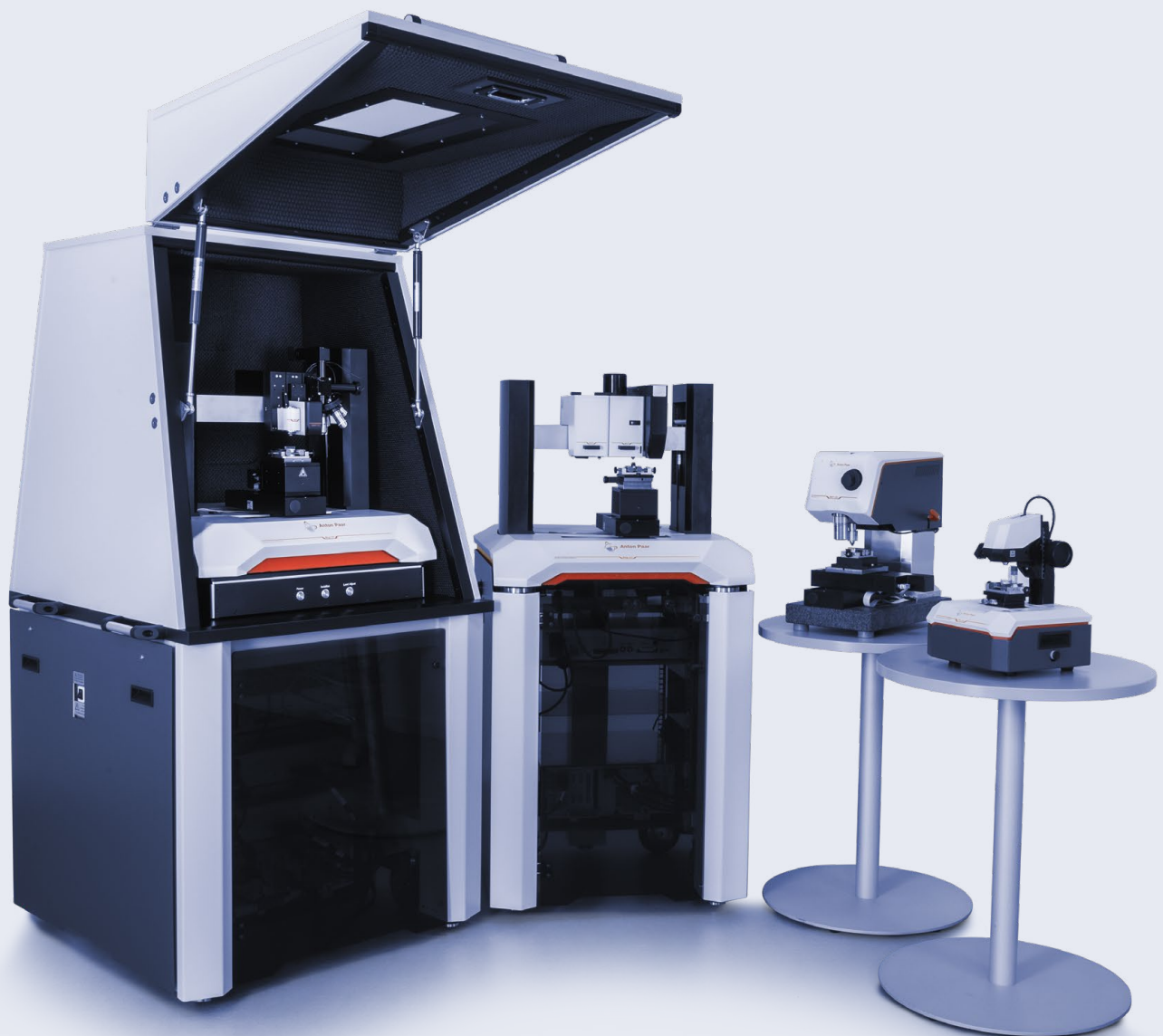


# Instrumented Indentation and Scratch Testers

Mechanical Surface Characterization



# One Portfolio. Every Surface Challenge.

Anton Paar's mechanical surface testers are versatile, multifunctional instruments that measure a wide range of mechanical properties of materials – from the hardest diamond-like carbon (DLC) coating to the softest hydrogels.

Anton Paar's mechanical surface testers cover four of the most important test methods for mechanical surface characterization: indentation, scratch, tribology, and calotest. Thorough characterization of surface mechanical properties is the outcome.

We measure what others estimate: Anton Paar is the only company to offer high-resolution nanoindentation and nanoscratch testers with a real force sensor. This means force is continuously measured with a direct sensor and not estimated via a derivative coming from an actuator.

**All-in-one instrument: seamless transition between measuring methods**

**Extraordinary magnification range and continuous zoom**

**Worldwide support via 40 subsidiaries and a full three-year warranty**

**Automate your workflow: a flexible API and expert support to get you up and running**

**No compromise on sample size: measure the samples directly off the production line**



RST series



MCT³ (Step 101)



Hit 300



NHT³ (Step 301)



UNHT 700 and NST³ (Step 701)



UNHT 300 Bio (Step 301)



Hard →

← Soft

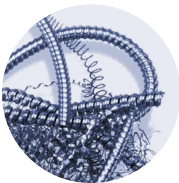
Diamonds



Hard coatings



Metals



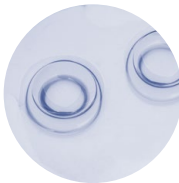
Bones



Polymers



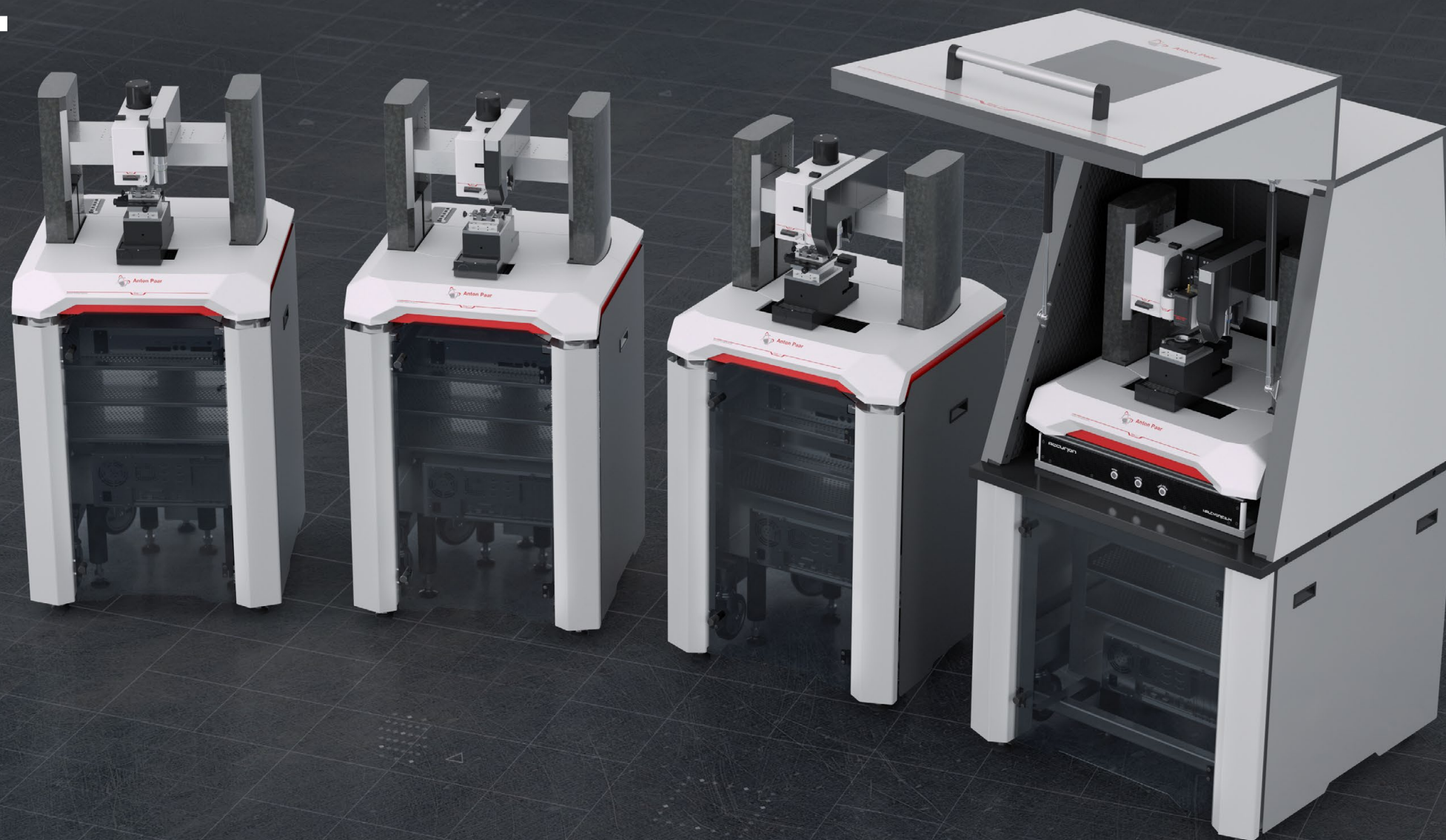
Hydrogels



# Surface Testing Platform (Step): All-in-One

Stay one *Step* ahead

Step platforms are the basis for Anton Paar's mechanical surface measuring heads. They can house various types of testing on a single platform and ensure you're perfectly prepared for future lab upgrades.



## Revolutionize your testing capabilities

Step is your all-in-one platform for wide-force-range scratch, instrumented indentation, automatic conventional hardness, and tribology testing. Transition from one method to another with zero setup adjustments. Buy a single head or a full all-in-one setup. Either way, our Step platform solution equips you for future upgrades and constant competitiveness.

## 2x faster

Visualize samples 2x faster than with the previous model. The unique dual view microscope has a continuous zoom and exceptional magnification range of 20x to 10,000x, and provides seamless transition from panoramic surface overview to maximum magnification.

## Reduce costs via automation

Reduce costs and increase measurement throughput: We'll help you integrate your Step platform into the QC area of your production plant for automatic sample handling, loading, and testing. All Step platforms include an API to enable future integration into automation solutions.

## Reduce effort, save time

Mount differently-sized samples on the instrument and measure these directly off the production line, saving time and effort. Unlock custom solutions designed specifically for your sample holding needs, available upon request.

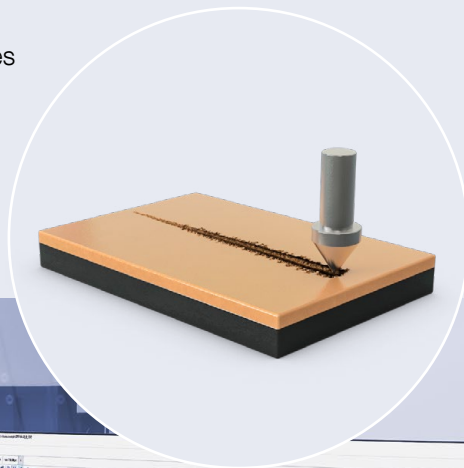
# Scratch Testing: Features and Measuring Principles

Scratch testers from Anton Paar are used to characterize film-substrate systems and quantify material parameters such as adhesive and cohesive fractures, deformation, elastic recovery, friction force, and conventional hardness using a variety of complementary methods. They are invaluable tools for the determination of coating adhesion and scratch-and-mar resistance in research, development, and quality control.

The technique involves generating a controlled scratch with a diamond tip on the sample being tested.

## Key features

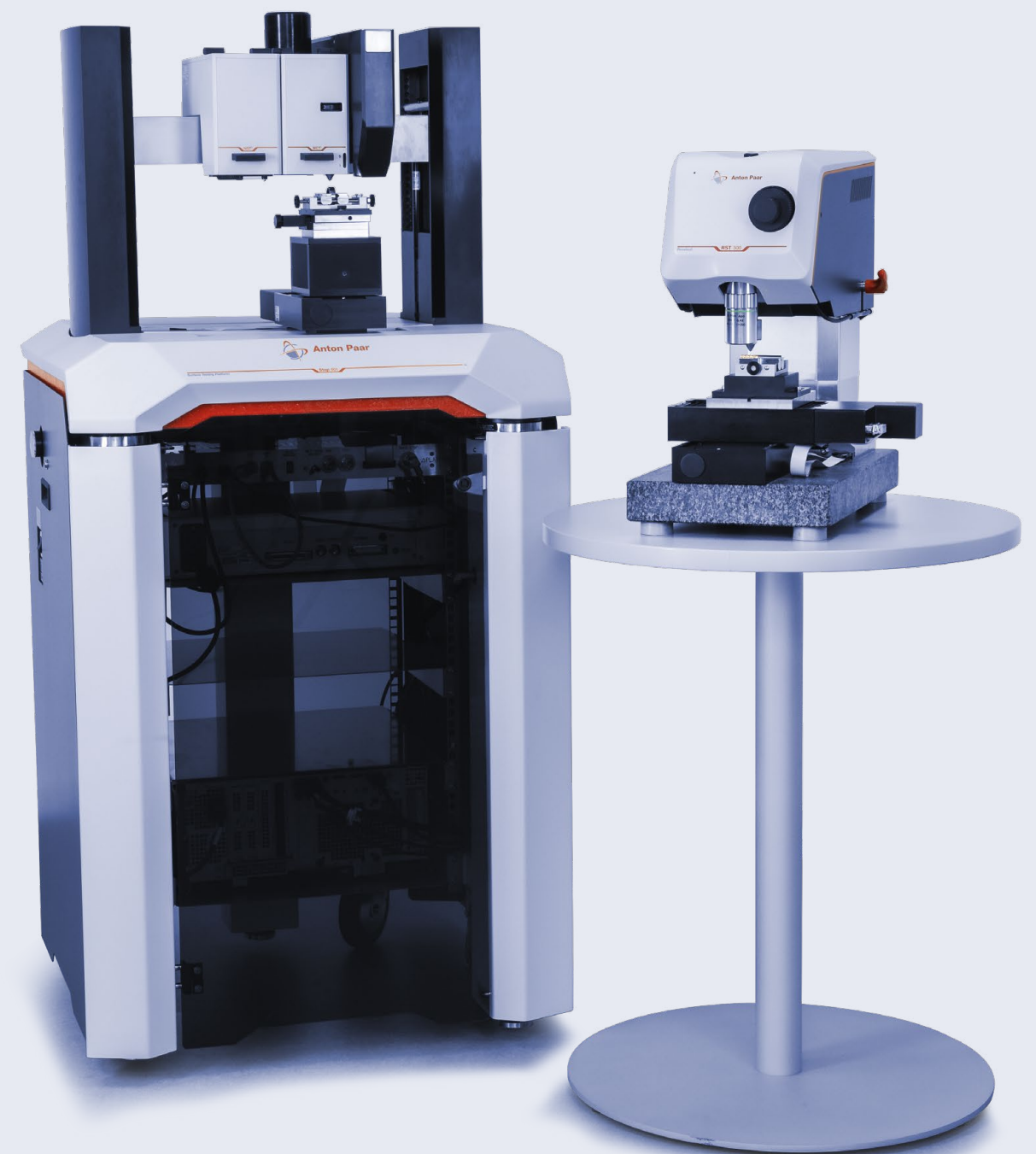
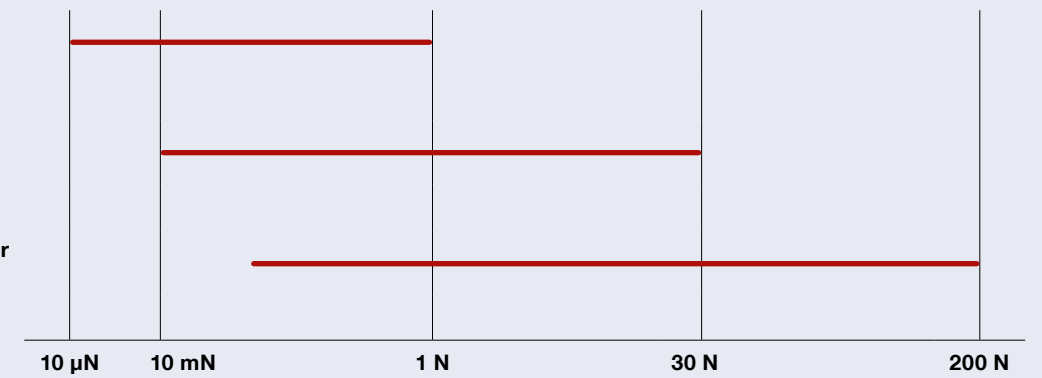
- Patented synchronized panorama
- True penetration depth measurements for advanced elastic recovery studies
- Active force feedback for full reproducibility even on complex surfaces
- Automatic detection of critical loads to optimize results



Nano Scratch Tester (NST<sup>3</sup>)

Micro Combi Tester (MCT<sup>3</sup>)

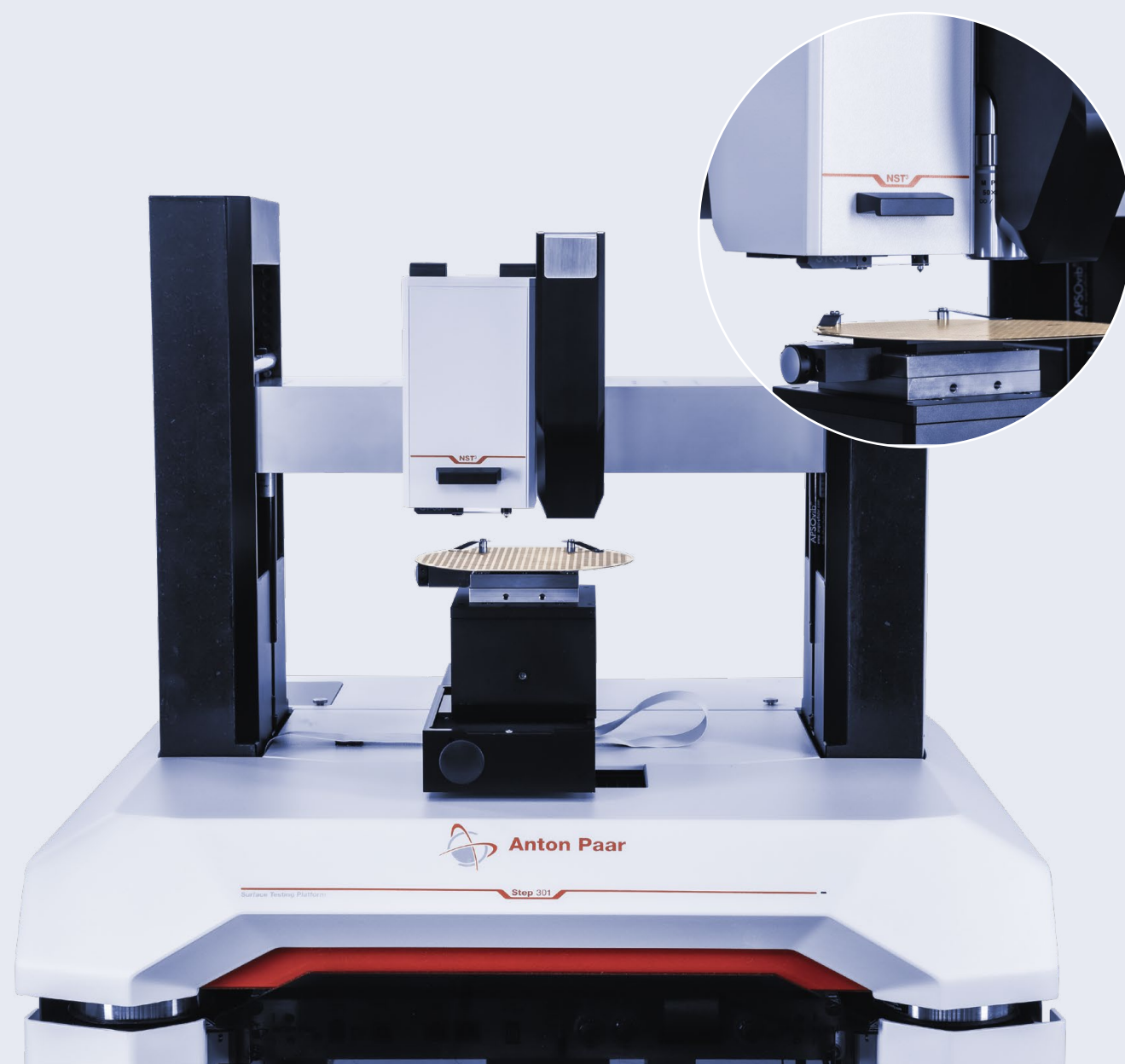
Revetest® Macro Scratch Tester (RST series)



# NST<sup>3</sup> Nano Scratch Tester



NST<sup>3</sup>, the most accurate nano scratch tester on the market, is particularly suited for characterizing the adhesion of films and coatings with a typical thickness below 1  $\mu\text{m}$ . You can use NST<sup>3</sup> to analyze all types of coatings. The unique design of NST<sup>3</sup> includes two sensors for force and depth measurements associated with a state-of-the-art piezoelectric actuator. On top of exceptional accuracy, these features deliver a response time of milliseconds and flexibility for all kinds of scratch measurements.

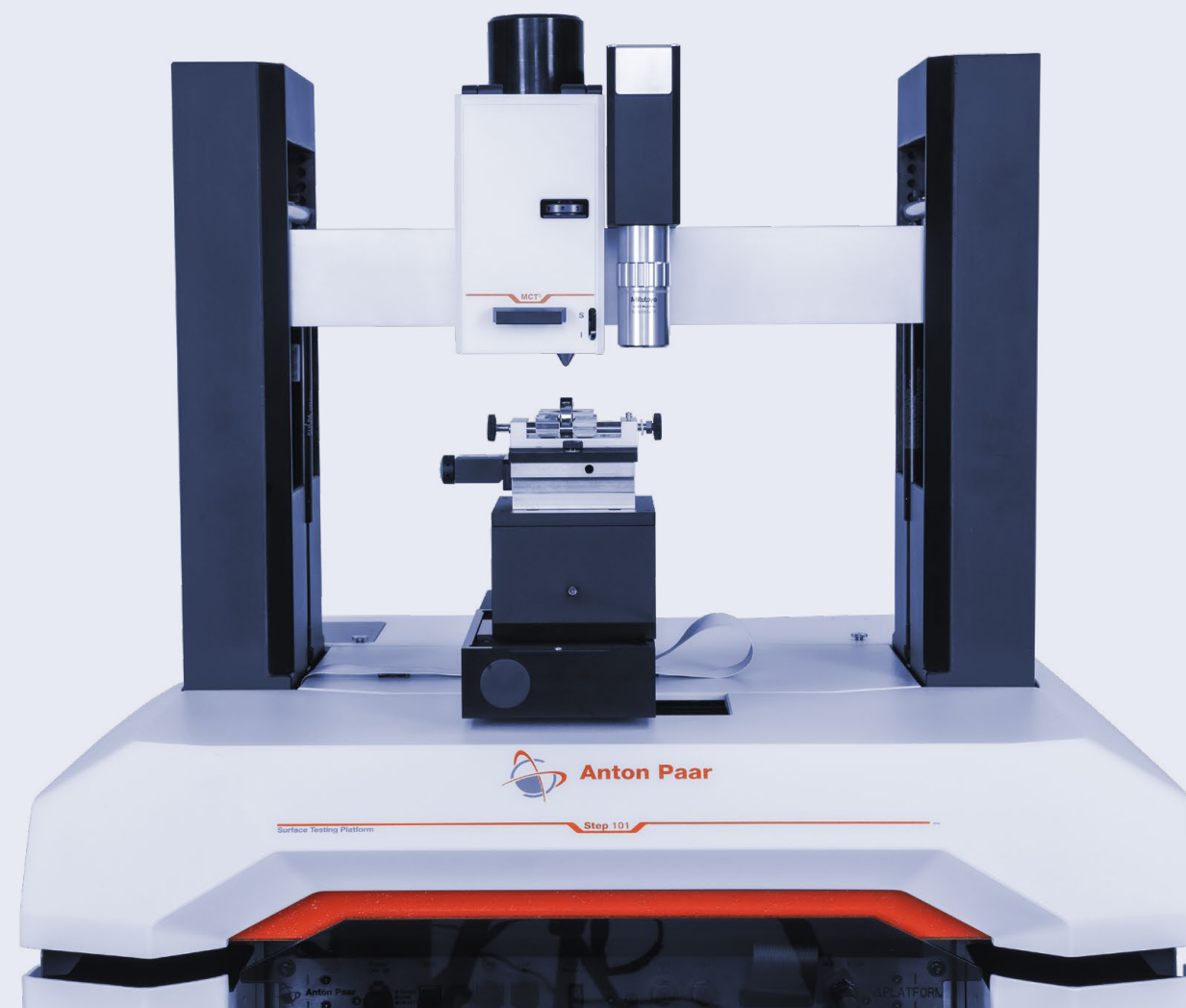


# MCT<sup>3</sup> Micro Scratch Combi



MCT<sup>3</sup> is the only high-quality four-in-one setup for scratch, basic tribology, instrumented-indentation, and automatic conventional hardness testing. Perform measurement of coating adhesion, scratch resistance, hardness, friction, and wear for various materials including hard coatings, thermal/plasma spray coatings, metals, and polymers.

This scratch tester is widely used to measure adhesion and scratch resistance of coatings with a typical thickness below 5  $\mu\text{m}$ .



# RST Series Revetest Scratch Testers



With more than 1,500 Revetest® scratch testers installed worldwide, Revetest® has become the industry standard for scratch testing. The RST series builds on this proven heritage, providing reliable characterization of coating adhesion and scratch resistance for a wide range of coating systems, including hard, decorative, and functional coatings.

The RST series combines intuitive software with accurate and reproducible measurements for scratch testing and conventional Vickers hardness testing with automatic detection of the imprint. For more advanced coating characterization, RST 300 additionally offers basic tribological analysis and acoustic emission monitoring for enhanced detection of coating failure events during scratch testing.



Great people | Great instruments  
**Great service**  
Great people | Great instruments



**Your trusted partner  
across the full lifecycle  
of your instrument**

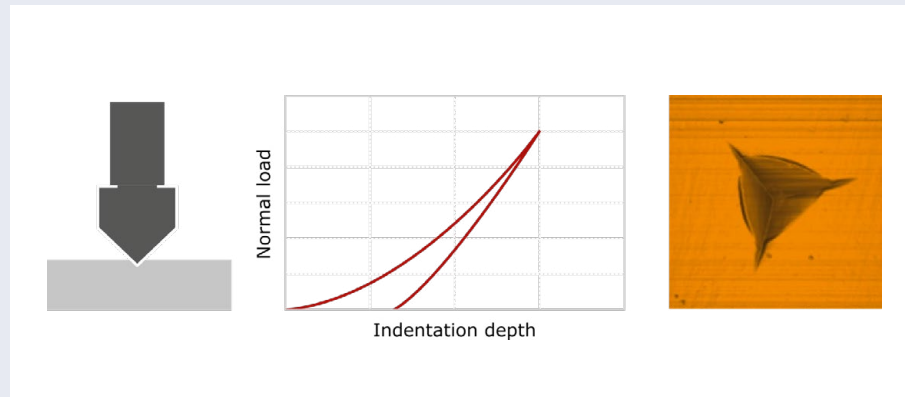


- Consistent performance
- Audit-ready compliance
- Maximum uptime
- Fast local support

# Indentation Testing: Features and Measuring Principles

Anton Paar indentation testers offer a wide range of testing modes from standard quasi-static DMA to stress-strain properties measurement, along with a broad spectrum of test results: hardness, elastic modulus, viscoelastic properties, creep, adhesion forces, and stress-strain curves. A combination of unique top-surface referencing for maximum thermal stability, together with a DualView microscope, precise positioning; and high throughput, makes the Anton Paar indentation tester the best choice for mechanical surface characterization.

The instrumented indentation technique involves pressing a sharp indenter with a known geometry into the surface while recording penetration depth and normal load.



## Key features

- The highest thermal stability (0.0008 nm/s) and frame stiffness on the market ( $10^8 \mu\text{N}/\mu\text{m}$ ) for the most accurate results without any corrections
- High repositioning accuracy: down to 200 nm for indentation targeting
- A wide range of testing modes: quasi-static, fast indentation mapping, constant strain rate, SPM, DMA (CSM or frequency/amplitude sweep), and stress-strain

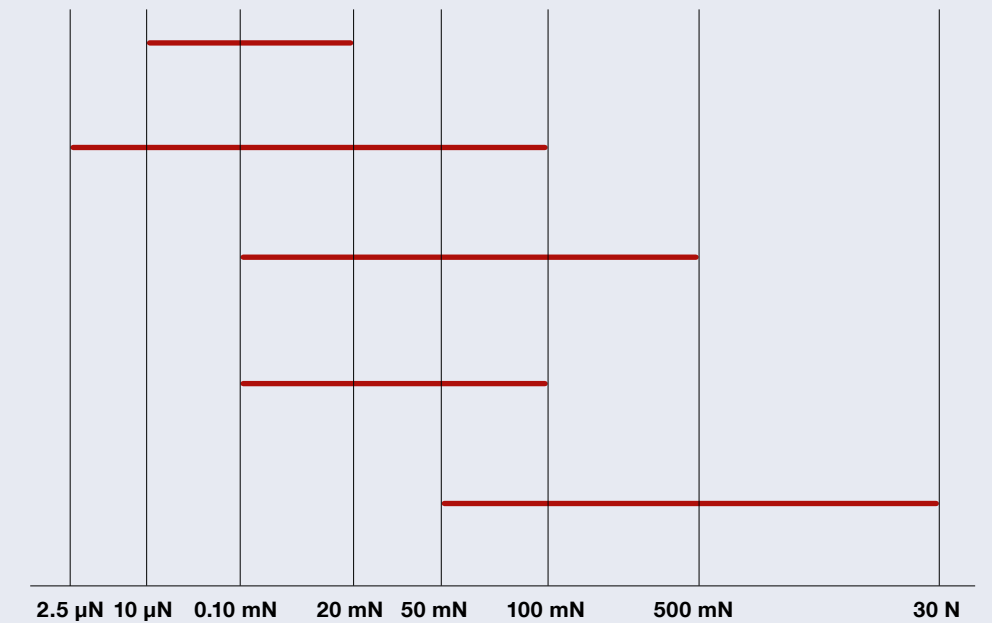
Bioindenter  
(UNHT 300 Bio)

Ultra Nanoindentation Tester  
(UNHT 700)

Nanoindentation Tester  
(NHT<sup>3</sup>, Hit 300)

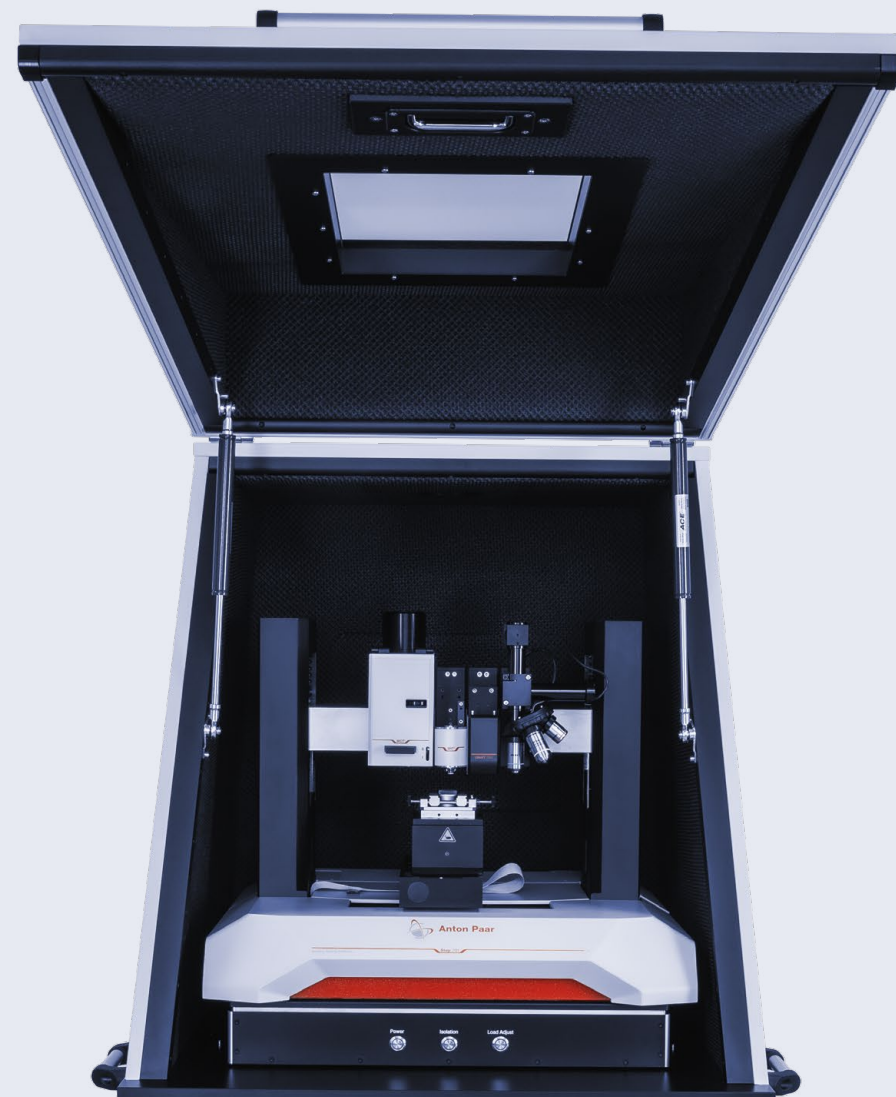
High Vacuum and Temperature  
Nanoindentation Tester  
(UNHT HTV)

Micro Combi Tester  
(MCT<sup>3</sup>)



# UNHT 700 Ultra Nanoindentation Tester

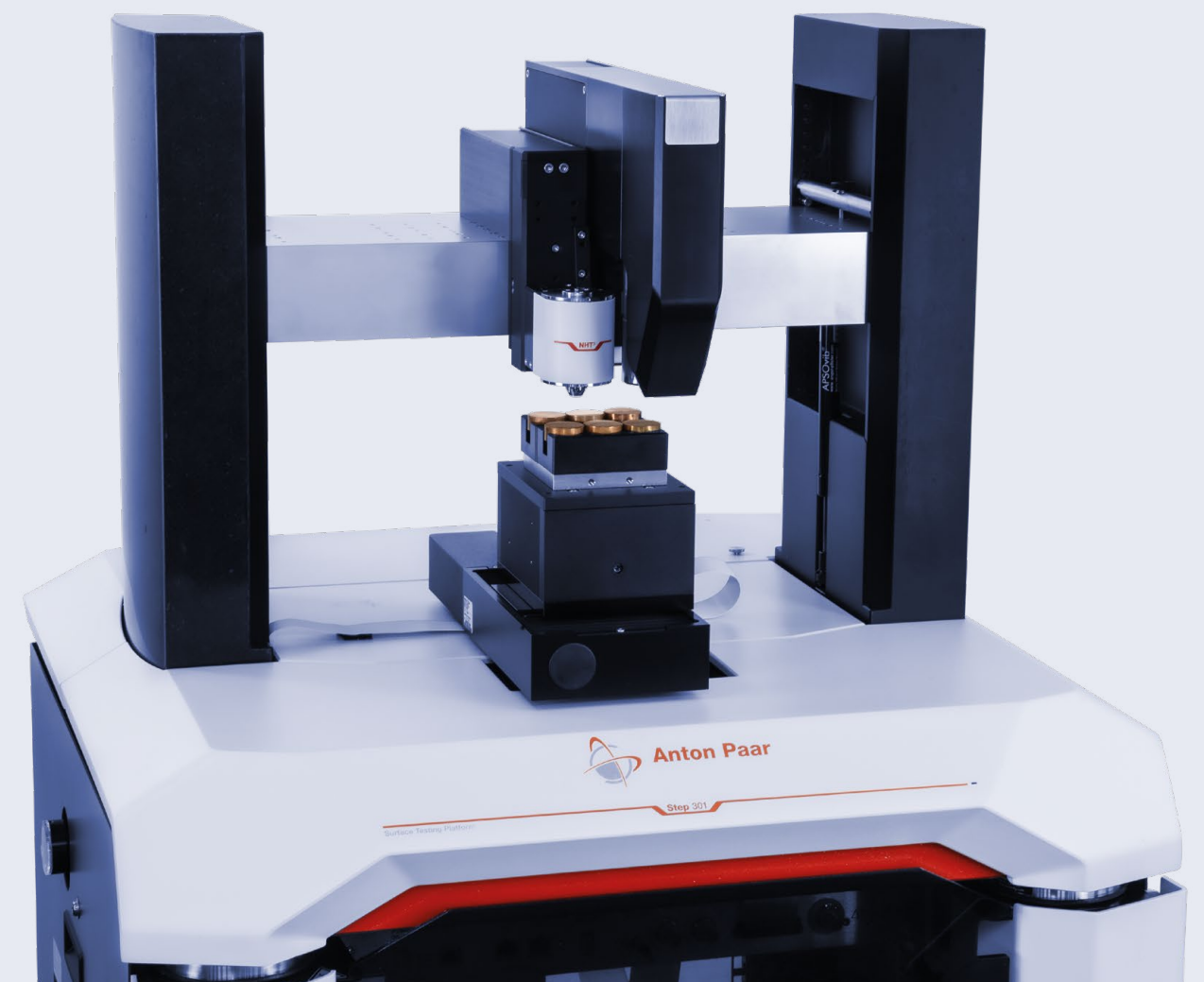
UNHT 700 redefines nanoindentation by removing the usual trade-offs between accuracy, speed, and usability. It delivers true, correction-free measurements with positioning accuracy down to 100 nm, ensuring reliable results. High-speed testing enables up to two indents per second, while advanced DMA capabilities reach 300 Hz. An integrated SPM mode adds nanoscale imaging to make complex sample analysis more efficient. Combined with workflow-driven software, live visualization, and automated routines, UNHT 700 reduces setup time and accelerates insights, providing a versatile, high-performance solution for modern material characterization.



# NHT<sup>3</sup> Nanoindentation Tester



NHT<sup>3</sup> is a robust, fast instrument for multiple advanced indentation modes: continuous multi-cycles (CMC), user-defined sequences, sinus mode, and multi-sample protocols. Thanks to the top surface referencing design, it features high load frame stiffness ( $10^7$  N/m) and exceptional thermal stability (raw drift rate down to 0.003 nm/s) – resulting in high accuracy. NHT<sup>3</sup> is also compatible with liquid testing and in a specific configuration provides an ECR testing mode.



# Hit 300



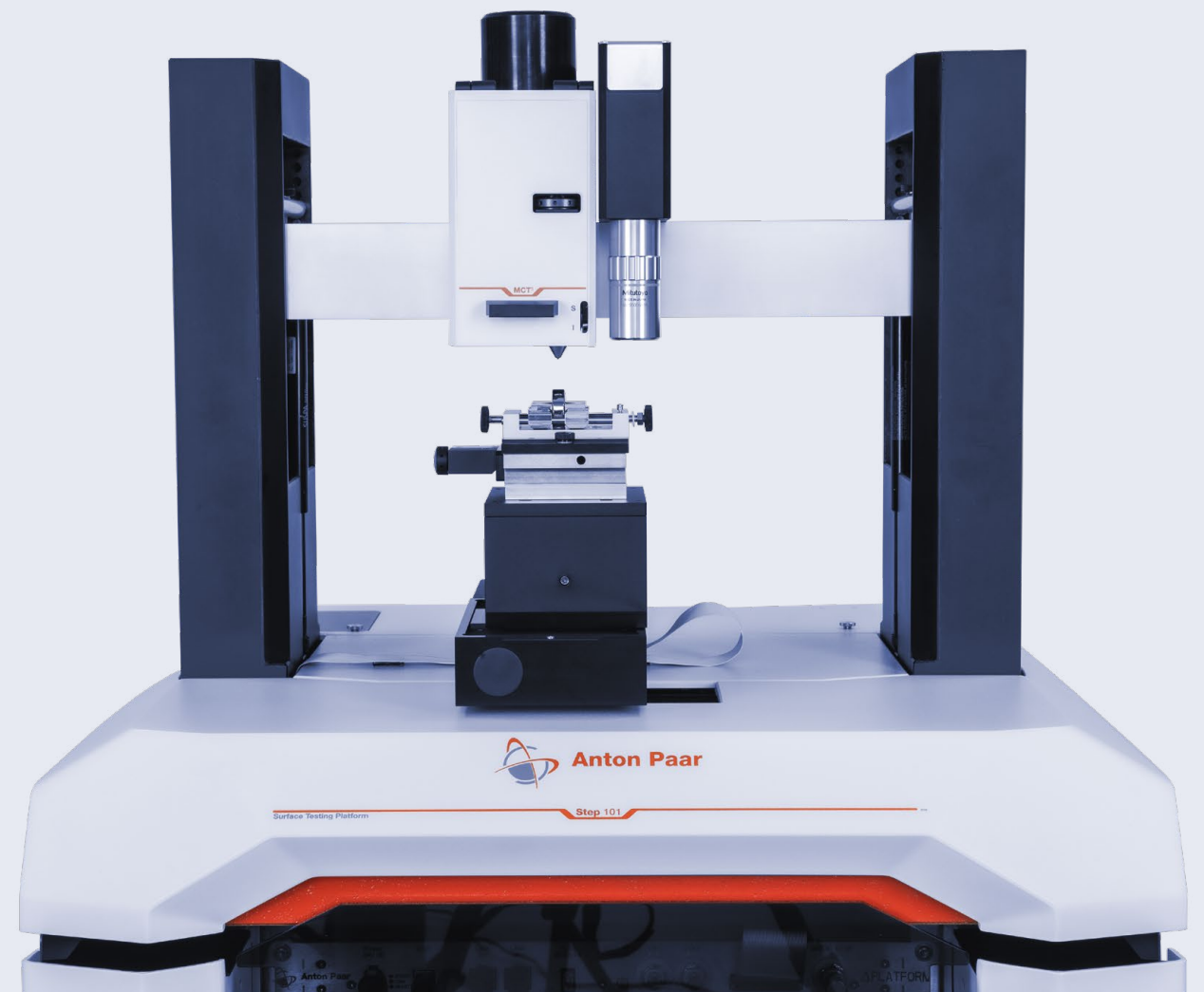
Simple-to-use, robust nanoindentation instrument Hit 300 is a premium yet highly affordable nanoindentation instrument with a self-explanatory interface. The integrated active anti-vibration damping and a unique two-laser targeting system make it accurate to <1  $\mu\text{m}$  in all environments. Start-up takes 15 minutes, and within an hour, you will be able to go from training to generating results. Hit 300 is a delightful fusion of simplicity and power.



# MCT<sup>3</sup> Micro Combi Tester



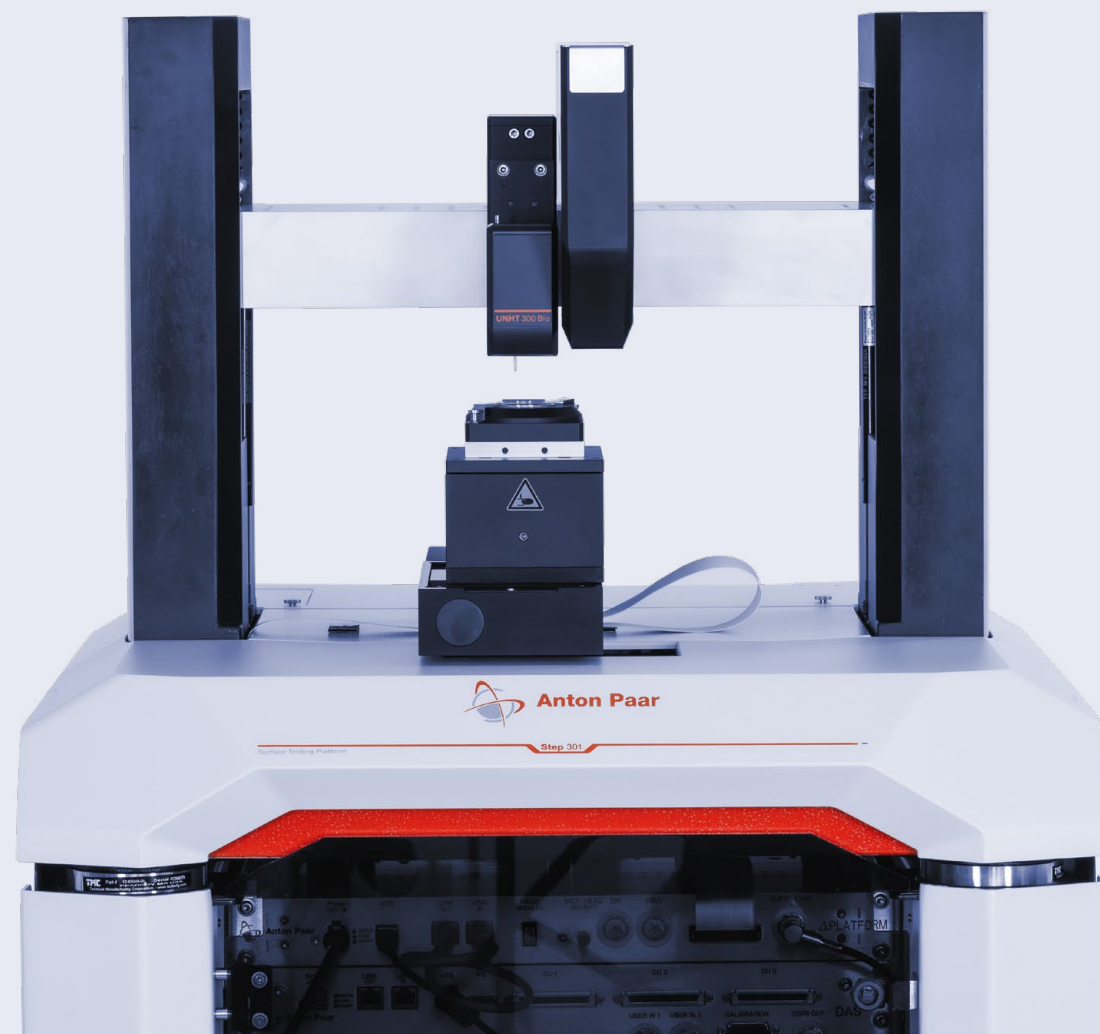
MCT<sup>3</sup> is the only high-quality, four-in-one setup for scratch, basic tribology, instrumented indentation and automatic conventional hardness testing. It measures the hardness and elastic modulus using high loads: instrumented indentation testing up to 10 N and automatic conventional hardness testing up to 30 N. The combination of instrumented indentation testing for thin coatings and conventional hardness testing for bulk samples with rough surface broadens the spectrum of measurable properties.



# UNHT 300 Bio Bioindenter



UNHT 300 Bio offers a wide range of indenters and integrated Hertzian contact model analysis for soft materials, making it ideally suited for studying time-dependent properties such as creep and viscoelasticity. Its advanced dynamic mechanical analysis (DMA) capabilities include frequencies up to 300 Hz and measurement modes such as frequency and amplitude sweeps, enabling comprehensive characterization of soft and biological samples.



# UNHT HTV High- Temperature Ultra Nanoindentation Tester



UNHT HTV is an instrumented indentation tester for high-temperature testing up to +800 °C. The actuating system is based on patented technology with two independent depth and load capacitive sensors. Thermal barriers, water circulation, and reflective mirrors prevent the head from heating, resulting in unmatched stability. In addition, a high-vacuum chamber minimizes oxidation as well as heat loss from convection. The lowest thermal drift over the entire temperature range ensures high reliability of measurements.



# Surface Explorer Software

Built around your workflow

## High-resolution microscope

The DualView microscope integrates a high-resolution top-view microscope with a side-view camera, enabling fast and precise positioning of the testing area.

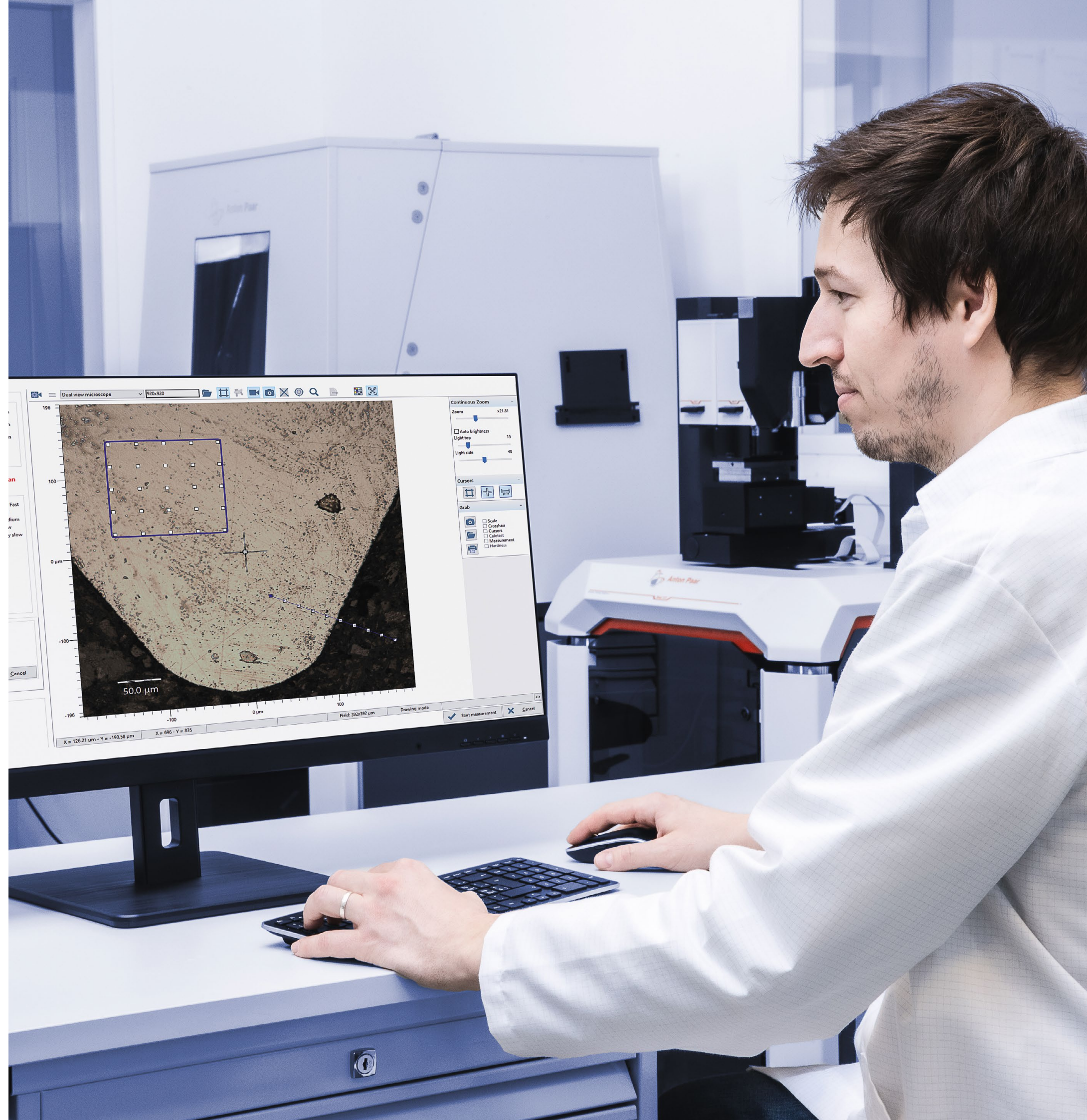
The turret microscope provides maximum flexibility for Step platforms equipped with multiple measurement heads, offering a wide zoom range to accommodate diverse applications.

## Streamlined, workflow-oriented operation

A redesigned, workflow-driven user experience guides the entire process from sample mounting to final report. Predefined protocols, flexible load profiles, and integrated drawing and calibration wizards simplify test setup. Simultaneous analysis, live heatmap generation during fast mapping, and real-time DMA plotting provide immediate insights, while a full audit trail ensures traceability.

## Automatic conventional Vickers hardness

The software automatically detects and measures Vickers indents, eliminating user influence and ensuring consistent hardness results.



# Choose Your Perfect Combination

Combine different measuring heads and imaging solutions to obtain the measuring platform you need. To provide configuration flexibility, multiple testing and imaging heads can be installed together on the same platform. Customized platforms for glovebox, vacuum chamber, and humidity chamber are available.



**Step 101**

- Your choice of basic or advanced video microscope
- Motorized x (75 mm), y (75 mm), z (30 mm) table included



**Step 301**

- Anti-vibration table included
- Your choice of basic or advanced video microscope
- Motorized x (75 mm), y (75 mm), z (30 mm) table included



**Step 501**

- Anti-vibration table included
- Advanced video microscope (obligatory)
- Motorized x (215 mm), y (75 mm), z (30 mm) table included



**Step 701**

- Acoustic enclosure included
- Active electronic anti-vibration
- Advanced video microscope (obligatory)
- Atomic force microscope can be ordered as an option
- Motorized x (215 mm), y (75 mm), z (30 mm) table included



|           | NHT <sup>3</sup> | UNHT 300 Bio | UNHT 700 | MCT <sup>3</sup> |
|-----------|------------------|--------------|----------|------------------|
| Max. load | 500 mN           | 20 mN        | 100 mN   | 30 N             |
| Step 101  |                  |              |          | ✓                |
| Step 301  | ✓                | ✓            |          | ✓                |
| Step 501  | ✓                | ✓            |          | ✓                |
| Step 701  | ✓                | ✓            | ✓        | ✓                |



|           | NST <sup>3</sup> | AFM | Advanced video microscope | Basic video microscope |
|-----------|------------------|-----|---------------------------|------------------------|
| Max. load | 1,000 mN         | -   | -                         | -                      |
| Step 101  |                  |     | ✓                         | ✓                      |
| Step 301  | ✓                |     | ✓                         | ✓                      |
| Step 501  | ✓                |     | ✓                         |                        |
| Step 701  | ✓                | ✓   | ✓                         |                        |



| Turret microscope |   |
|-------------------|---|
| Max. load         | - |
| Step 101          | ✓ |
| Step 301          | ✓ |
| Step 501          | ✓ |
| Step 701          | ✓ |

# Application and Industries

## 1 Hard coatings

Optimize hard coating processes with our precise instruments. Fast data analysis, customizable views, and advanced techniques like nanoindentation and scratch optimize quality control. The instruments are ideal for cutting tools and for use in the automotive and aerospace industries.

## 2 Semiconductors

Transform semiconductor processes with state-of-the-art methodologies implemented via our UNHT series and NST<sup>3</sup> instruments. From R&D characterization of new wafers to quality control in manufacturing, we ensure precision. Ideal for wafers, sensors, MEMS, and electronics components, our solutions empower you to excel in hard disk characterization and low-k dielectrics quality control.

## 3 Automotive

Upgrade automotive standards with our advanced techniques. Ensure DLC coating injector quality, brake pad durability, and engine component integrity. The techniques are ideal for coatings, varnishes, plastics, and lubricants. Choose between comprehensive characterization or targeted analysis: scratch, tribology, or nanoindentation, for precise results. Operate with ease, customize data views, and perform instant quality assessments.

## 4 Optical and glass

Elevate your optical and glass standards. From enhancing resistance in eyeglass lenses to precision control in photography optics, we ensure quality. These techniques are ideal for optical glass in watches, smartphone displays, and more. Leverage advanced methods like nano scratch and ultra nanoindentation for comprehensive characterization and accurate assessments.

## 5 Metallurgy

Ensure optimal mechanical properties of metallic components, from strength to durability. These advanced methods are ideal for metals and alloys in various applications. Perform comprehensive characterization and precise evaluation, assisted by intuitive product interfaces for seamless integration.

## 6 Civil engineering

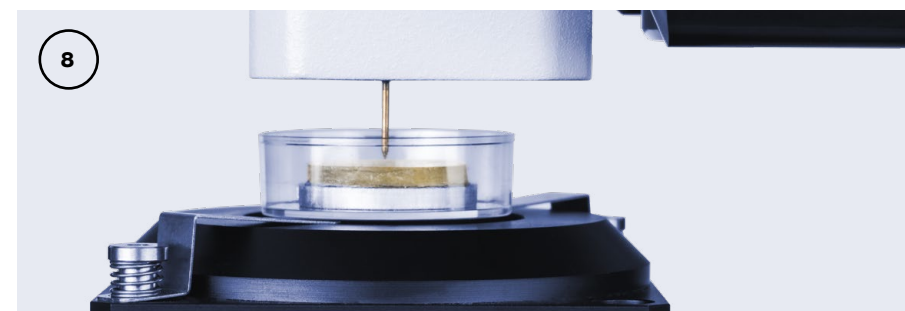
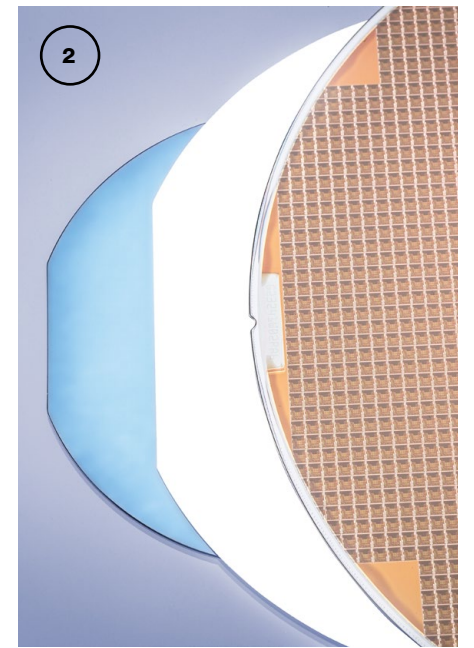
Evaluating the scratch resistance of ceramic tiles or tracking the evolution of the mechanical properties of cement with humidity – in both cases our techniques deliver precise analysis for durability and performance enhancement, guaranteeing product quality. If you need customizable sample holders to accommodate specific testing samples, we can help.

## 7 Biomedical

Our advanced methods cater to diverse needs. Whether you're addressing wear in prosthetics, assessing arterial stent resistance, studying tablet hardness, examining osteoporosis, or evaluating cornea elasticity, our instruments deliver precise results and personally tailored data views. With customizable holders and intuitive interfaces, seamless operation is ensured.

## 8 Academia

Benefit from accurate results to drive innovative discoveries across diverse fields. Whether for pure research or specific applications, experience the distinct advantages of our products. Achieve rapid, accurate measurements, expedite sample preparation and waiting time, and maintain control with raw – not corrected – data.



|                               | NST <sup>3</sup> | MCT <sup>3</sup> | RST 300    |
|-------------------------------|------------------|------------------|------------|
| Scratch Testing               |                  |                  |            |
| Maximum load [N]              | 1                | 30               | 200        |
| Load resolution [μN]          | 0.01             | 10               | 100        |
| Load noise floor [rms] [μN]*  | 0.1              | 100              | 1,000      |
| Loading rate [N/min]          | up to 100        | up to 300        | up to 300  |
| Depth range [μm]              | 600              | 1,000            | 1,000      |
| Depth resolution [nm]         | 0.1              | 0.05             | 0.05       |
| Depth noise floor [rms] [nm]* | 1.5              | 1.5              | 2.5        |
| Data acquisition rate [kHz]   | 192              | 192              | 192        |
| Scratch speed [mm/min]        | 0.1 to 600       | 0.1 to 600       | 0.4 to 600 |
| Options                       |                  |                  |            |
| Heating stage up to 200 °C    |                  | ✓                |            |
| Heating stage up to 450 °C    |                  | ✓                |            |
| Liquid testing                | ✓                | ✓                | ✓          |

|                                          | UNHT 700 | NHT <sup>3</sup> | Hit 300 | MCT <sup>3</sup> | UNHT 300 Bio | UNHT HTV |
|------------------------------------------|----------|------------------|---------|------------------|--------------|----------|
| Indentation Testing                      |          |                  |         |                  |              |          |
| Maximum indentation load [mN]            | 100      | 500              | 500     | 30,000           | 20           | 100      |
| Load resolution [nN]                     | 0.003    | 20               | 20      | 6,000            | 0.003        | 6        |
| Load noise floor [rms] [μN]*             | <0.05    | <0.5             | <1      | <100             | 0.1          | 0.5      |
| Maximum indentation depth [μm]           | 100      | 200              | 200     | 1,000            | 100          | 100      |
| Depth resolution [pm]                    | 0.0075   | 10               | 10      | 30               | 0.015        | 6        |
| Depth noise floor [rms] [nm]*            | <0.03    | <0.15            | <0.3    | <1.5             | 0.25         | 0.15     |
| Data acquisition rate [MHz]              | 2        | 0.192            | 0.192   | 0.192            | 2            | 0.192    |
| Sensor converter (ADC) resolution [bits] | 24       | 16               | 16      | 16               | 24           | 16       |
| Options                                  |          |                  |         |                  |              |          |
| Sinus mode                               | ✓        | ✓                | ✓       |                  | ✓            | ✓        |
| Liquid testing                           | ✓        | ✓                | ✓       | ✓                | ✓            |          |
| Heating stage up to 200 °C               | ✓        |                  |         | ✓                |              |          |
| Heating stage up to 450 °C               |          |                  |         | ✓                |              |          |
| Heating stage up to 800 °C               |          |                  |         |                  |              | ✓        |
| Petri dish holder                        |          |                  |         |                  | ✓            |          |

Additional options and accessories are available on specific request: Electrical contact resistance (ECR), cooling for low temperatures (-150 °C in vacuum), wafer holder, multiple sample holder, ...  
\*Noise floor value specified under ideal laboratory conditions and using an anti-vibration table.  
✓ available option

|                                                                                                                                                            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Measurements                                                                                                                                               |
| Scratch Testing                                                                                                                                            |
| Adhesive strength, friction force, coating adhesion, scratch, and mar resistance                                                                           |
|                                                                                                                                                            |
| Indentation Testing                                                                                                                                        |
| Hardness and elastic modulus, creep compliance, relaxation, Hertz analysis, dynamic mechanical analysis (E', E'', tan delta), stress-strain curve, fatigue |

| Standards           |                                                                                         |
|---------------------|-----------------------------------------------------------------------------------------|
| Indentation Testing |                                                                                         |
| ISO14577            | Metallic materials — instrumented indentation test for hardness and material parameters |
| ISO 6507            | Metallic materials — Vickers hardness test                                              |
| ISO19278            | Instrumented microindentation test for hardness measurement of plastics materials       |
| ISO 4516            | Metallic and other inorganic coatings – Vickers and Knoop microhardness tests           |
| ASTM E2546          | Standard practice for instrumented indentation testing                                  |
| ASTM C1327          | Standard test method for Vickers indentation hardness of advanced ceramics              |
| ASTM C1326          | Standard test method for Knoop indentation hardness of advanced ceramics                |
| ASTM B933           | Standard test method for microindentation hardness of powder metallurgy (PM) materials  |
| ASTM E384           | Standard test method for Knoop and Vickers hardness of materials                        |
| ASTM B578           | Standard test method for microhardness of electroplated coatings                        |

| Scratch Testing |                                                                                                                             |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------|
| ISO 20502       | Fine ceramics – determination of adhesion of ceramic coatings by scratch testing                                            |
| DIN EN1071      | Advanced technical ceramics – test methods for ceramic coatings                                                             |
| ASTM C1624      | Standard test method for adhesion strength and mechanical failure modes of ceramic coatings by quantitative scratch testing |
| ASTM D7187      | Scratch/mar behavior of paint coatings by nanoscratching                                                                    |
| ASTM G171       | Scratch hardness of materials using a diamond stylus                                                                        |
| ISO 27307:2015  | Thermal spraying – evaluation of adhesion/cohesion of thermal sprayed ceramic coatings by transverse scratch testing        |

| Patents                   |                                                      |
|---------------------------|------------------------------------------------------|
| EP 1828744 and US 7685868 | Active top surface referencing (UNHT 700)            |
| EP 2065695 and US 8261600 | Synchronized panorama mode (scratch testers)         |
| US 6520004                | True penetration and residual depth (scratch tester) |

