UPGRADE OPTIONS

3D OmniProbe™

Indentation, Scratch, and Dynamic Mechanical Analysis at Nano- to Micro-Scale

The **3D OmniProbe** is a unique instrument tailored to extend indentation and scratch testing capabilities from nano- to micro-scale. Through exceptional three-dimensional force and displacement sensing and control technology, the 3D OmniProbe opens additional possibilities for mechanical and tribological characterization of a wide variety of materials.

Unique Capabilities

The 3D OmniProbe is designed with three axes of movement allowing for quasi-static as well as dynamic indentation testing and scratch testing in any direction with a maximum scratch length of 15 centimeters.

Combining the trusted, proprietary sensor technology from the standard Hysitron nanoindentation systems with independent piezoelectric actuating systems, the 3D OmniProbe expands the force and displacement ranges of Hysitron's **TI Series** instruments, connecting the nano and micro-scale regimes for both indentation and scratch testing.

The wider force and displacement ranges available with the 3D OmniProbe expand the range of testing options to material systems that may not be appropriate for true nano-scale testing. The higher force range allows indentation and scratch testing on relatively hard, thick, and/or rough films where the low force range of the standard nano-scale transducer may not suffice. Dynamic capabilities allow for depth profiling over the extended displacement range. The same three-axis movement can also function as a profilometer for post-analysis of deformation created on tested surfaces. The increased displacement range permits measurement of larger material volumes and scratch testing of thicker coatings. Dynamic mecahanical capabilities

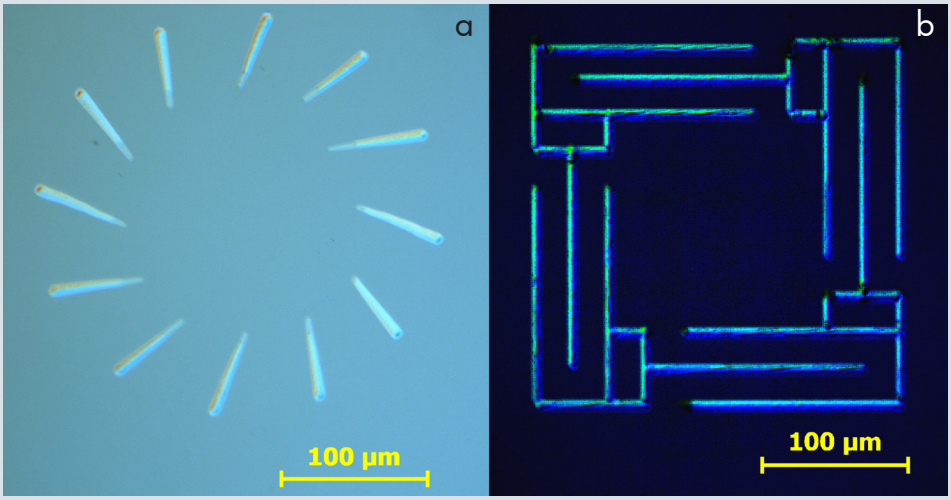

Figure 1. Optical microscope images of a) ramped force scratch testing on Si illustrating the unique multi-directional testing capabilities, b) automated routine results from 24 constant force automated scratches on Si creating the Hysitron logo. 3D OmniProbe continuously measures and controls force and displacement along all three axes.

HIGHLIGHTS

3D OmniProbe

- Three dimensional force and displacement sensing and control for indentation or scratch testing across a wide force and displacement range
- Multi-directional scratch capabilities
- Closed-loop load or displacement controlled testing

High Load DMA Option

- *CMX* tests for continuous measurement of hardness and modulus as a function of indentation depth and strain rate
- Frequency sweeps from 0.1-100 Hz to characterize frequency-dependence of material properties
- Reference Frequency Technique: Creep testing with in-situ drift correction

APPLICATIONS

3D OmniProbe

- Film/substrate adhesion measurements over a wide thickness range
- Tribological characterization (friction, scratch resistance), especially on relatively hard, rough, and/or thick films
- Microhardness testing of bulk specimens or relatively thick films

High Load DMA Option

- Material systems with depth-dependent properties
- Creep studies of metals and polymers
- Frequency sweeps for measurement of viscoelasticity
- Characterization of strain rate dependence

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(**High Load DMA**) provide even more insight into the materials characterization through continous property measurements, real-time drift correction or characterization of the time-dependent properties such as viscoelasticity, creep, or strain rate response.

Superior Design

Allowing for scratch testing in any direction and utilizing piezoelectric loading and capacitive sensing technology, the 3D OmniProbe is truly a unique instrument. Each axis is independently driven and monitored to allow microscratch testing at arbitrary angles and indentation testing across orders of length scales. Piezoelectric actuation and capacitive sensing eliminate the use of magnetic coils which can introduce thermal drift into the system. The specially designed environmental isolation enclosure in combination with an active vibration isolation system and solid granite base provide isolation from thermal gradients, vibration, acoustic disturbances, and air drafts.

The tunable design of the 3D OmniProbe gives users the flexibility to select the maximum force of the transducer head from 1 N to 10 N so that the system's capabilities can be tailored to the intended applications. The 3D OmniProbe head uses a high bandwidth, closed-loop feedback control system powered by Hysitron's advanced ***performech***® controller that can operate in either load or displacement controlled feedback modes.

3D OmniProbe with High Load DMA

The 3D OmniProbe may be used in combination with the High Load DMA testing option to provide a greater range of testing options. High Load DMA superimposes a small oscillating force during indentation testing, and by measuring the dynamic response of the system, it gives a continuous measurement of the contact stiffness throughout the test. The stiffness measurement is used to calculate hardness, modulus, and contact depth in real time. The addition of the dynamic component to an indentation test opens several additional testing possibilities:

- **Continuous Measurement of Mechanical Properties** (*CMX*) testing adds a dynamic signal at a constant frequency to produce a continuous curve of hardness and modulus as a function of depth – a capability not possible with conventional quasi-static indentation testing. *CMX* testing can be used to quickly determine if a sample's properties are depth dependent, and performing *CMX* tests over a range of strain rates can rapidly characterize the strain rate dependence of the material's properties.
- **Frequency sweeps** from 0.1 to 100 Hz measure modulus as a function of frequency for characterization of viscoelastic materials.
- **Reference creep testing** uses the dynamic signal to correct for thermal drift in-situ, allowing indentation creep tests with much longer duration than would typically be possible in an indentation test.

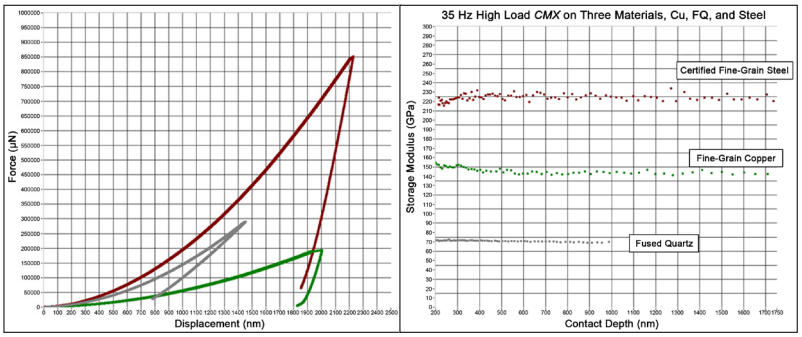

Figure 3. Load-displacement curves and *CMX* modulus depth profile for three different materials: fine-grain steel, fine-grain copper, and fused quartz. A single test generates a continuous curve of modulus and hardness as a function of depth.

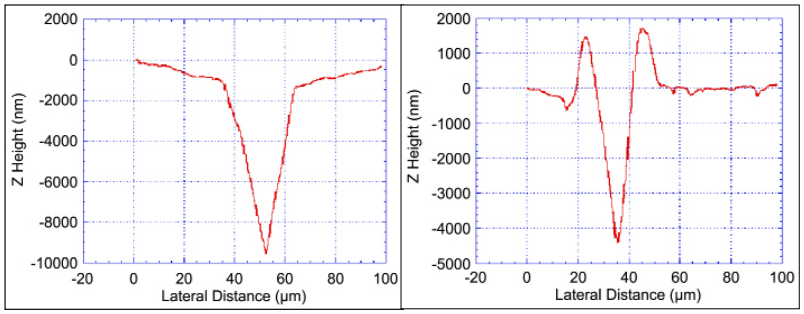

Figure 4. In-situ profilometry measurements show sink-in (left) and pile-up (right) responses surrounding micro-scratch impressions on polymer coatings.

SPECIFICATIONS

3D OmniProbe

- **Maximum Lateral Force:** 5 N
- **Maximum Scratch Length:** 150 mm
- **Maximum Normal Force:** Selectable, 1 N to 10 N
- **Maximum Normal Displ.** 80 µm

High Load DMA Option

- **Frequency Range:** 0.1-100 Hz