NanoTest Vantage

Vantage

Advantages

- **Unrivalled technique versatility**
  nanoindentation, nano-scratch, nano-impact, nano-fretting, nano-wear
- **High-accuracy multiple force scales**
  nano (to 500 mN) and micro (to 30 N)
- **Market-leading environmental capabilities**
  high temperature (to 850 °C*), low temperature (to -20 °C), liquid and humidity cells
- **True measurement flexibility**
  dynamic, static, electrical, and multiple imaging modes

Quantum Design

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Micro Materials
Excellence in Nanomechanics

NanoTest Vantage

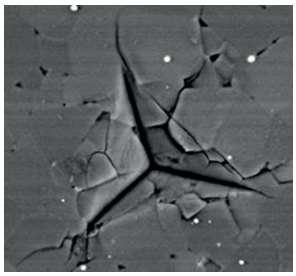
Vantage

Flagship System Offers Superior Vantage Point

The NanoTest Vantage from Micro Materials cleverly combines multiple nanomechanical and tribological test techniques over multiple force scales and multiple environments in a single instrument to provide the most complete and reliable solution on the market today.

Scientists and engineers at leading universities, research institutions, and industrial R&D labs worldwide depend on the unique capabilities of the modular NanoTest Vantage.

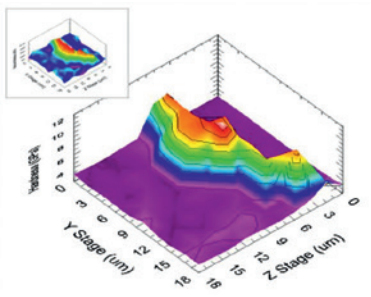
The benefits of a single high-resolution measurement head capable of up to 500 mN include improved data reliability on rough surfaces, better calibration data, less tip wear during scratch experiments, and the ability to study thicker, tougher coatings.



The figure shows indentation-induced fracture in spinel. Inducing this cracking required a 500 mN load.

Nanoindentation Module

The nanoindentation module has been designed to provide the user with the optimum combination of sensitivity and load range to cover the widest range of applications and sample types. Reliable calibration procedures, experimental protocols and instrument stability ensure that ISO 14577 compliant measurements can easily be performed. High resolution XYZ stages enable precision targeting of test locations, e.g. for indentations into specific phases in multi-phase materials or for micro-pillar compression and micro-cantilever tests. This excellent repositioning accuracy combined with very high thermal stability allows the NanoTest Vantage to target specific features of interest, produce detailed mechanical property maps across surface and depth-profiles of hardness and elastic modulus and perform long-duration creep tests.



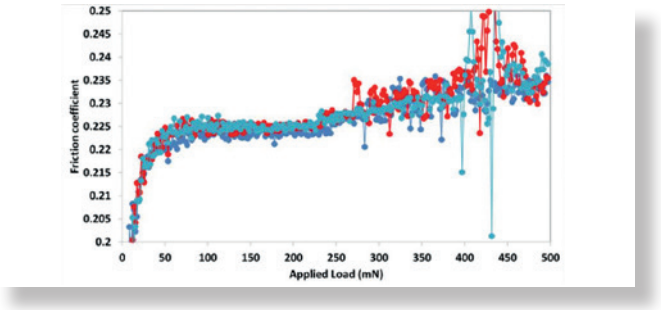
Mapping the mechanical properties of a hard and stiff intermetallic inclusion (Al_7Cu_2Fe) in a high-strength Al-Mg-Zn automotive/aerospace alloy.

Unrivalled Technique Versatility

Every NanoTest Vantage includes an advanced controller with intuitive software, a thermally controlled environmental enclosure with an anti-vibration system, and a four-objective optical microscope. This remarkably flexible nanomechanical test and characterisation solution can be configured to perform nanoindentation, nano-scratch, nano-impact, nano-fretting, and nano-wear techniques. The fully ISO- and ASTM-compliant system can even be configured with a nanopositioning stage to provide SPM imaging, or with an AFM.

Nano-Scratch Module

The nano-scratch module has been engineered to provide the optimum combination of (1) wide load range, (2) high lateral rigidity during scratching, and (3) high frictional sensitivity.
This module extends the instrument's ability to perform a broad range of nano-tribological tests, including single scratches, multiple-pass scratch and wear tests, surface profilometry, and friction measurements.
It is particularly suitable for assessing abrasive wear resistance and critical load for coating failures. The NanoTest Vantage loading heads have a high lateral stiffness so it is very effective at testing hard coatings, even those with very high surface roughness.

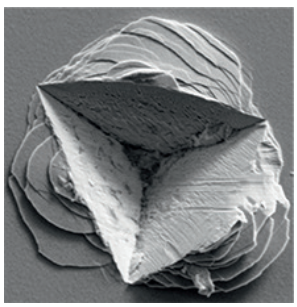


Frictional sensitivity and reproducibility in repeat nano-scratch tests on a hard nanocomposite coating.
Friction coefficient at failure = 0.223 ± 0.002.

Nano-Impact and Fatigue Module

Nano-impact works by accelerating the indenter towards the sample surface under controlled conditions. This high-energy impact results in a very high strain rate contact (typical strain rate:

~10^3–10^4 s^{-1}) that is orders of magnitude higher than the strain rates in nanoindentation.



Nano-impact of a layered Cr_2AlC MAX-phase coating.

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Single impacts and repetitive impact tests are possible with this patented technique; each provides different data. Single impacts are utilised to study rate sensitivity and dynamic hardness in metallic materials or energy damping in polymers and biomaterials. Repetitive impact tests are used for assessing fatigue resistance, most commonly on coatings.
Nano-impact complements nanoindentation techniques, especially for applications where toughness is important and hardness alone is insufficient. Impact with the NanoTest Vantage has been shown to be an effective accelerated wear test capable of accurately simulating interrupted contacts (e.g., in metal cutting, in erosive wear, or in auto- or aero-engines).

Nano-Fretting/Nano-Wear Module

The nano-fretting/nano-wear module in the NanoTest is used for reciprocating wear and fretting testing. By changing the wear track length both reciprocating nano-wear and true nanoscale fretting tests can be performed with the same module. This technique is important for studying the onset of wear in coatings and metallic materials.

Owing to the very high stability of the NanoTest Vantage high-cycle wear tests can be run. This makes it possible to run tests at a lower contact pressure more reflective of real wear situations where coatings fail gradually not straightaway. The nano-wear tests can then be used to more effectively develop materials with improved wear resistance.

High-Accuracy Multiple Force Scales

The NanoTest Vantage is engineered to accommodate the system's low-load loading head and optional high-load loading head simultaneously, giving a load range from 0.01 mN to 30 N. This saves time because, unlike other instruments, there is no need for a physical change and recalibration of loading heads.

The second head provides microindentation and micro-scratch capabilities as well as a wide range of other micromechanical measurements for true depth-sensing at 30 N.

Market-Leading Environmental Capabilities

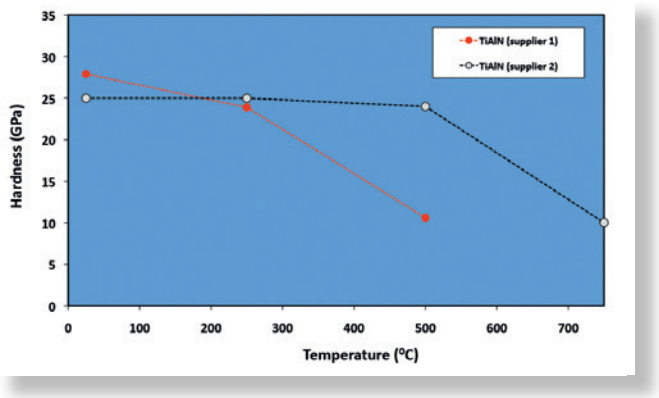
No other nanomechanical test and characterisation instrument on the market can match the environmental capabilities of the NanoTest Vantage. The system's unique, high-precision horizontal loading is critical for accurate and reliable testing at elevated temperatures, practically eliminating thermal drift. For still greater experimental versatility, the instrument can be configured with a low-temperature option (to -20 °C). The system can also use a temperature controlled liquid cell to test samples fully immersed in a fluid with constant buoyancy force, and constant surface tension on loading column. A fully programmable humidity cell that allows rapid, stable humidity changes from 10% to 90% for studying moisture sensitivity in polymers, biomaterials, and nanocomposites. Furthermore, researchers can characterise and optimise their materials in reduced oxygen / purged conditions with the NanoTest Vantage.

Hot Stage for Elevated-Temperature Nanomechanics to 850 °C*

Dual active heating of the indenter and the sample, a patented stage design, and a patented temperature control methodology ensure the optimum thermal stability needed for repeatable high-temperature measurements up to 850 °C* when using the system's high-temperature option.

With the addition of water cooling and an environmental chamber for testing in reduced oxygen atmosphere, reliable measurements can be performed.

- **Active tip heating** – the indenter and the sample are both actively and independently heated, resulting in an isothermal contact.
- **Patented tip heating power feedback system** – fast response to minimise heat flow on contact
- **Horizontal loading** – the unique loading configuration of the NanoTest Vantage means that there is no heat flow onto the loading head or depth measurement sensor.
- **Highly localised heating** – a heat shield and insulating shroud around the heated zone ensure instrument stability during high-temperature experiments.
- **Patented control protocol** – software routines are used to precisely match the indenter and stage temperatures to within an accuracy of 0.1 °C.
- **Time-dependent measurements** – As no significant thermal drift occurs during high-temperature measurements, it becomes possible to perform long-duration tests (e.g., indentation creep tests) that are not possible with other systems.



The change of hardness vs. temperature for two different commercially available TiAlN coatings.

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Specifications	
Load frame	granite composite material designed specifically for metrology applications
Load application	electromagnetic
Maximum load with standard head	500 mN
Displacement sensor	linear capacitive
Load resolution	3 nN
Displacement resolution	0.002 nm
Repositioning accuracy	< 0.4 µm
Testable surface area	50 mm x 100 mm
Sample manipulation	manual control and point and click from microscope image
Thermal drift	<0.005 nm/s
Contact force	<1 µN
Microscope – 4 objectives	x5, x10, x20 and x40
On screen magnification	x410, x825, x1650, x3300
Vibration isolation	Minus K, mechanical passive
Indenter exchange time	<1 min
Compliance with standards	fully compliant with ISO 14577 and ASTM 2546
Scratch module	
Maximum friction force	>250 mN
Friction load resolution	10 µm
Maximum scratch distance	>10 mm
Scratch speed	100 nm/s to 0.1 mm/s
Impact module	
Acceleration distance	Up to 20 µm
Strain rate at contact	Up to 10^4 s^{-1}
Fretting module	
Track length	≤20 µm
Frequency	≤20 Hz
Maximum number of wear cycles	$>10^6$
SPM nanopositioning stage	
XY scan range	100 µm x 100 µm
Z scan range	20 µm
Positioning accuracy	≤2 nm
Closed loop linearity	99.97%
AFM	
XY scan range	110 µm x 110 µm
Z range	22 µm
High-temperature option	
*Temperature	Choice of: 500 °C and 850 °C
Active, independent sample and indenter heating	yes
Indenter materials	diamond, boron nitride, sapphire
High-load head	
Maximum load	30 N
Frictional load resolution	300 µN

Applications

The NanoTest Vantage is perfect for studying a wide range of materials systems for both fundamental research and industrial applications, including:

- Metals
- Hard coatings
- Ceramics
- Composite materials
- MEMS
- Thin films
- Polymers

The tougher the application, the more likely it requires the NanoTest Vantage!

Micro Materials Ltd has been at the forefront of nanomechanics innovation since 1988 with:

- The first commercial high-temperature nanoindentation stage
- The first commercial nano-impact tester
- The first commercial liquid cell
- The first commercial instrument for high-vacuum, high-temperature nanomechanics

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