thin films and individual phases or materials, or across interfaces

In-Situ SPM Imaging

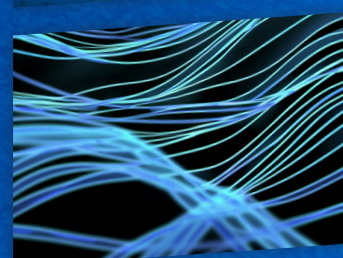
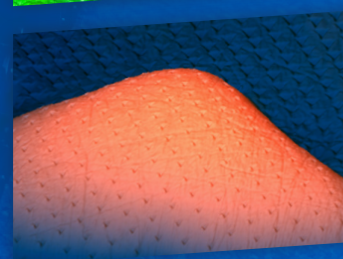
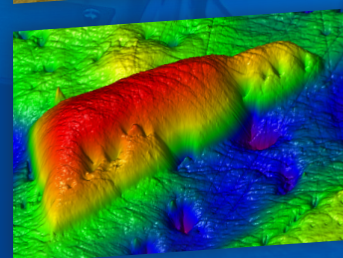
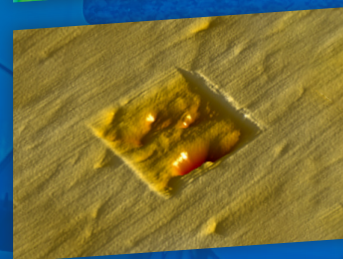
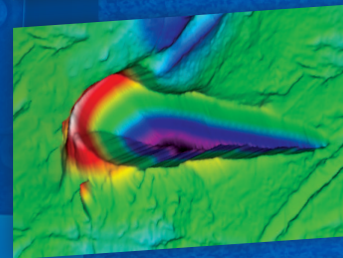
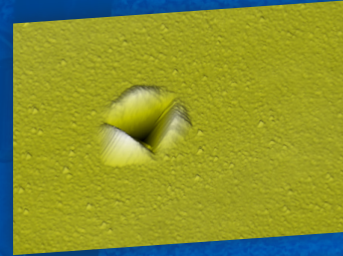
- Enables superior nanomechanical characterization through high-precision probe placement accuracy (± 10 nm), test placement validation, and observation of material deformation behavior
- Customizable SPM resolution options from 64x64 to 4096x4096
- Dual piezo scanners provide in-situ SPM imaging capabilities with any combination of electrostatic transducers without hardware modification

XPM II

- Ultrahigh-speed quantitative mechanical property measurements (12/second)
- High-resolution spatial mapping of hardness and modulus with distribution statistics
- 1000x faster data acquisition than traditional quasistatic nanoindentation testing
- xSol® environmental control stage compatibility for rapid testing under extreme conditions

nanoDMA IV with CMX

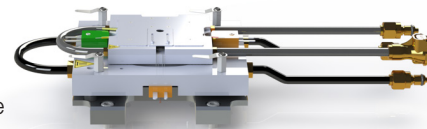
- Quantitative measure of elastic-plastic and viscoelastic properties as a function of depth, frequency, and time
- Automated displacement amplitude tuning with dual lock-in amplifiers for 2nd-harmonic analysis
- Exclusive reference-frequency drift correction for long-duration tests
- Force amplitude control assures continuous surface contact when measuring at small depths or on highly plastic materials



Expanding Capabilities

Comprehensive Suite of Upgrade Options Enable the TI 990 to Grow with Your Research

xSol Environmental Stage enables quantitative, accurate, and reliable nanomechanical and nanotribological characterization at elevated temperatures up to 800°C. The xSol can be expanded to enable low temperature and humidity-controlled measurements. The xSol design incorporates a micro-environment for guaranteed tip/sample temperature equilibrium and the ability to test under customizable gaseous atmospheres.



3D OmniProbe extends force and displacement measurement capabilities from the nano- to micro- regime for both indentation and scratch. The higher forces and greater displacements of the 3D OmniProbe were developed to enable micromechanical characterization of rough, thick, or hard films.

Additional Upgrade Options

nanoECR	In-situ conductive nanoindentation correlates nanomechanical properties, material deformation behavior, and electrical characteristics of materials
iTF	Patented analytical software package that provides quantitative, substrate effect-free elastic properties of thin films
MultiRange NanoProbe	Expanded force- and displacement-range transducer providing microscale mechanical testing
Synchronized Raman Spectroscopy	Spatial correlation of mechanical and tribological properties with material structure and chemistry
Modulus Mapping	Scanning dynamic nanoindentation mode provides quantitative, high-resolution maps of viscoelastic properties across a surface
Fluorescence Microscopy	Integrated fluorescence microscope enables fluorochrome-guided test placement
Electrochemical Cell	Quantitative, in-situ measurements of nanoscale mechanical and tribological behavior under oxidizing and reducing conditions
Automated Probe Changer	Push-button exchange of testing probes provides maximum uptime, ease of use, and probe-customizable automation routines
Sample Chucks	Diverse range of magnetic, mechanical, and vacuum chucks secure almost any sample for testing, up to a 300 mm wafer
TriboAE	Transducer that provides in-situ, through-tip monitoring of acoustic signals generated from fracture and deformation events during the nanoindentation process
Tribolmage	Time-resolved cyclic nanoscale scratch/wear characterization
Dual Z Stages	Independent approach/withdrawal of any two measurement heads, enabling multi-technique characterization on large substrates

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