

CETR-Apex

- Nano & Micro Indenter & Scratcher

CETR-Apex

Industry-Leading Sensitivity, Unmatched Performance and Versatility

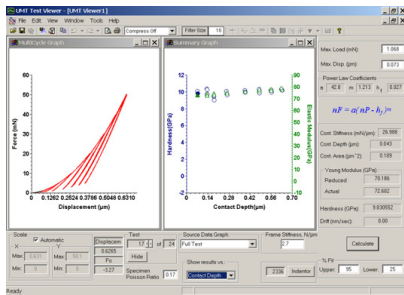
Nano Module NH

With the progress of nanotechnology and development of thin films (solar cells, cvd, pvd, DLC, MEMS, etc.) nano-mechanical tests have become standard. They improve on the traditional tests by being done at low loads and shallow depths with very sharp tips, high spatial resolution and in-situ precise load-displacement data.

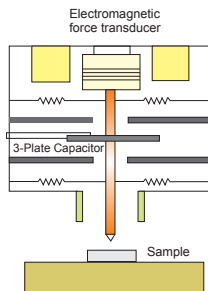
Nano Indentation – Single/multiple indents per the ISO 14577 to measure hardness, Young’s modulus, tensile and von Mises stresses, contact stiffness, etc. of thin films, thick coatings and bulk material.

Nano Scratch at constant, increasing and user-defined programmable load to evaluate scratch hardness and scratch adhesion of thin films, thick coatings and bulk materials.

Dynamic Indentation (with vibrating tip) to measure depth-dependent loss and storage moduli.



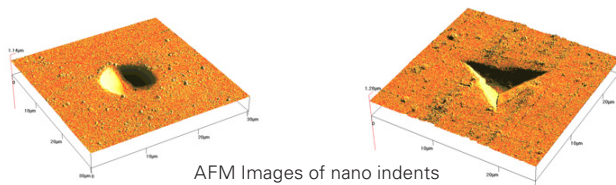
Multiple loading-partial unloading cycle



N-3 setup schematic

Features of NH

- Electromagnetic force transducer
- 3-plate capacitance sensor to measure displacement with ultra high accuracy
- Berkovich, spherical, cube, corner, etc. indenter tip geometries
- Mapping of unlimited number of indents
- In-line imaging options (AFM recommended)
- High throughput and repeatability
- Optional advanced in-situ sensors
- Thermal & acoustic enclosure, vibration isolation table
- ASTM, DIN and ISO compliant



AFM Images of nano indents

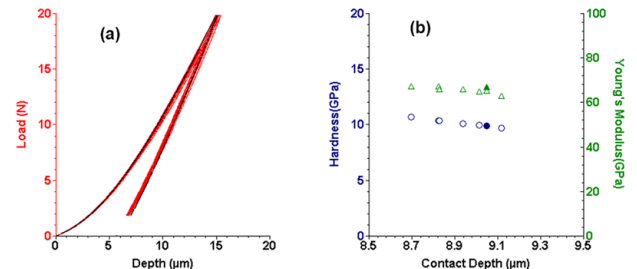
Micro Module MH

Micro-mechanical tests have been used to measure mechanical properties of coatings or bulk materials. Instrumented micro-mechanical test improves on the traditional ones by providing in-situ load-displacement data and by using advanced signals like acoustic emission, ECR, friction, etc. for more comprehensive characterization.

Instrumented Micro Indentation – per the ISO 14577 on macro-scale (for loads greater than 2 N) and micro-scale (loads under 2 N) to calculate hardness, Young’s modulus, tensile and von Mises stresses, contact stiffness, etc. of coatings and bulk materials.

Traditional Vickers and Knoop micro-hardness per the ASTM E384-99.

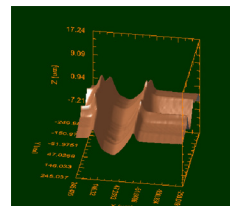
Micro Scratch at constant, increasing and user-defined programmable load to evaluate scratch hardness and scratch adhesion of coatings.



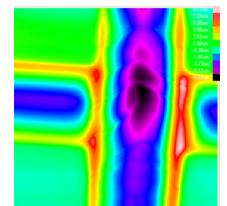
Load-unload curves at multiple positions

Features of MH

- Electromagnetic force transducer
- 3-plate capacitance sensor to measure displacement with ultra high accuracy
- Berkovich, spherical, cube, corner, etc. indenter tip geometries
- Mapping of unlimited number of indents
- In-line imaging options (3D profiler recommended)
- High throughput and repeatability
- Optional advanced in-situ sensors
- User-definable analysis algorithm or models to calculate material properties
- ASTM, DIN and ISO compliant

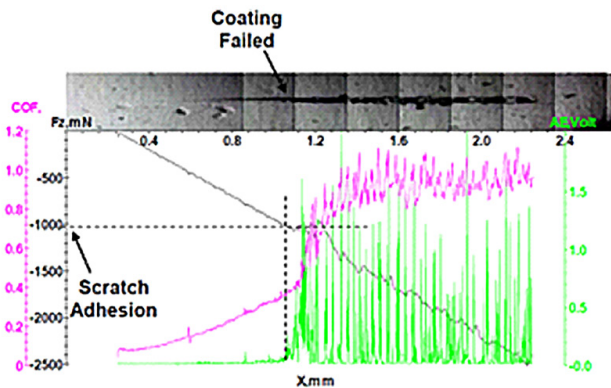


3D Profilometer images of a cross scratch



Scratch Options

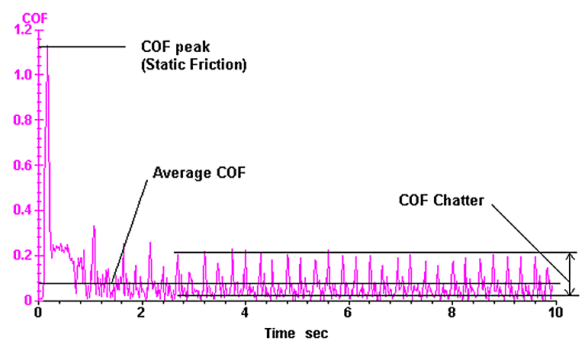
- Customized scratch tracks (zigzag, linear, spiral, rotary)
- Auto-focus microscopy enables automatic scratch imaging across the entire field-of-view and depth
- Panoramic scratch image and the data such as friction, acoustic emission, depth, force, etc. are automatically plotted on same plot
- Advanced view options such as zoom-in, zoom-out of entire plot with both image and data



Panoramic image, coefficient of friction and acoustic emission plot

Nano Tribology Options

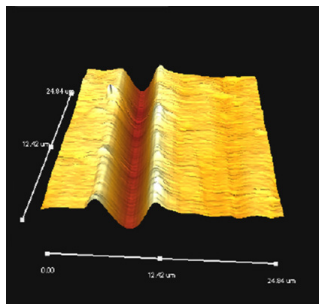
- Easily interchangeable Linear and Rotary drives
- Temperature, humidity and gases options
- Wide range of speeds from ultra high to ultra low
- Ultra low loads – precision servo-control of loads, speeds, and positions for uniquely reproducible test data
- Patented sensors for simultaneous measurements of forces in X, Y and Z axes
- Friction, wear, striction, stick-slip



Static and dynamic friction in reciprocating test

In-line Imaging

Advanced in-situ and in-line imaging options. The images are generated automatically after the test without removing the sample from the tool.



AFM – scanning ranges up to 110 x 110 x 20 μm

3D Profilometer – scanning ranges from 10 x 10 x 10 μm up to 500 x 500 x 50 μm

High Magnification Microscope – with revolving head and multiple objectives

Medium Magnification Microscope – for in-situ imaging and precise positioning: both top and side views

Advanced In-situ Sensors

AE

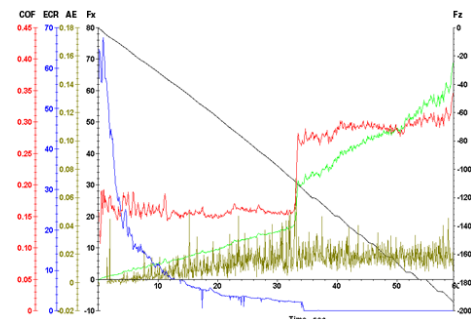
The high-frequency *acoustic emission* sensor detects the crack initiation and propagation in the hard and metallic coatings.

COF

When the coating breaks or when the indenter digs deep in the coating the *friction* changes. Coefficient of friction (static and dynamic) is automatically calculated.

ECR

The *electrical contact resistance* changes as a conductive tip digs deeper into the coating.



CETR-Apex Technical Specifications

Parameter		Nano (NH)	Micro (NH)
Load	Range Resolution	up to 500 mN 0.03 μ N	up to 20 N 5 μ N
Friction	Range Resolution	up to 100 mN 3 μ N	up to 10 N 0.2 mN
Depth	Range Resolution	200 μ m 0.001 nm	500 μ m 0.05 nm
XY Stage	Range Resolution	120 x 120 mm 0.1 μ m	120 x 120 mm 0.1 μ m
Optical Microscope		from 10x to 2500x	from 10x to 2500x
Scratch	Speed Length Depth	1 μ m/s to 10 mm/s 1 μ m to 100 nm 1 nm to 200 μ m	1 μ m/s to 10 mm/s 1 μ m to 100 mm 10 nm to 500 μ m

CETR-Apex Three Head Positions

- Left Mechanical (easily interchangeable micro and nano heads)
- Middle Revolving-head microscope (up to 4 easily interchangeable objectives)
- Right Imaging (easily interchangeable AFM and 3D profiler)

ASTM/DIN/ISO Standards

Apex is compliant with multiple standards.

- ASTM E2546 Standard practice for nano indentation
- ISO 14577 Instrumented indentation for hardness
- ASTM C1624 Adhesion and mechanical failure of ceramic coatings
- ASTM G171 Scratch hardness of materials
- ASTM E384 Microindentation hardness of materials

and many more

Cover Images

Foreground: CETR-Apex.

Background: (left) Nano scratch at increasing load and (right) DLC coating scratched with Berkovich tip at loads 60, 40, 20 μ N.

Applications

- Wear-resistant coatings
 - TiN, TiC, DLC, WC
 - Cutting tools
- Semiconductors
 - Low K materials
 - Interconnects
 - Passivation layers
- Biomedical
 - Tablets and pills
 - Implants and tissues
- Thin films
 - CVD/PVD coatings
 - Solar cells, MEMS, fuel cells
- Optical components
 - Window glass
 - Lenses
 - Optical coatings
- Decorative coatings
- Hard disk industry
 - Disk and head overcoats
 - DLC coatings
- Automotive & Aerospace
 - Paints and intermediate layers
 - Windows
 - Engine components

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