UPGRADE OPTIONS

Closed Loop Scanner

In-Situ SPM Imaging for Precise Test Placement

HYSITRON®

In-situ Scanning Probe Microscopy (SPM) imaging* and industry-leading test placement accuracy have been two defining characteristics of Hysitron's nanomechanical testing suite for over a decade. The increasing complexity of newly developed nanostructured materials and devices, along with the emergence of standardized nanomechanical testing practices, are now requiring ever-increasing test placement accuracy, stability and faster sample throughput. To meet these needs, Hysitron has integrated a high-precision 3-axis closed-loop scanner option for the **TI 900** series. This provides unparalleled performance for the most demanding applications.

The unique capability from the closed loop scanner interface is brought about due to the tip scanning capability, which allows the sample to be held stationary. Typically, closed loop scanners consist of a flexure stage which require the sample to be scanned under a fixed probe. Hysitron's top-down closed loop scanning capability provides an increased scan range (X-Y: 100µm, Z: 15µm) while still using tip scanning for more accurate positioning and enabling studies on larger samples.

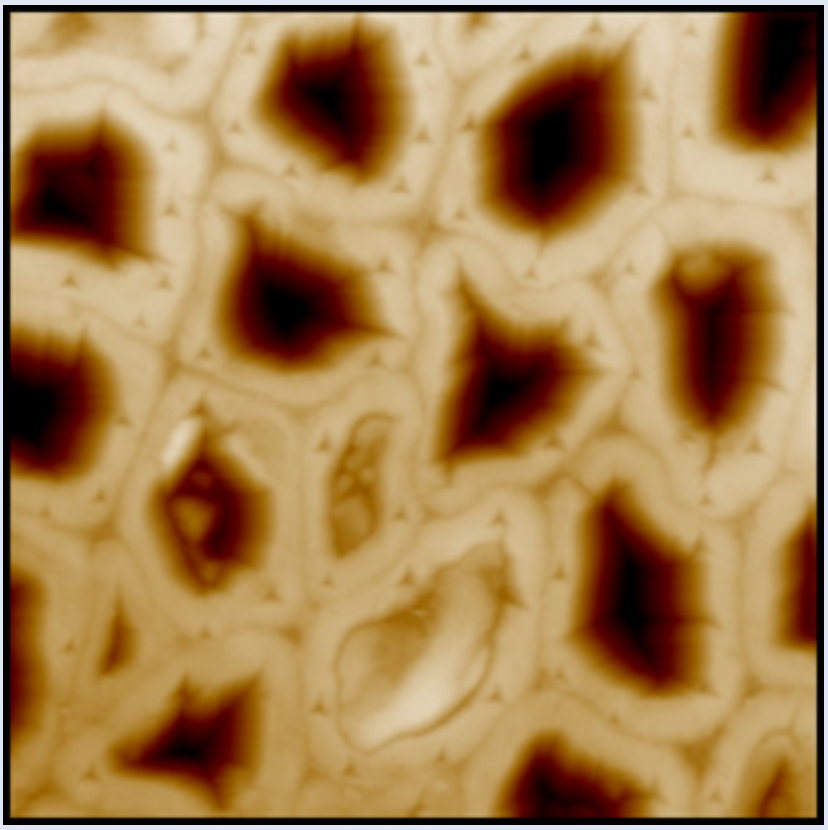

Figure 1. 57 indentation tests placed on wood cell walls obtained through a single **ClickMode**™ piezo automation.

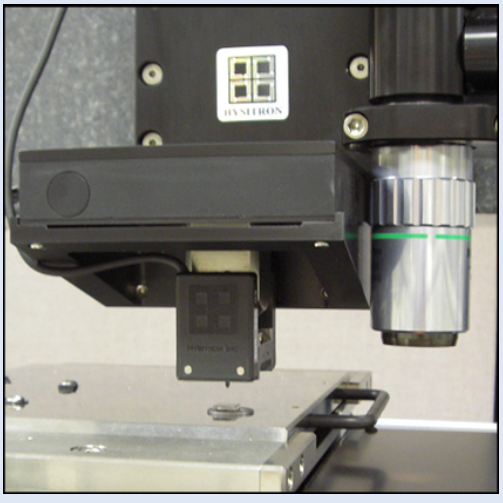

Figure 2. Closed loop scanner showing top down configuration mounted on a **TI 900** Series nanomechanical testing system.

Test Placement Accuracy

In-situ SPM imaging is critical for all applications requiring microstructure identification and accurate test location. Precise indent placement is mandatory for obtaining reliable data when testing at the nanoscale. Sample defects, such as surface asperities and contaminants, will greatly impact the results obtained from any nanomechanical testing technique.

Figure 1 shows how precise positioning is crucial to accurate data. The image shows a cross-section through a wood sample, with the individual wood cells identifiable by their circular cell wall and the residual indent impressions placed within the walls.

The *in-situ* SPM images are obtained by raster scanning the indenter probe over the sample surface with a fixed force. These images can be used to reliably place a test within ten nanometers of the desired testing location. For the majority of applications, Hysitron's standard open-loop scanner is sufficient to quickly identify surface features and acquire data at the location of interest. However, open-loop scanners suffer from the intrinsic flaw of piezo creep and hysteresis, which can lead to drift in the image. This drift can take several minutes to subside after the tip is stopped.

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Increased Sample Throughput

Hysitron's closed loop scanners offer real-time position feedback and needs only milliseconds to settle. Piezo creep and hysteresis are eliminated using capacitive sensors for real-time position feedback. Figure 3 shows an SPM image of 64 residual indents on fused quartz showing the positioning accuracy for each indent placed in the 10 µm grid pattern

The ultra-fast settle time and quick positioning response of the closed loop scanner allows researchers to run piezo automation experiments 2× to 3× faster than experiments run in open loop mode. Additionally, the absence of piezo drift simplifies the process of identifying and targeting small surface features. The closed loop scanner provides the capability of accurately positioning the probe on the desired surface feature the first time, every time.

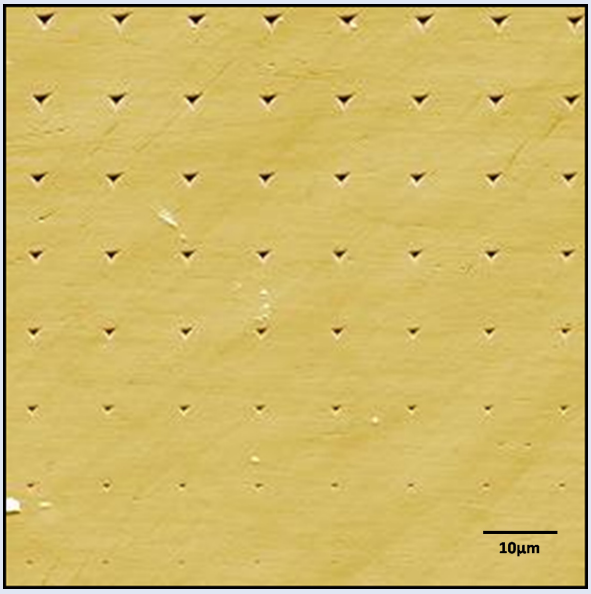

Figure 3. 64 indentation tests with 10 µm spacing between measurements. The movement time between each indentation cycle is ~30 seconds with a positioning accuracy of >99.9%.

	Unit	X-Y Axis	Z Axis
Scanning Range	µm	100	15
Resolution	nm (RMS)	<0.5	<0.07
Linearity Error	%	<0.05	<0.1
Hysteresis	%	<0.05	<0.1

*Covered under US patents: 5,553,486; 5,576,483; 5,661,235; 5,869,751; 6,026,677; 7,107,694

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HIGHLIGHTS

- Tip scanning closed loop scanner, ensuring sample is not moved during imaging or testing
- *In-situ* SPM imaging capability exclusive to Hysitron instrumentation
- Increased scan range (X-Y: 100µm, Z: 15µm)
- Real-time position feedback eliminates testing difficulties arising from piezo creep and hysteresis
- Capacitive position sensors with sub-nanometer noise performance and a scanning linearity of >99.95%
- Advanced DSP control algorithms to maintain accuracy and speed
- Ultra-fast settle time allows for increased sample throughput
- Integration takes minutes

APPLICATIONS

- Nano-metrology requiring accurate and distortion free measurements
- Nanostructured materials and devices relying on precise test placement
- Combinatorial analysis requiring fast throughput
- Nanolithography/nano-wear