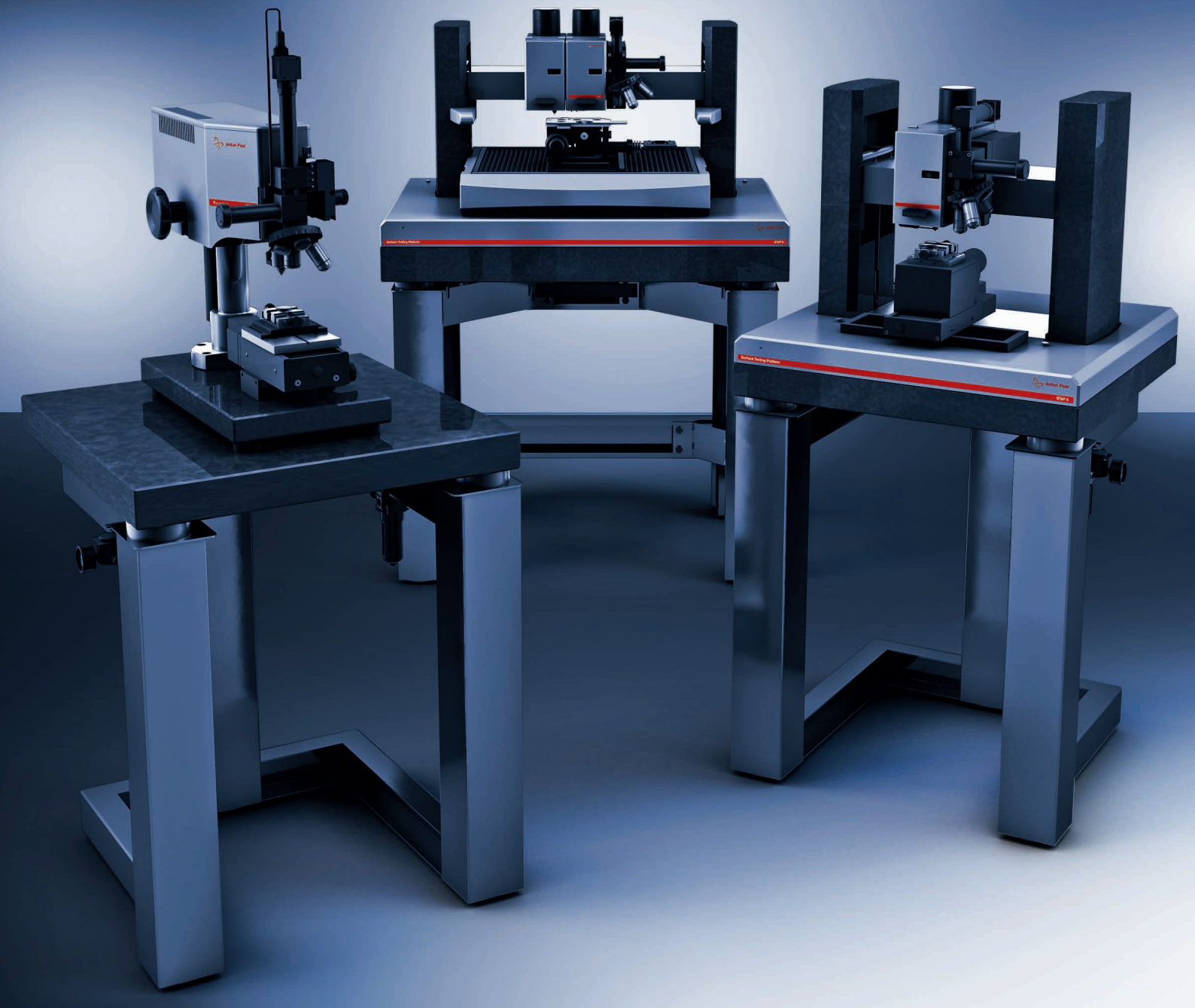
Anton Paar

Scratch Testers

Coating Adhesion, Scratch and Mar Resistance



Scratch Test Principles

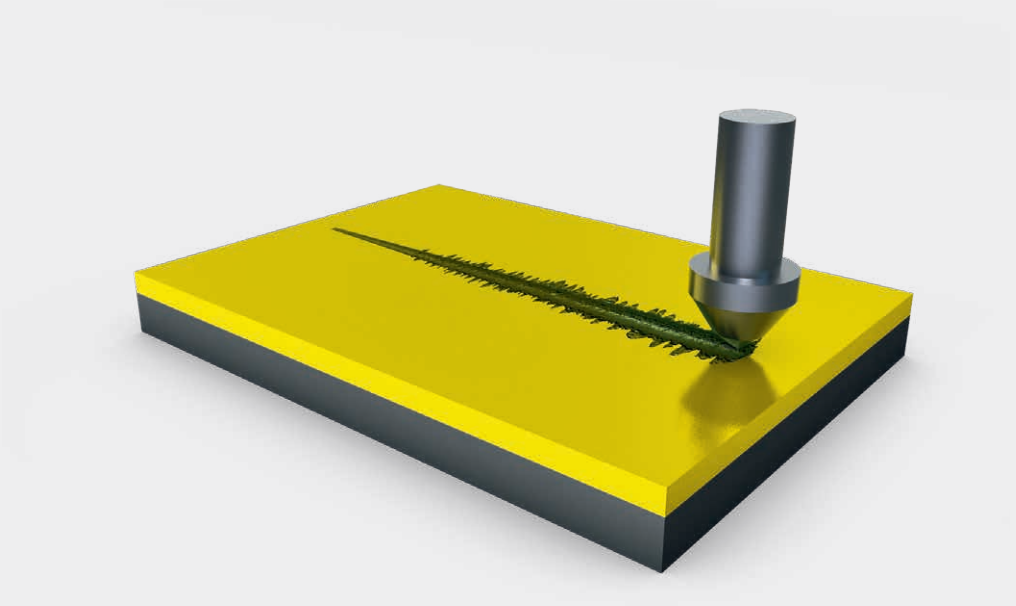
Anton Paar scratch testers (previously from CSM Instruments) are ideal instruments for characterizing the surface mechanical properties of thin films and coatings, e.g. adhesion, fracture and deformation.

These instruments can be used for all kinds of industrial coatings, from the plasma-processed layers used in semiconductor and optical technology to the decorative and protective coatings used for consumer goods and automobile parts.

The ability of the scratch tester to characterize the film-substrate system and to quantify parameters such as friction force and adhesive strength, using a variety of complementary methods, makes it an invaluable tool for research, development and quality control.

The technique involves generating a controlled scratch with a diamond tip on the sample under test. The tip is drawn across the coated surface under constant, incremental or progressive load. At a certain load the coating will start to fail. Critical loads are very precisely detected by means of the tangential force, the penetration depth, and the acoustic emission sensors together with observations from a built-in optical microscope.

The critical load data is used to quantify the adhesive properties of different film-substrate combinations by using different sensors (acoustic emission, penetration depth, friction force) and video microscope observations. When you purchase your scratch tester from Anton Paar, you choose a high-quality product. Day after day, you can rely on its accuracy and stability.



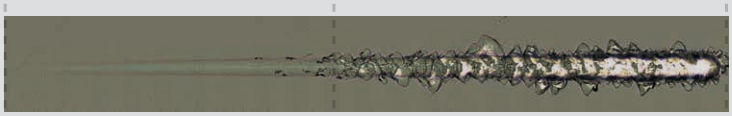
Anton Paar provides configuration flexibility to grow with all your needs. Multiple testing and imaging modules are installed together on the same Surface Testing Platform: **“STeP 4”** or **“STeP 6”**.

All the measurement and imaging modules are “synchronized” with each other. The optical microscope is included as a standard module on both platforms.

Anton Paar Scratch Testers

Nano Scratch Tester **(NST³)**

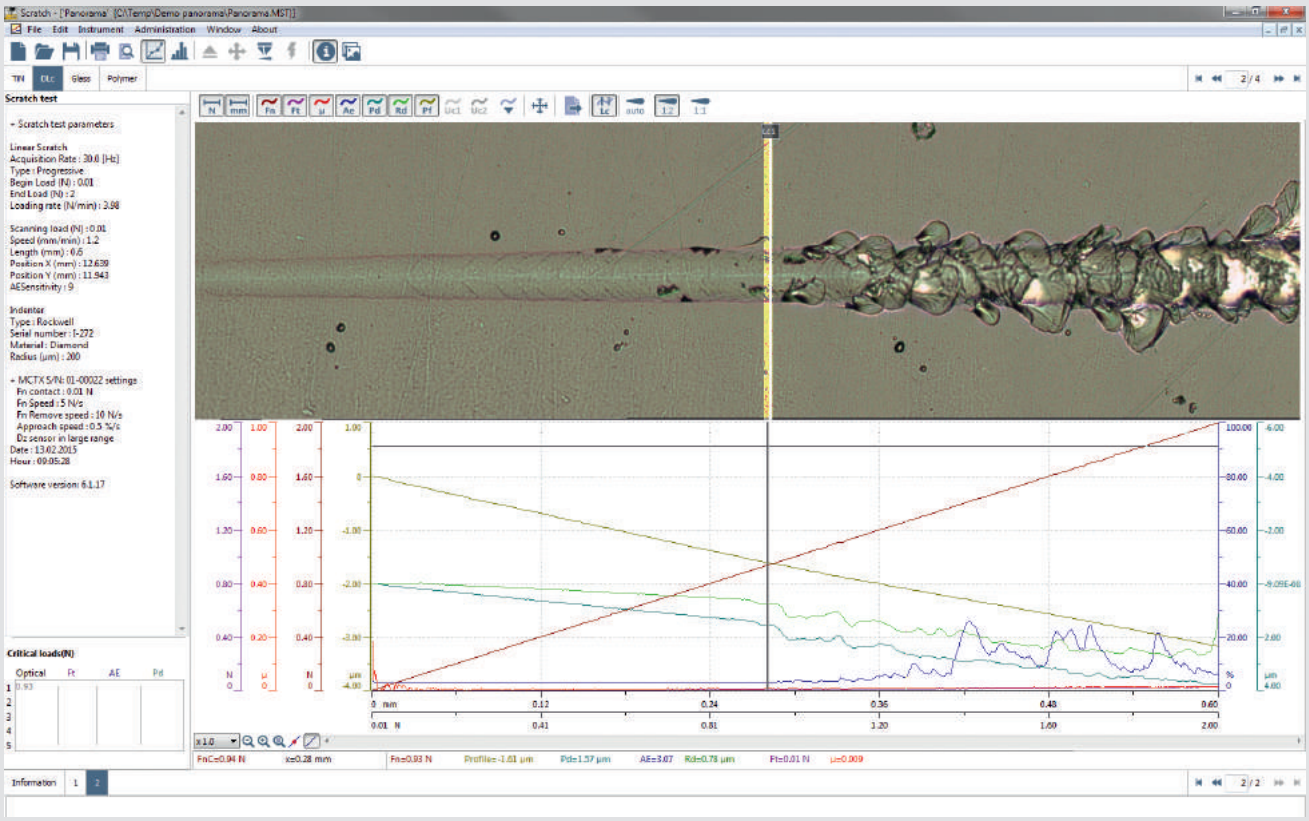
Micro Scratch Tester **(MST³)**



Revetest Macro Scratch Tester **(RST)**

10 µN 30 mN 1 N 30 N 200 N

Unique understanding of the scratch test and traceability with our patented* synchronized panorama



* Patents: US 8,261,600, EP 2065695 and JP 5311983

1. Choose your measurement module

NST³
Nano Scratch Tester

MCT³
Micro Combi Tester
(Microindentation & Micro Scratch)

MST³
Micro Scratch Tester

UNHT³
Ultra Nanoindentation Tester

NHT³
Nanoindentation Tester

MHT³
Micro Indentation Tester

NTR³
Nano Tribometer

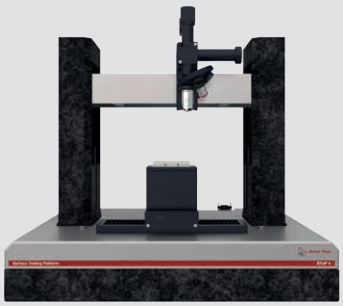
2. Choose your imaging module

COS
ConScan Confocal
Microscope

AFM
Atomic Force
Microscope

IVID
In-situ Video
Microscope

3. Choose your platform



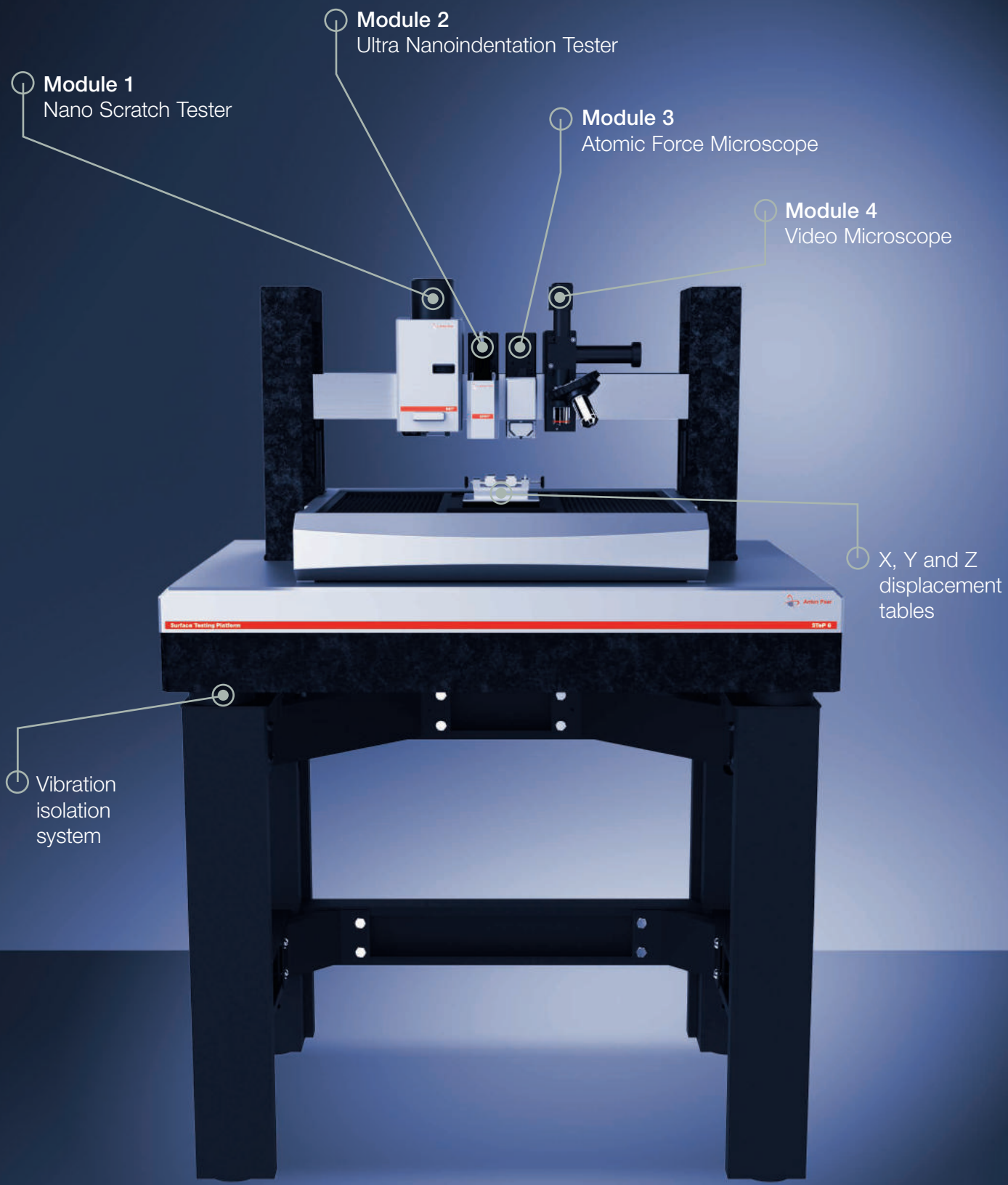
STeP 4
Surface Testing Platform

STeP 6
Surface Testing Platform

Surface Testing Platform (STeP 6):

The perfect modular platform for mechanical surface testing

To provide configuration flexibility, multiple testing and imaging heads can be installed together on the same platform. All the measurement and imaging heads are “synchronized” with each other.



Example of a Surface Testing Platform STeP 6 with Nano Scratch Tester, Ultra Nanoindentation Tester, AFM and Optical Video Microscope

NST^3: Nano Scratch Tester (up to 1000 mN)

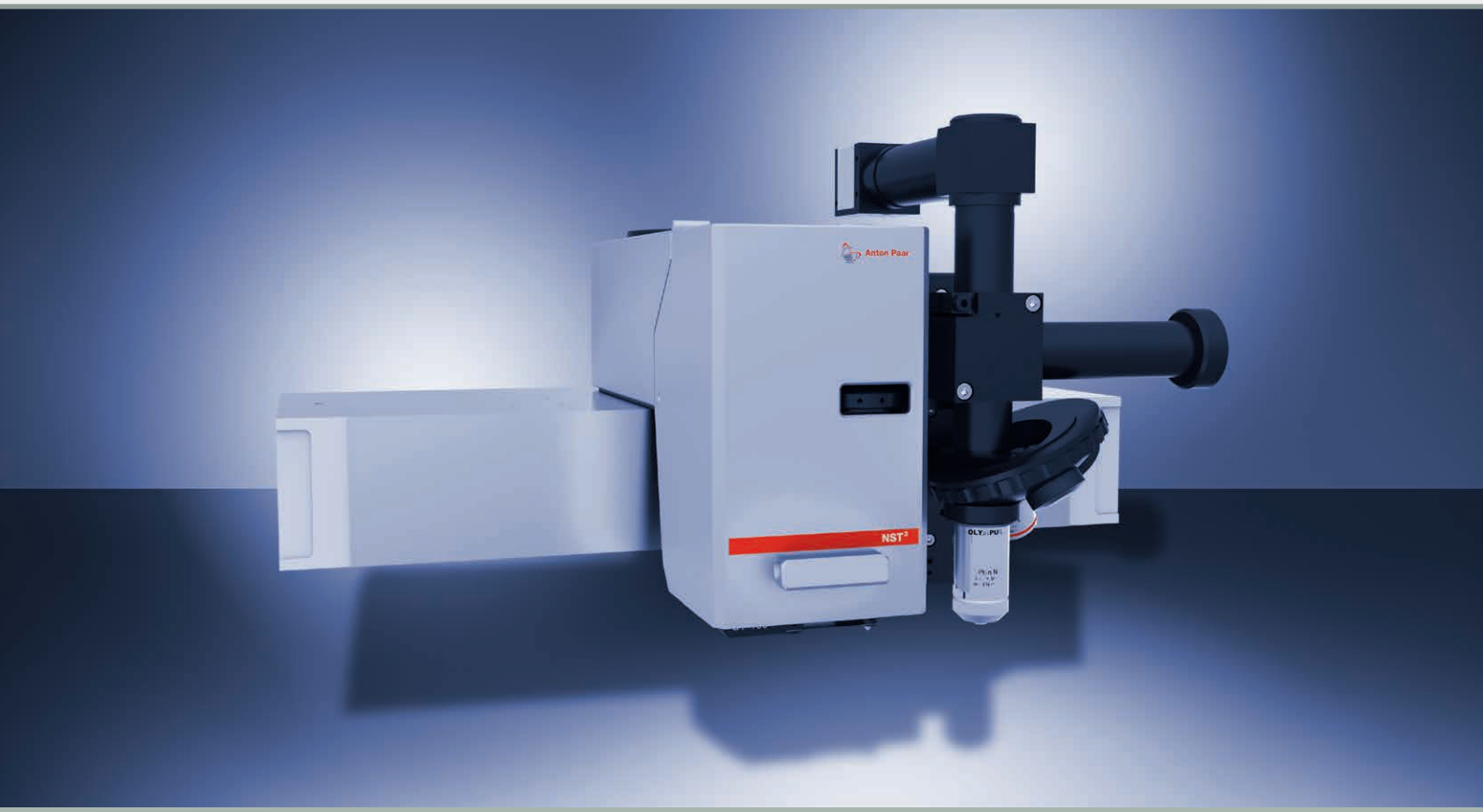
The highest accuracy nano scratch tester on the market

The Nano Scratch Tester is particularly suited for the characterization of the practical adhesion failure of thin films and coatings with a typical thickness below 1000 nm. The Nano Scratch Tester can be used to analyze organic and inorganic coatings as well as soft and hard coatings.

Features:

- Patented double-cantilever beam* combined with piezoelectric actuator
- Active force feedback loop control
- High-precision profiling
- Automated video microscope with synchronized panorama and multi-focus
- Patented true penetration depth measurements* for elastic recovery studies
- Scratch depth measurement with both pre-scan and post-scan corrections
- High-quality optical imaging (optical video microscope turret with up to 4 objectives)
- Accurate wear testing
- Compatible with ISO and ASTM standards

* Patents: US 6,520,004, EP 1092142, CN 1143128C and JP 4233756



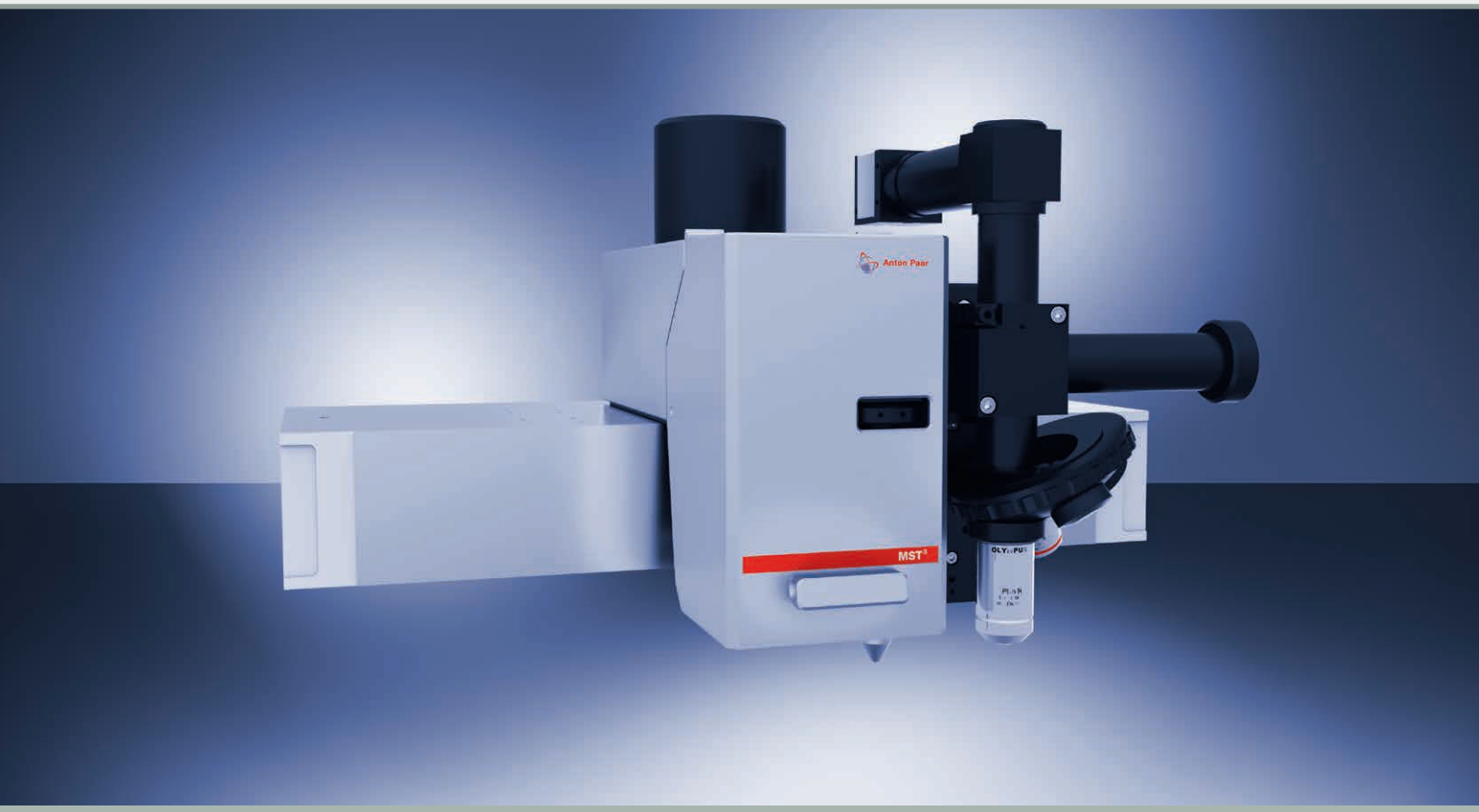
MST^3: Micro Scratch Tester (up to 30 N)

The wide range tester for demanding users

The Micro Scratch Tester is widely used to characterize the practical adhesion failure of thin films and coatings with a typical thickness below 5 µm. The Micro Scratch Tester is also used in the analysis of organic and inorganic coatings as well as soft and hard coatings.

Features:

- Stylus scratch method
- Automated video microscope with synchronized panorama and multi-focus
- Active force feedback loop control
- Compatible with ISO and ASTM standards
- Scratch depth measurement with pre-scan and post-scan corrections
- Numerous scratch testing capabilities
- Acoustic emission detection



RST: Revetest® Scratch Tester (up to 200 N)

The industry reference

The Revetest® Scratch Tester is widely used for characterizing hard-coated materials with a typical coating thickness exceeding 1 µm.

Features:

- Diamond-stylus scratch method
- Feedback-controlled normal force
- Acoustic emission detection
- Video microscope with patented synchronized panorama mode
- Long-term stability of calibration
- Conventional hardness mode included
- Complies with ASTM C1624, ISO 20502 and ISO EN 1071

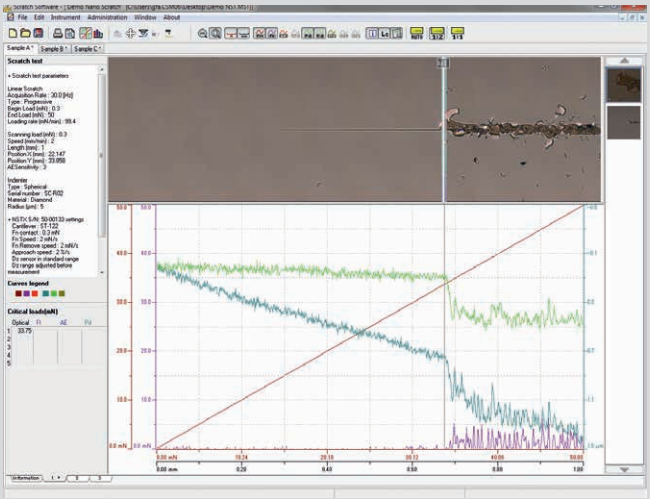
Software

Measurement modes:

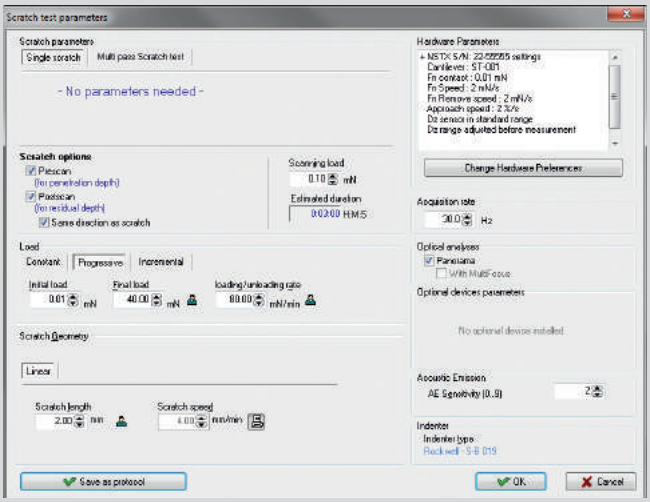
- Unique patented synchronized panorama mode, protected by patents: US 8,261,600, EP 2065695 and JP 5311983
- Pre- and post-scan: Anton Paar is the exclusive license holder of patents: US 6,520,004, EP 1092142, CN 1143128C and JP 4233756
- Multi-focus imaging
- Real-time display of force and depth data during acquisition
- User-definable scratch modes:
  - single and multiple scratches; constant, incremental or progressive loads;
  - user-defined load profiles
- Large range of testing modes: scratch, wear, indentation
- Programmable system setting for every single scratch in a multi-scratch experiment
- Fully customized management of user access rights
- Automated positioning between the tip and imaging module
- Full integration of AFM and video imaging into the same software (only for NST^3 and MST^3)
- Multi-language support

Data analysis:

- Critical loads, Lc, as a function of normal loads
- Powerful and fully integrated statistics module (data and graphics)
- Automatic measurement report generator with unlimited templates
- Logging of all operations executed on the instrument
- Data export in ASCII format - Open files with Excel or text editor
- Material deformation modeling software



Typical scratch with panorama



Scratch settings window

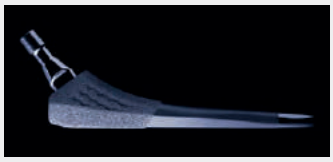
Applications

Hard Coatings

- TiN, TiC, DLC
- Cutting tools
- Forming tools
- Plasma spay coatings
- PVD and CVD coatings

Semiconductor Technology

- Passivation layers
- Metallization
- MEMS and NEMS
- Hard disks
- Low-K



Biomaterials

- Arterial implants (stents)
- Bone tissue
- Prosthetics
- Tablets and pills

Optical Components

- Eyeglass lenses
- Optical coatings
- Contact lenses

Decorative

- Evaporated metal coatings
- Jewelry and watches
- Mobile phone cases

Automotive

- Paints and polymers
- Varnishes and finishes
- Engine valves, ejector pins
- Brake pads

Ceramics

- Tiles
- Concrete
- K_{1C} of bulk materials

General Engineering

- Rubber
- Touchscreens
- Lubricants and oil additives
- Sliding bearings

International Standards

ISO 20502
Fine ceramics – determination of adhesion of ceramic coatings by scratch testing

ISO 1518
Paints and varnishes - scratch test

DIN EN 1071-3
Advanced technical ceramics
Determination of adhesion and other mechanical failure modes by a scratch test

ASTM C1624
Standard Test Method for Adhesion Strength and Mechanical Failure Modes of Ceramic Coatings by Quantitative Single Point Scratch Testing

ASTM D7027
Evaluation of scratch resistance of polymeric coatings and plastics using an instrumented scratch machine

ASTM D7187
Standard Test Method for Measuring Mechanistic Aspects of Scratch/Mar Behavior of Paint Coatings by Nanoscratching

ASTM G171
Standard Test Method for Scratch Hardness of Materials Using a Diamond Stylus

Specifications

	NST^3	MST^3	RST
Maximum load [N]	1	30	200
Load resolution [µN]	0.01	10	100
Load noise floor [rms] [µN]	0.1	250	3000
Loading rate [N/min]	0 to 10	0 to 300	0.4 to 300
Depth range [µm]	600	1000	1000
Depth resolution [nm]	0.3	0.05	1.5
Depth noise floor [rms] [nm]	1.5	1.5	4
Data acquisition rate [kHz]	192	192	192
Scratch speed [mm/min]	0.1 to 600	0.1 to 600	0.4 to 600
Options			
Peltier heating up to 120 °C	●	●	● (up to 100 N)
Heating stage up to 200 °C	●	●	●
Heating stage up to 450 °C	○	●	●
Cooling to -120 °C	●	●	●
Electrical Contact Resistance (ECR)	●	●	●
Liquid testing	●	●	●
Camera resolution	1280 x 1024	1280 x 1024	1280 x 1024

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