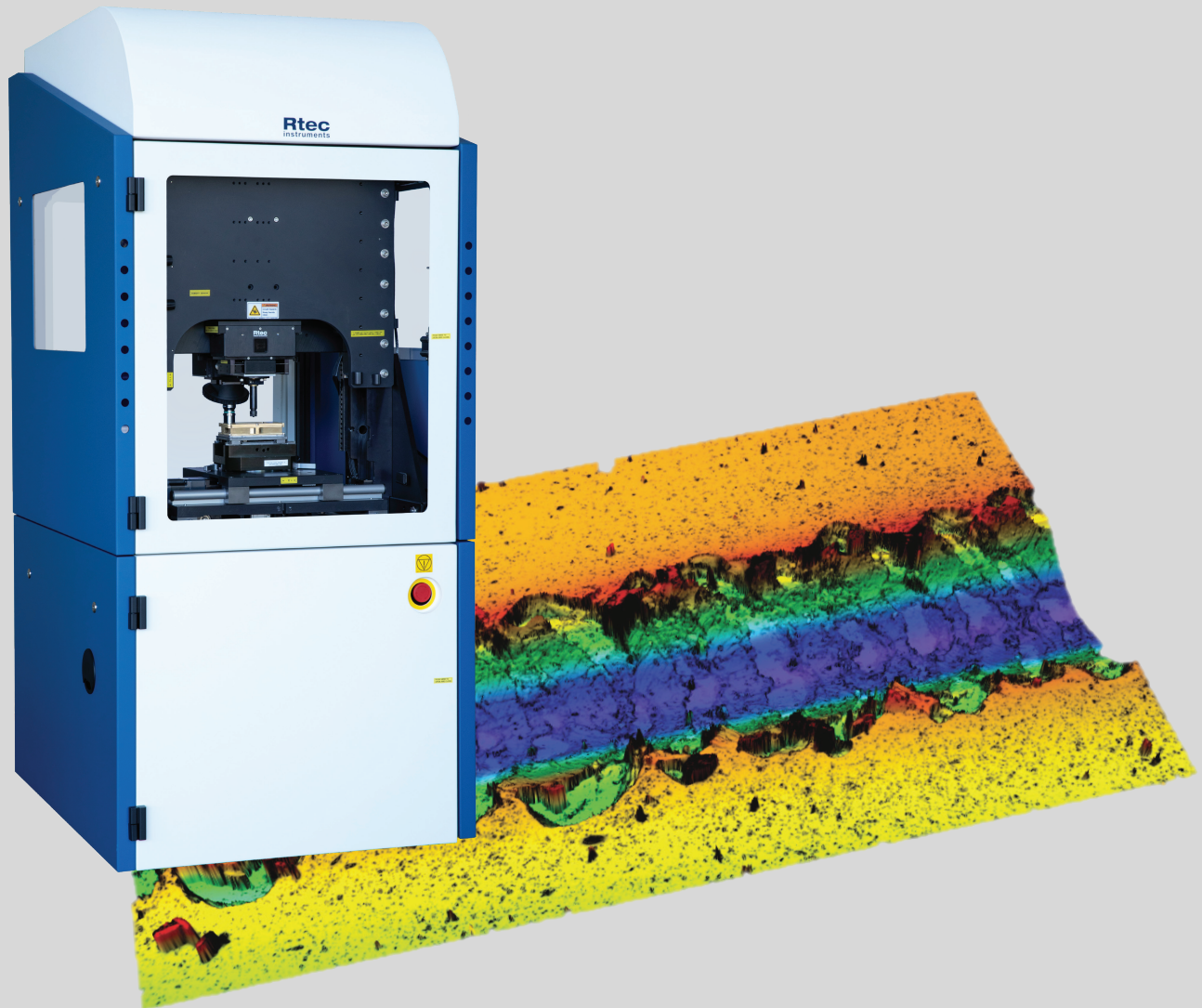




Universal Tribometer + Inline 3D Imaging



Tribology And Mechanical Tester With Integrated 3D Profilometer

Multiple ASTM, DIN, ISO Standards Compliant

Research &
Development

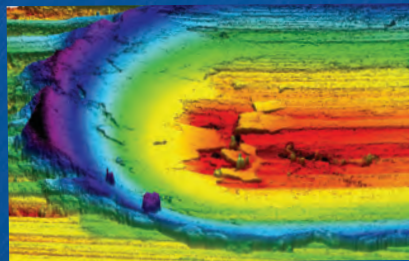
Quality
Control

Industry Standard

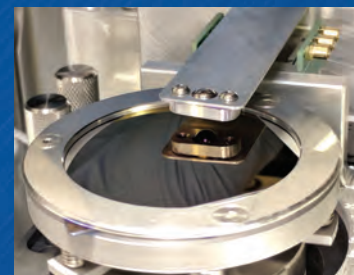
Platform

The state of the art Rtec-Instruments Multi Function Tribometer MFT-5000 is globally regarded as the most versatile and technologically advanced tribometer.

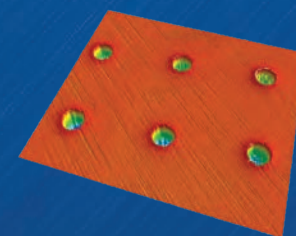
The tribometer offers break-through technology in tribology equipment with ultra low resolution and negligible thermal drift force sensors, highest speeds, widest environmental control range and ultra accurate stroke control. The patented integrated 3D profilometer allows to analyze surface change vs time.



3D Imaging



Tribology



Mechanical Tests

- Wear
- Friction
- Coefficient of friction
- Adhesion
- Scratch hardness
- Scratch, Mar resistance
- Film Thickness
- Step height
- Hardness
- Modulus
- Fracture toughness
- nm resolution 3D images
- Wear track, volume wear
- Radius of curvature
- Cracks, features, defects
- Chemical properties
- Fretting
- Tensile, compression
- High Temperature Hardness

01

Multi ASTM, DIN, ISO tests on same platform
Run both standard and non standard tests on coupons or real components

02

Wide load range - nano, micro , macro
Interchangeable load cells to allow a wide range of force mN to 12,000N

03

Several easy to interchange test modules
Allows to test coatings, materials, lubricants across wide test conditions

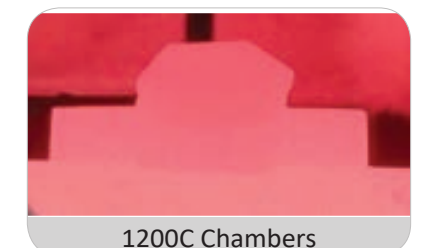
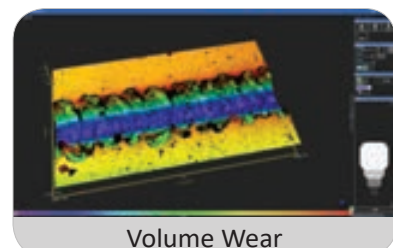
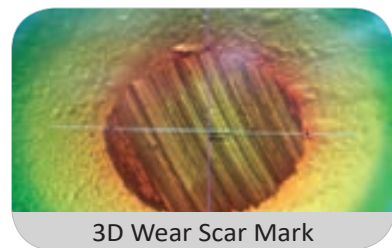
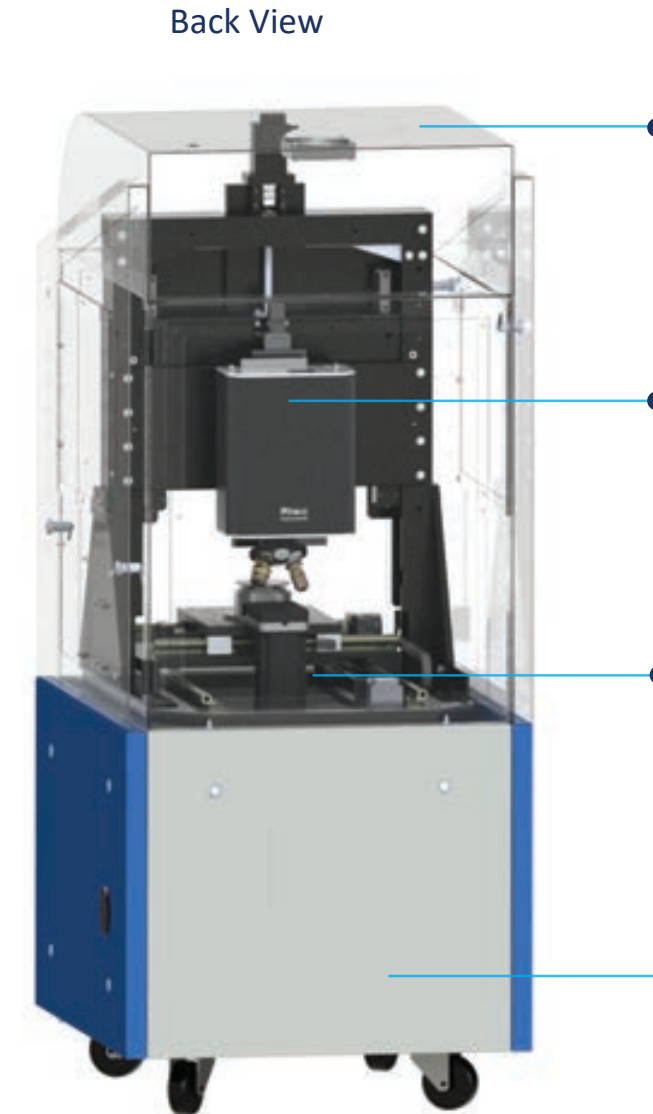
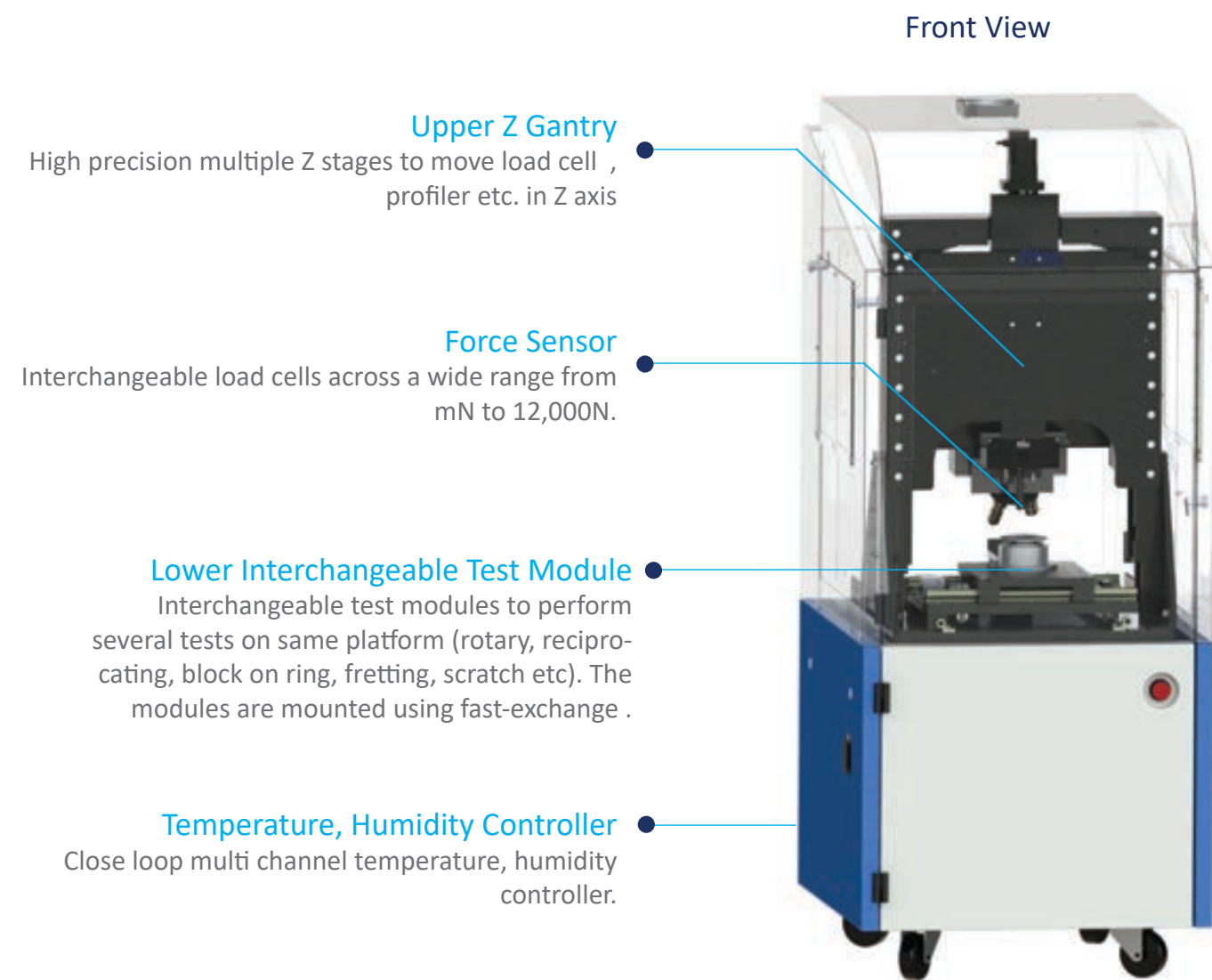
04

Integrated in-line 3D profilometer
Study surface roughness, volume wear, topography change with test time

05

Multi function or single function configurations
The tester can be configured as single function test only.

Tribometer Configuration



A Tribometer That Comprehensively Characterizes Surface Change vs Time

Tribology Mode

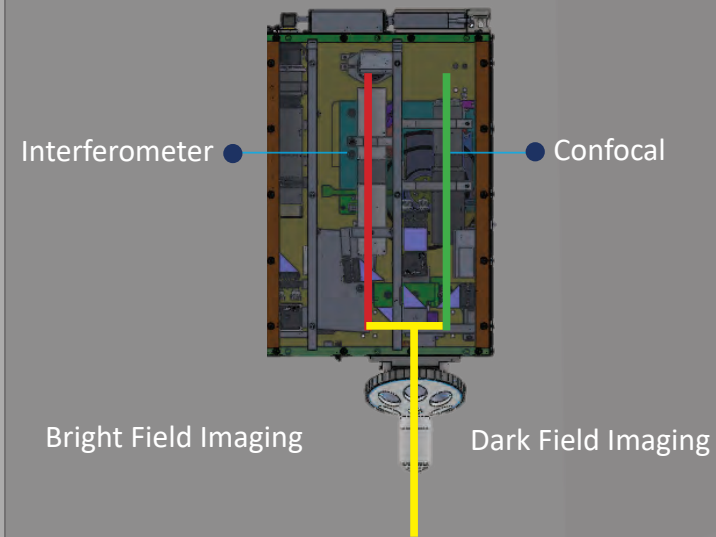
Several Modules Available for Test

Nano Load
Micro Load
Macro Load

Rotary Motion
Linear Motion
Horizontal Rotation Motion
Upper Rotation
Fretting

Imaging Mode

Sub nm automated 3D Images of Surfaces



Surface roughness
Film thickness
Wear track, volume wear
Step height
Add on - Confocal Raman

In-line Profilometer With Automatic Stitching

Technology Optimised for Tribology

Steep Slopes

Universal profiler allows to image wear tracks with steep slopes.

Rough, Dark, Smooth Surfaces

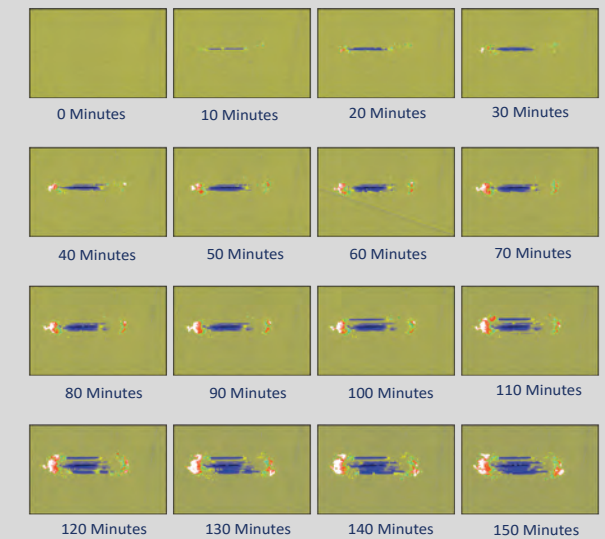
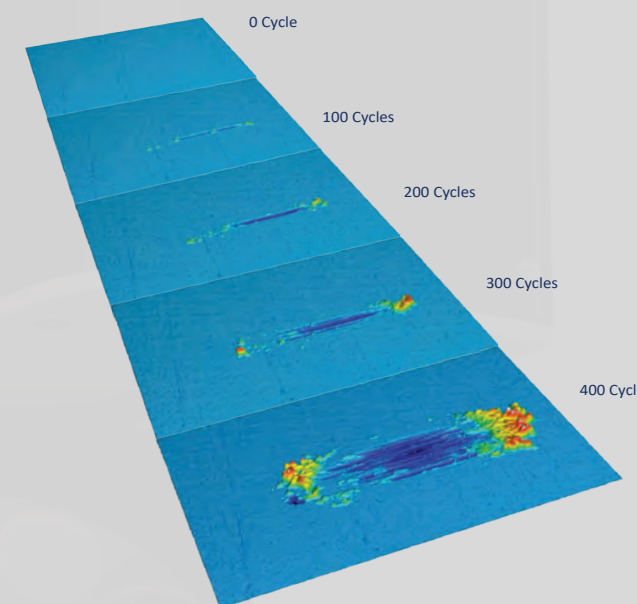
The universal profiler can scan any material (transparent, dark, corroded, flat, curved).

Auto Stitch Entire Sample

High precision XY stage allows to scan and stitch entire wear track automatically.

Image with Liquids

Confocal microscopy allows to image samples under liquid media.



Sub nm 3D Image of Wear Mark Progression During Test

Wide Range Of Sensors

Industry Leading Specification

Automatic Recognition

The tester allows to mount various easy to interchange force sensors. Each sensor has automatic recognition feature, calibration file, PID values etc. to maintain optimized performance on testing parameters.

Fast Exchange

Dependent on the application a sensor from various types of load cells can be selected.

Highest Resolution

- Capacitive Load cells - Highest resolution load cells with negligible thermal drift.

Low Floor Noise

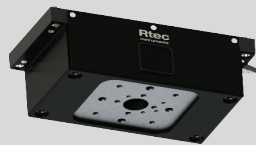
- Piezo Load cells - Sensors to measure data at highest frequency.
- Strain Gauge Cells - Sensor with widest load range.

Choice Depends On Application

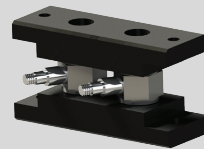
Capacitive Sensor



Strain Gauge Sensor



Piezo Sensor



Other Types

- Torque Sensors
- 1D,2D,6D Sensors
- In-line Dynamic Torque Sensors

Technology

Stroke Control from 5 microns

High Torque Motors, 45Nm @ 1000RPM

High Frequency Capacitive and Piezo Sensors

In-line Confocal + Interferometer Profilometer

Widest Environmental Range -120 to 120C

Voice Coil and Flexure Based actuators

Industry Leading Resolution and Lowest Noise

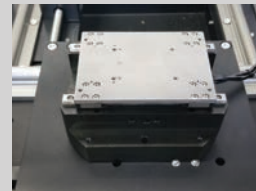
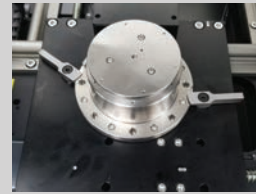
Robust Design To Minimise Sensor Damage

Modular Drives With Fast Exchange

MFT-5000 allows to run tests across a wide range of force and applications using its modular concept. Various interchangeable modules can be added on the same platform based on the intended application. The modular nature of tester allows it to test coatings, bulk materials, lubricants, components etc.

The test modules are quickly swapped. The modules, load cells and lower test drives comes with fast exchange mechanism that easily allows to change test configuration.

The software and hardware automatically recognizes the test module and allows to run the tests with ease.



Automatic Recognition

Ease of Use

Same Software

Future Field Add-ons

Cost Effective

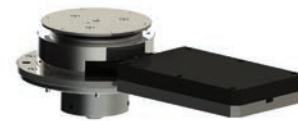
Environmental Chambers

The tester comes with several environmental chambers. The chambers are typically mounted on top of room temperature drives. Using interchangeable chambers a wide range from -120 to 1000C, controlled humidity, vacuum up to 10⁻⁷ torr etc. is achieved. Few setup also allows to heat both upper and lower sample separately to simulate real life situations.

The advanced temperature controller allows temperature measurement at multiple points simultaneously. All the chambers are close loop controlled and the requested conditions are controlled using the software automatically. The PID for different range of chambers are automatically loaded once an option is mounted.

Modular Design For Maximum Versatility

Drives



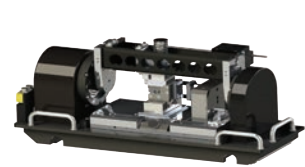
Rotary Drive



Reciprocating



Block on Ring Drive



Fretting Drive



Long Stroke High Frequency



Upper Rotary Drive

-120C to 1200C Temperature Control, Tribo-Corrosion

Chambers



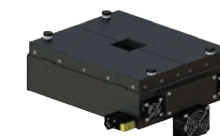
1000C



Salt Spray



500C



1200C



-60C



-120C

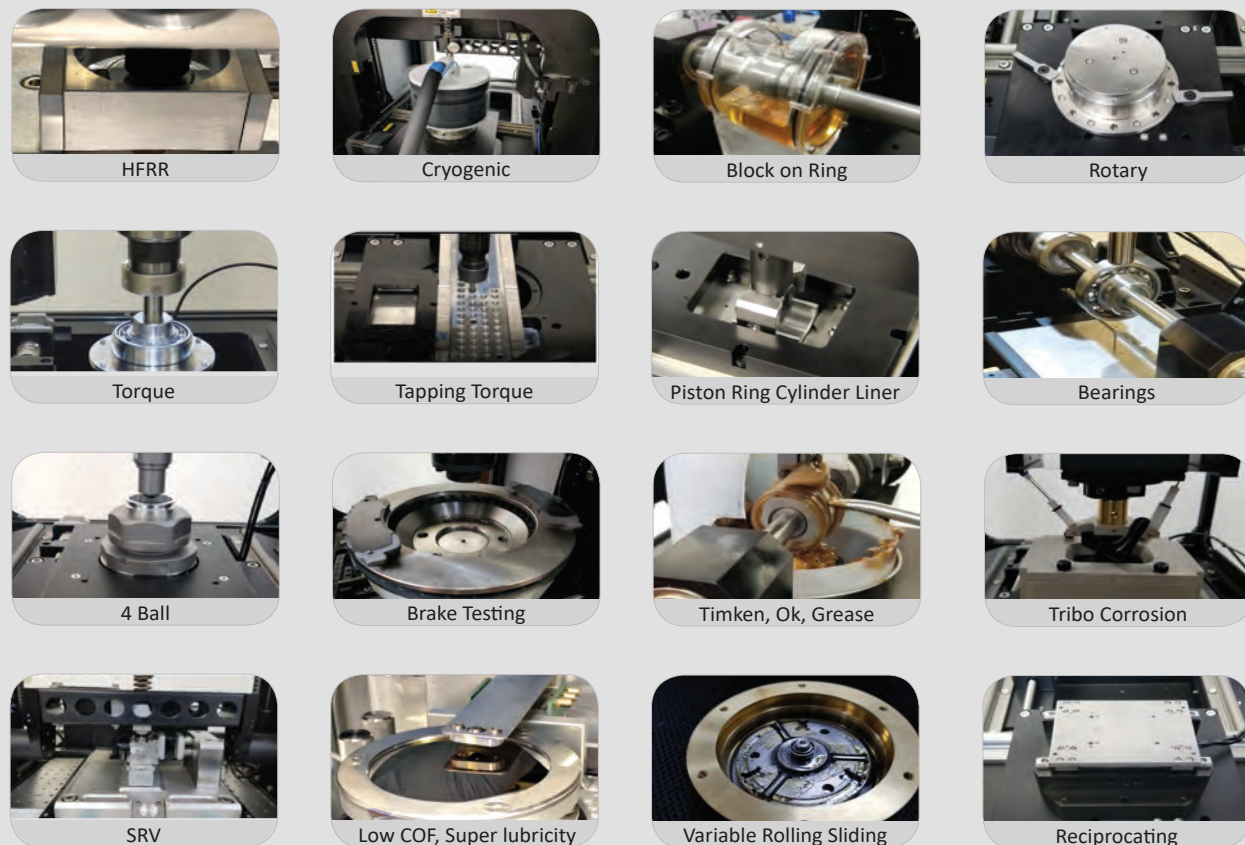
Salt Spray, Vacuum, Inert Gas, Humidity, High Pressure Chambers etc.

Multiple ASTM, DIN, ISO

Stribeck Curves



Industrial Tribology



The Universal Tribometer is ideally suited for Industrial Tribology involving lubricants, additives, oils, metal working fluids etc. The sturdy design, various lubricant dispensing system, speed range from ultra slow to 10,000 RPM, temperature control etc. allows to precisely develop, characterise and do quality control. Few of the common tribology tests and features are described below.

Lubricant Recirculation

High Speed Containers

Temperature Control

All Regimes

Automatic Stribeck

Up to 12000N Force

Real Components

Low Friction Measurement at High Loads

Ultra High Torque Motors

Certified Reference Calibration Oil, Samples

HFRR

The High Frequency Reciprocating module HFRR (ASTM D6079) is used for evaluating diesel fuel lubricity. The ball slides against the disk with a 1 mm stroke at a frequency of 50 Hz for 75 min

Linear Oscillating test

The standard Test to determine extreme pressure, friction wear properties of lubricant greases, solid bonded films, gear and hydraulic fluids, lubricating oils. All tests are done in oscillation mode under controlled environmental conditions. ASTM G119, G174, G133, G203, G204, G206, D5706, D5707, D6425, D7217, D7420, D7594 ,D7421 , DIN 51834 and others.

Block on Ring, Timken EP

The block on ring module is typically used to evaluate friction wear of materials, lubricant where a ring/bearing/shaft is rotated under axial load. ASTM G77, D2509, D2714, D2782, D2981, D3704 and others.

4 Ball, EP wear

4 ball module is used to measure friction properties of extreme pressure oils and greases. The test involves rotating one ball on three stationary balls at controlled environmental conditions. ASTM D2596, D2783, D2266, D4172, D5183 and others.

Tapping torque, Twist Compression

Tapping torque module allows to characterize friction, wear, torque etc. during forming and machining. The test involves tapping/drilling using taps of various standard sizes on materials of choice. Twist Compression is designed to measure friction and adhesion in metal forming. Test involves slowly rotating a ring on top of material of choice.

Piston Ring Liner

This test allows to assess friction and wear parameters of piston ring, liner material in presence of engine oils. Few applicable standards are ASTM G181, D1894 etc.

Thrust Washer

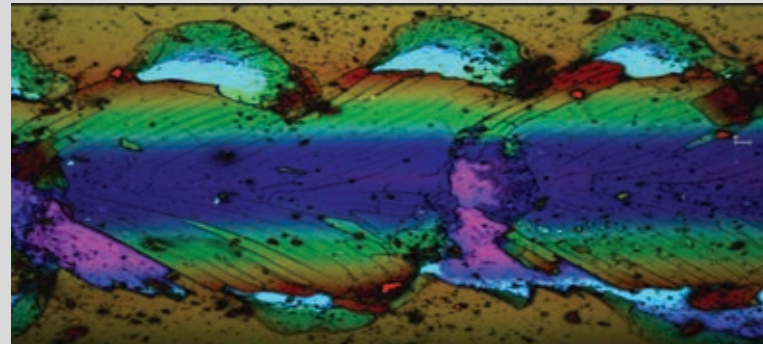
This test (ASTM 3702) allows to assess friction and wear parameters of self-lubricated materials in thrust washers ASTM 3702 etc.

Pin, ball on disk

The module measures friction during sliding using pin/ball on disk setup. ASTM G99, G132, D3702, DIN 50324 and others.

Stribeck Curve

Stribeck curve displays the evolution of the coefficient of friction as a function of load or velocity. In all modules users can change the load and velocity to automatically plot Stribeck Curves with ease.



Scratch

nm to mm Thick Coatings

High Temperature

Hard Coatings

Polymer Coatings

Paints

Soft Coatings

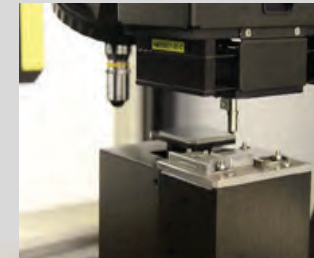
Optical Lenses

Decorative Coatings

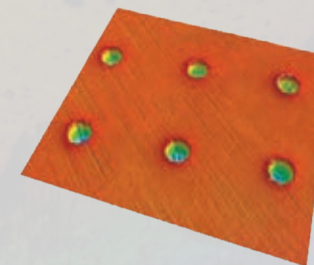
Real Components

2D Materials

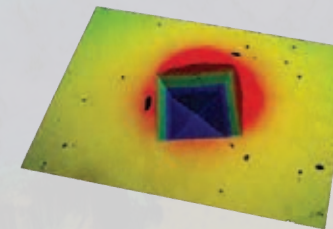
Thermal Spray Coatings



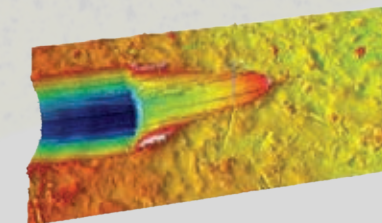
Scratch Module



Spherical Indents



Vicker's Indent



Wear Mark



Hydrogels - Contact Area Change vs Force

Coating Adhesion, Scratch and Mar Resistance

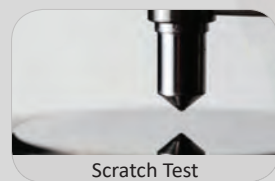
The scratch test quantifies adhesion, scratch hardness of coatings. With the advent of new deposition methods and technologies, thinner coatings are finding its way in every aspect of our life. Coatings are present on LCD displays, phones, cutting tools, mems, glass, automobiles, devices etc. The quantitative coating adhesion scratch test is a simple practical test that has been around for a long time. But reliable, reproducible and comprehensive test requires careful control of the test system configuration and testing parameters.

The scratch test requires applying a load on the sample that needs to be tested with a spherical or custom tip. During the process of applying the load the sample is moved at a constant velocity and several parameters such as Friction (Fx), Down force (Fz), Coefficient of friction (COF), displacement (Z), acoustic emission (AE), temperature etc. are measured in-situ.

Mechanical Tests - Hot Hardness, 3-4 Point Bending

The tribometer measures and monitors forces and displacement in all axis. The multi axis force measurement allows is to run several standard mechanical tests such as hardness, 3-4 point bending, tensile, compression, fatigue, torsion, fretting etc. test with ease. All these tests can be done using any of the environmental chambers.

ASTM, ISO, DIN Compliant



Scratch Test



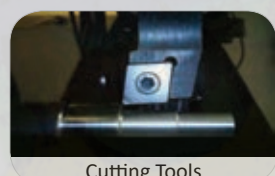
High Temperature



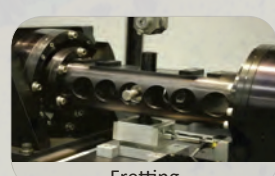
Nano Tribology



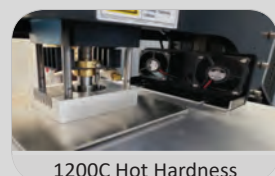
Cryogenic



Cutting Tools



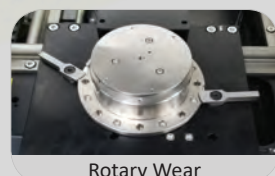
Fretting



1200C Hot Hardness



Reciprocating



Rotary Wear

Nano Tribology

Ultra Low Frictions nm to Micron Films



Super Lubricity, 2D Materials, DLC etc.

Low Friction Force Measurements

Negligible Drift Force Sensors

Capacitive Load Sensors

High COF Reproducibility

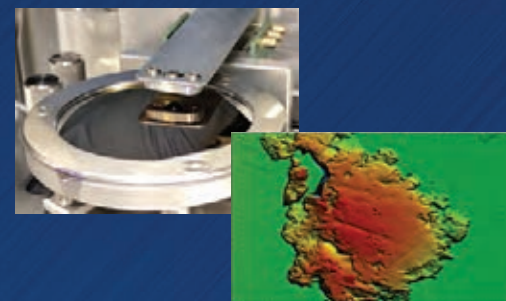
The nano tribometer modules allow for a comprehensive friction, wear, adhesion etc. characterization over nano to micro scale. Ultra sensitive capacitive load cells, combined with low floor noise and robust design provides quantitative tribology characterization of interfaces, thin films, 2d materials, super lubricity etc. The tests can be done in air, vacuum chamber or in controlled inert gas atmosphere. The wear mark can be easily imaged using in-line profiler and raman spectrometer to characterise roughness, wear and chemical property across the track automatically.

- 2D Materials
- Polymers
- Soft Coatings
- Paints
- Lens
- Optical Coatings
- Displays

Precision At Best

Super Lubricity

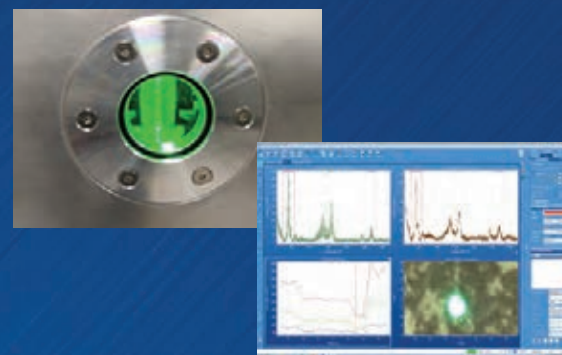
The tribometer uses decoupled capacitive load cells to measure friction at COF 0.001 level even at high down forces (1N, 10N etc.). The unique design, controlled environmental condition, high resolution sensors allow to measure friction for 2d materials, superlubricity etc. with ease.



Ball on Disk Setup for Nano Tribology
Agglomerated Particles on Coating

In-line Confocal Raman Spectroscopy

In-line confocal raman spectroscopy can be added to the tribometer. The confocal mode allows to image the chemical property of locations within the wear mark with high resolutions. The XY stage allows to stitch the Raman maps across the entire wear track. The tests sample can be in air or in vacuum chamber.



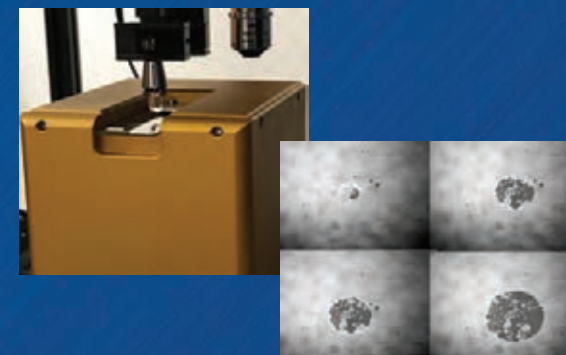
Vacuum Chamber with In-line Raman And Profiler
Raman Spectrometer Data on Wear Mark

Touch Screen, Displays, Glass

The tribometer uses 6D sensor and close loop XY stage that allows to create custom motions to simulate any kind of profiles. The test is used to simulate finger motion on touch screens accurately to quantify perception.

Contact Area Vs Force

Surface adhesion module can be added to the tribometer that allows to analyse real time contact area using imaging system that is placed under the sample. This allows to calculate surface adhesion and also observe the interface in real time.



Test Showing Hydrogel Against a Coated Glass Slide
Real Time Contact Area Analysis vs Force

Software

The tester comes with a powerful operation, statistical and image analysis software. All softwares are windows based and are very easy to learn and operate. The software allows to run the tool in advanced mode for experienced users or just simple mode for new users or operators. The data can be saved in proprietary format or in ASCII format.

Stop Criteria

Each test step can be stopped by user's defined logical criteria.

Automatic Recognition

The testing system recognizes load cells automatically and loads the associated calibrations files.

Recipe Driven

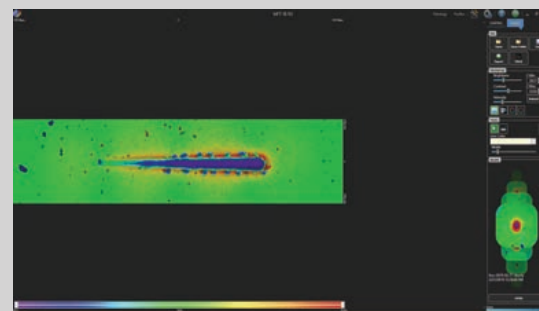
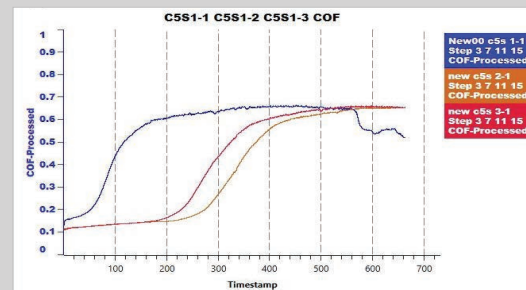
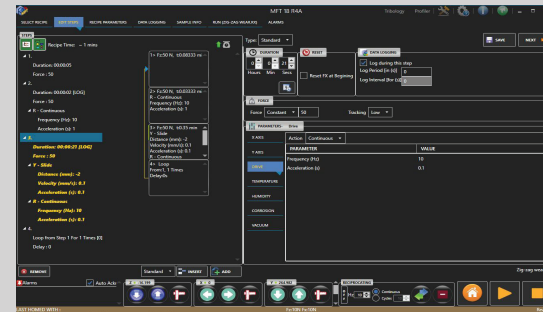
Each test can be controlled by a series of command blocks forming a protocol or "recipe". The recipes are saved and easily drive the instrument.

Easy to learn

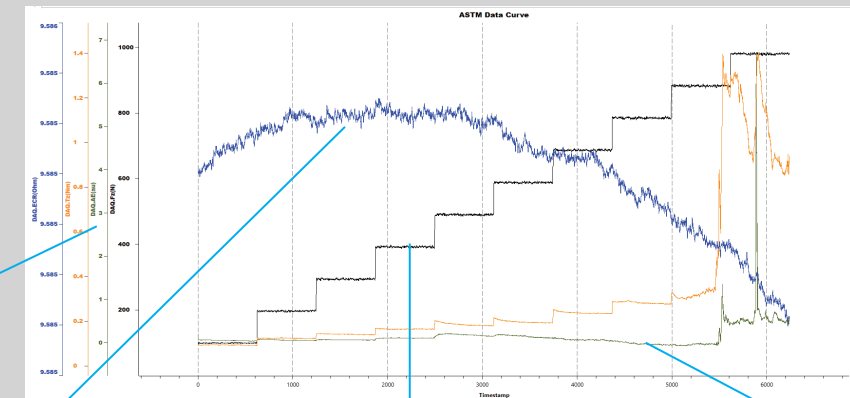
The software is intuitive and easy to learn for new user providing a low threshold to utilization.

Test Library

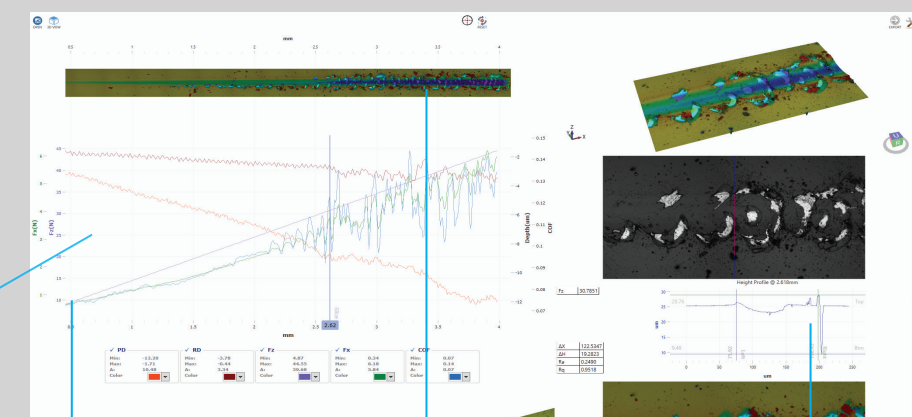
The instrument comes standard with a series of test protocols that match user's applications and can easily be modified.



Automatic Image , Tribology Data Correlation



- Torque, friction, coefficient of friction are recorded and displayed in real time. As the failure starts to happen the forces jump.
- Electrical contact resistance sensor measures the surface electrical properties. The film quality or thickness in real time can be quantified using the sensor.
- Down force is recorded and displayed in real time. This test shows step increase in down force. The force can be controlled in constant, linear or custom modes.
- The acoustic emission signal indicates initiation of failure at the test interface. The sensor uniquely filters out the motor and ambient noise and shows the interfacial acoustic signal.



- Synchronised 3D, 2D, Image and data zoom
- Friction, Wear, Depth Data
- Image associated with the wear mark.
- Roughness, Wear volume associated with the track.

Wide Applications

The versatility of tester allows the tribometer to play an important role for several applications. It can be used for thin or thick films, lubricants, materials, soft materials, hydrogels, bio materials, smooth or rough surfaces, flat or non flat surfaces, transparent or opaque surfaces, nano or macro scale, coating or bulk materials etc.

High Temperature

- Hot hardness Tester (up to 1200C)
- High Temperature Tribology (up to 1200C)

Lubricants, Grease

- Block on Ring, Timken OK
- 4-Ball EP and Wear
- HFRR
- Twist Compression
- SRV
- Tapping Torque, Cutting, Drilling
- Piston Ring Cylinder Liner

Mechanical

- Hot Hardness
- 3,4 Point Bending
- Adhesion

Cryogenic

- Low temperature Tribology (from -120C)

Corrosion Testing

- Tribocorrosion
- Salt Spray

Friction Wear

- Rotary Pin on Disk Tribometer, Ball on Disk
- Reciprocating
- Brake Materials Tribology
- Fretting
- Low Friction, Nano Tribology
- Bio Tribology

Coatings

- Scratch Test, Adhesion, Hardness
- 2D Materials, Low Friction Coatings
- Fretting
- Pin on Disk, Ball on Disk
- Reciprocating
- Fracture Toughness
- High Temperature Tribology upto 1200C
- Scratch and Marr Resistance

Industrial

- Brake Materials Screening
- Optical lens
- Cutting Tools, Hard Coatings
- Piston Ring Cylinder Liner
- High Pressure Chamber
- Aerospace Tribology
- Textile
- Bearings

Platform Specification

- Floor standing- Micro, Macro
- Bench top -Nano, Micro

XY stage

- Range: 150x210mm
- Motion resolution: 0.1µm
- Maximum speed: 50mm/s

Multiple Z stages

- Max speed: 10mm/s, 500um/s
- Motion resolution 0.25um, 10nm

Computer console

- Latest Windows OS
- LCD monitor, printer

Facilities requirement

- Power Requirements: 240 VAC /480VAC

Environmental chambers (optional)

- 120°C up to 1200°C
- 5 to 95% RH
- Vacuum
- Liquid
- Inert gas
- Corrosion
- Salt Spray
- High Pressure

Surface Inspection

Various imaging modules

- White light interferometer
- Confocal microscope
- Variable Focus
- Raman spectrometer
- High Mag microscope
- Atomic force microscope

Additional Sensors

- Potentiostats
- Acoustic emission
- Electrical resistance
- pH probes

Test Modules

Various mechanical heads

- Tribometer
- Indentation
- Scratch
- Mechanical

Lower drives

All drives are in addition to drives mentioned in platform specification

Rotary drive

- Range 360°
- Max speed up to 10000 RPM
- Min speed 0.001RPM (low speed drive)

Fast reciprocating drive

- Speed up to 80Hz
- Stroke 0.1mm to 30mm

Long Stroke Fast Reciprocating

- Speed 40Hz
- Stroke 40mm at 40Hz

Fretting drive

- Speed up to 500Hz
- Stroke 5 µm to 4mm

Block on ring drive

- Range 360°
- Speed up to 7000 RPM

Interferometry Objectives						
	2.5X	5X	10X	20X	50X	100X
Numerical Aperture (NA)	0.075	0.13	0.3	0.4	0.55	0.7
Working Distance (mm)	10.3	9.3	7.4	4.7	3.4	2
FOV (um)	6910x5180	3460x2590	1730x1300	860x650	350x260	170x130
Spatial Sampling (um) SMP CCD	2.7	1.35	0.67	0.34	0.13	0.07
Optical Resolution (L&S 460 nm) (um)	1.87	1.08	0.47	0.35	0.26	0.20
Maximum Slope (arcsin(NA))	4	7	17	24	33	44
Vertical Resolution	Better than 0.01nm					
Vertical RMS repeatability RMS	0.01nm					
Vertical measurement range	Up to 10mm					

Confocal Platform									
	Standard Working Distance					Long Working Distance			
	5X	10X	20X	50X	100X	150X	20X	50X	100X
Numerical Aperture (NA)	0.15	0.3	0.45	0.8	0.9	0.95	0.4	0.6	0.8
Working Distance (mm)	23.5	17.5	4.5	1	1	0.3	19	11	4.5
Field of view (um)	3460x2590	1730x1300	860x650	350x260	170x130	120x90	860x650	350x260	170x130
Spatial Sampling SMP	1.35	0.67	0.34	0.13	0.07	0.04	0.34	0.13	0.07
Optical Resolution (L&S 460nm)(um)**	0.94	0.47	0.31	0.18	0.16	0.15	0.35	0.23	0.18
Maximum Slope (arcsin(NA))	9	17	27	53	64	72	24	37	53
Vertical Resolution (nm)	72.0	18.0	8.0	2.5	2	1.8	10.1	4.5	2.5
Confocal Frame Rate SMP/IMP	15/30 fps typical (>100 with binning)								
Typical Measurement Time (s)	<1s for 30 Confocal Slices								
Vertical Measurement Range (mm)	Up to 15 mm								

About us

Rtec-Instruments develops and manufactures advanced imaging and surface mechanical property measurement solutions for research and industrial applications. Based out of Silicon Valley, we are a leading provider of test instrumentation such as tribometer, optical profilometer, scratch tester, micro hardness tester etc.

We share a philosophy that embraces collaboration and partnering with customers and other leaders in academia and industry to ensure that our products answer real needs with innovative solutions. Our San Jose, California headquarter houses all research, development, manufacturing and factory support operations.

Other Products

Fretting Tester
3D Scratch and Indentation Tester
Universal Profilometer
High Temperature Indentation
CMP Polishers
Hot Hardness Tester
Air Jet Erosion Tester



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