

Friction, Wear, and Lubrication

Tribometers



Unique portfolio

Anton Paar develops, produces, distributes, and provides support for analytical instruments used in research, development, and quality control worldwide.

Our tribometer portfolio gives you the widest range of options available on the market

Under the previous brand name CSM Instruments, we've been designing and distributing tribometers for more than 35 years. Another high-quality choice is our MCR tribometer range, employing the EC measuring drive based on 20 years of experience. These instruments are used in research and high-end development applications.

Tribology is the science and technology of interacting surfaces in relative motion and of related subjects and practices. Tribology involves the study of friction, wear, and lubrication.

The force known as friction is defined as the resistance encountered by one body moving over another. Whenever two surfaces move against each other, wear will occur, causing damage to surfaces and progressive loss of material. In order to reduce this damage, thin layers of gas, liquids, and solids are applied between two surfaces to enable ideal motion. This is known as lubrication.

Biggest influencing factors

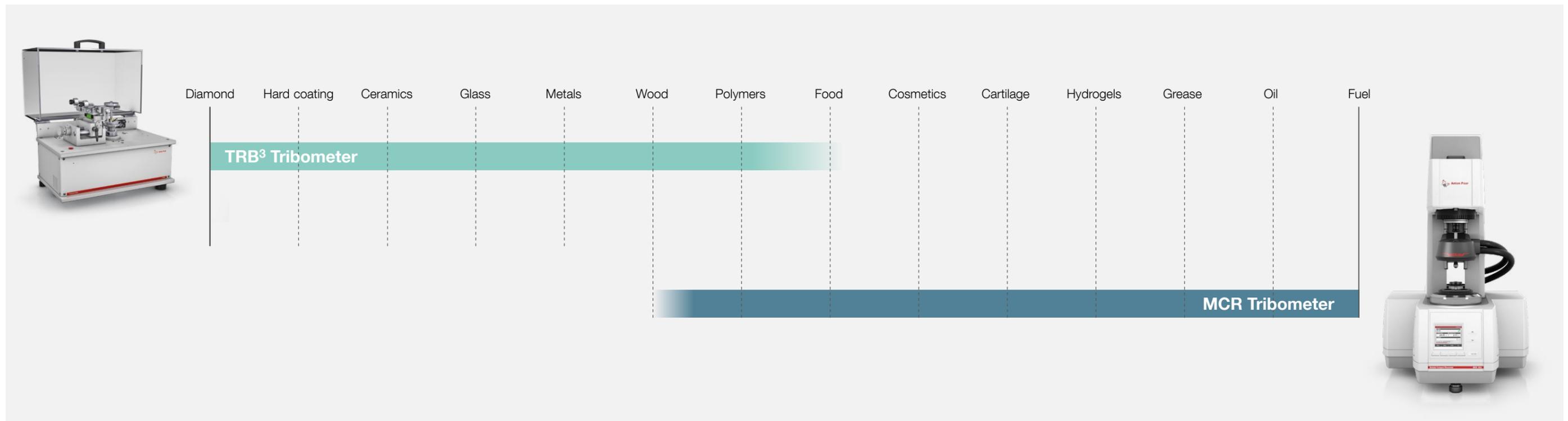
Knowledge and control of the materials' tribological behavior are essential before putting them into service. It's important to conduct tribology experiments and analyses under in-service conditions, as the materials' tribological properties are influenced by many external factors, such as:

- Contact pressure
- Movement mode
- Movement velocity
- Test duration
- Temperature
- Humidity
- Vacuum level
- Gaseous composition

... and many more

Our range of tribological testing solutions covers various experimental conditions.

It includes standard pin-on-disk models as well as tribometers for high temperatures, nanomaterials, humidity, and vacuum applications.



Tribology testing from Anton Paar

Anton Paar tribometers

Measuring principles

Our tribometers are unique instruments designed for high-precision measurements of the friction, wear, and lubrication behavior of various tribosystems. With both TRB³ tribometers and MCR tribometers, measurements can be carried out in dry or lubricated mode.

In a tribology test of a solid-solid contact with a TRB³ tribometer with or without lubricant, a static partner with a sphere, pin, or flat geometry is loaded onto a sample with a precisely known force. The static partner is mounted on a stiff cantilever designed as a precise frictionless force transducer, while the friction force is determined by measuring the deflection of the cantilever. The wear of the sample and static partner is calculated from the materials' volume lost during the test.

For MCR tribometers, typical contact geometries such as round-on-flat, flat-on-flat, and round-on-round are available, but also more complex scenarios like the testing for roller bearings can be realized. The controlled normal force is applied by the MCR drive moving up and down. The torque is controlled and measured by an EC motor, and the frictional force is calculated from the torque. Equipped with an air bearing, the MCR tribometer enables measurements over several decades of speed.

Customized solutions

Our tribometers are easily adapted to satisfy different customer testing needs. These customized solutions range from online wear depth measurement and online profilometry to electrical contact resistance, tribo-corrosion measurements, precise heating and cooling, liquid testing, and many more.

Motion modes

TRB³ tribometers feature rotating, linear reciprocating, and rotational reciprocating modes. In this way, the instruments can simulate different types of motion encountered in service. Moreover, measurement errors caused by mechanical misalignment between loading and rotating axes are cancelled out by the unique rotational reciprocating motion mode. Rotational as well as oscillatory motions can be realized on an MCR tribometer. Oscillatory measurements enable the evaluation of the complex behavior of tribosystems.

Tribology reference sample kit

With the tribology reference sample kit, the user can conduct a performance verification. TRB³ can measure accurately the coefficient of friction (CoF) with a standard deviation less than 0.0025. The unique design of TRB³ ensures this accuracy even for long-time measurements (e.g., more than one hour).

Environmental conditions

Our standard pin-on-disk tribometers are equipped with enclosures, so that controlled atmospheres of varying humidity and gas compositions can be maintained during the measurement. Dedicated humidity and vacuum chambers allow for state-of-the-art environmental control, while high and low temperature options are available to meet extreme testing conditions. MCR tribometers enable temperature control using either Peltier-based or electrical heating systems. These instruments can be extended with temperature devices (accessories) to apply a certain controlled atmosphere (gas and relative humidity).

International standards

Our TRB³ tribometer complies with the ASTM G99 and ASTM G133 standards.



Pin-on-disk tribometer (TRB³)

With over 1,000 installed bases worldwide over the last 35 years, our pin-on-disk tribometer is the standard for measurement of friction, wear, and lubrication. Its wide range of testing parameters, contact geometries, and add-on options allows users to conduct tribology testing by simulating all in-service conditions, such as different movement modes (rotating, linear reciprocating, and angular reciprocating), contact modes, speed, lubrication, materials, high temperature, humidity, etc.

Unique features:

- Two friction force sensors to minimize errors caused by thermal drift
- Independent normal load application and friction force measurement to avoid mutual influence between different force signals
- Integrated temperature and humidity sensors for real-time environment monitoring
- Easy friction force and rotation speed calibration
- Reference sample kit for easy performance verification of the tribometer by end users
- Integrated Python programming environment equipped with scripting function for data analysis and customized testing sequences
- Compliant with ASTM G99 and ASTM G133 standards



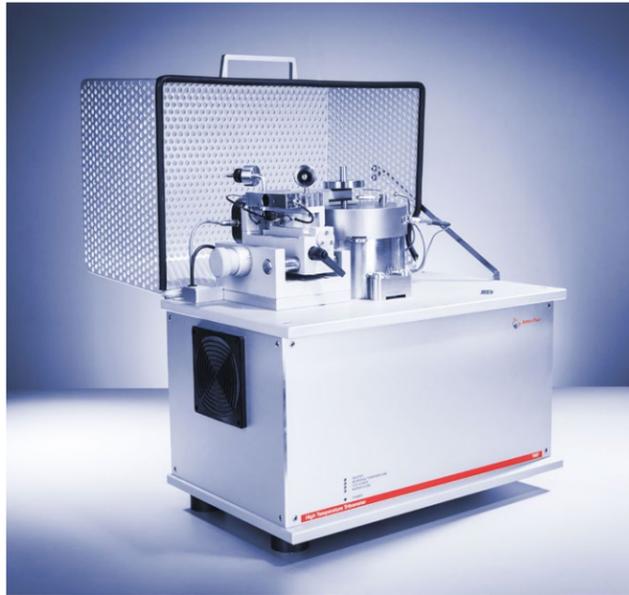
High-temperature tribometer (THT 800 °C)

The analysis of the materials' friction and wear properties at elevated temperature is becoming increasingly important, especially for the development and quality control of cutting tools, combustion engines, and power plants. To meet this requirement of material testing, we offer powerful high-temperature tribometers, which heat the sample homogeneously and accurately control sample temperature up to 800 °C to simulate the materials' in-service condition.

Unique features:

- Dual friction force sensors to minimize thermal drift error in friction measurement
- Circular heating element and water cooling system to allow for precise and homogeneous temperature control up to 800 °C
- Independent normal load application and friction force measurement design to avoid mutual influence between different force signals
- Highly linear and precise elastic arm for friction load measurement
- Compliant with ASTM G99 and ASTM G133 standards

Anton Paar tribometers



High-temperature tribometer (THT 1000 °C)

With its unique dual heating elements layout, THT 1000 °C brings high-temperature tribology testing to a new level of reliability and stability. Differential friction force measurement ensures negligible signal drift at extremely high temperatures. Careful design of the static partner and sample holders ensures trouble-free measurements for the user – even during tribology tests at 1000 °C.

Unique features:

- Dual friction force sensors to minimize thermal drift errors in friction measurement
- Top and circular heating elements combined with water cooling system to allow for precise and homogeneous temperature control up to 1000 °C
- Independent normal load application and friction force measurement design to avoid mutual influence between different force signals
- Highly linear and precise elastic arm for friction load measurement
- Compliant with ASTM G99, and ASTM G133 standards

Vacuum tribometer / vacuum high-temperature tribometer (TRB V/THT V)

Our vacuum tribometers are designed to provide precisely controlled vacuum levels down to 10^{-7} mbar or gaseous environments for friction and wear studies at room or high temperatures. The professional vacuum system allows the user to reach the required atmospheric condition in a well-controlled and reliable manner.

Unique features:

- Primary (10^{-3} mbar) or secondary (10^{-7} mbar) vacuum control
- Mixture of up to three kinds of gases with precise feedback control on pressure or on mass flow
- Independent normal load application and friction force measurement design to avoid mutual influence between different force signals
- Highly linear and precise elastic arm for friction load measurement
- Compliant with ASTM G99 and ASTM G133 standards



Specifications

	Standard tribometer (TRB ³)	High temperature tribometer (THT)
Normal force range	Up to 60 N	Up to 60 N
Normal force resolution	- (Dead weight)	- (Dead weight)
Friction force range	Up to 20 N (5 N option)	Up to 10 N (20 N option)
Friction force resolution	0.06 mN (0.015 mN option)	0.03 mN
Rotating movement		
Speed	0.2 rpm to 2000 rpm	0.3 rpm to 600 rpm (1500 rpm option)
Radius	Up to 40 mm	0.5 mm to 35 mm
Maximum torque	450 mN.m	450 mN.m
Linear reciprocating movement¹⁾		
Stroke length	Up to 60 mm	-
Speed	Up to 370 mm/s	-
Frequency	0.01 Hz to 10 Hz	-
Rotational reciprocating movement²⁾		
Speed	0.2 rpm to 2000 rpm	0.3 rpm to 600 rpm (1500 rpm option)
Frequency	0.01 Hz to 7 Hz	0.01 Hz to 7 Hz
Angular amplitude	$\pm 5^\circ$ to $\pm 150^\circ$	$\pm 10^\circ$ to $\pm 150^\circ$
Angular resolution	0.1°	0.1°
Options		
Online wear depth	-2 mm to 2 mm	Up to 1.2 mm
Heating capability	Up to 450 °C in dry condition Up to 150 °C in liquid condition	Up to 1000 °C
Electrical contact resistance	Up to 1000 Ohms	Up to 1000 Ohms
Vacuum level	Down to 10^{-7} mbar	Down to 10^{-7} mbar
Relative humidity level	15 % to 95 % ³⁾	-

1) Linear reciprocating movement specifications depend on the combination of stroke length, frequency, and mass on the stage.

2) Rotational reciprocating movement specifications depend on the combination of angular amplitude, frequency, and mass on the stage.

3) For humidity-controlled tribometers, customized solutions can be offered.

Software features:

- Continuous real-time data acquisition of friction signal during measurement
- Programmable incremental speed and normal force in one measurement
- User-defined testing sequences in one measurement
- Statistics mode for measurement data analysis
- Adjustable data acquisition rate up to 400 Hz for recording frictional phenomena with high fidelity
- Hertzian stress modeling software: better testing parameter selection for tribological analysis
- Multi-cycle angular reciprocating mode to cancel errors due to misalignment between normal load and sample rotating axes
- Friction force and friction coefficient threshold auto-protection
- Automatic calibration procedure for friction force, rotating speed, and measurement radius
- Automatic generation of reports for a set of measurements

Anton Paar tribometers



MCR tribometer: An evolution in tribological testing

Employ the precise motion and normal force control of MCR tribometers for your tribological measurements. Expand your traditional tribological tests by opening up entirely new measuring ranges on one single instrument. MCR tribometers come with numerous test setups and contact geometries to suit your requirements. Benefit from our decades of experience in precision instrumentation.

Unique features:

- Seamlessly measure breakaway forces as well as static and limiting friction of dry and lubricated contacts
- Plot Stribeck curves over nine decades of sliding speeds – few nanometers per second to 3.3 meters per second
- For food and beverages, lubes and greases, polymers, ophthalmics, biomedicine, etc.
- Full benefits of the extended atmosphere control
- Temperature range between -160 °C and +600 °C
- Humidity control 5 % to 95 %
- In addition to the existing setups, there's always scope for customization to perfectly suit your application



Ball-on-three-plates: (or T-PTD200) Full motion flexibility and precision

The ball-on-three-plates setup is a well-established method for measuring both lubricated as well as dry tribological systems. Different measuring geometries (plates, cylinders) are available and can be adapted to specific sample needs.

The heart of this setup is the T-PTD 200 tribology cell which ensures precise alignment and therefore a homogeneous distribution of normal forces on the measured specimen.

Unique features:

- Nine decades of sliding speeds – from a few nanometers per second to 3.3 meters per second
- Contact pressure of a few kPa to 1.2 GPa
- Broad range of applications – from food and beverages to lubricants and greases, metalworking, fluids, etc.
- Wide range of specimen and holders catering to individual applications
- The Peltier heating system allows excellent temperature control from -40 °C up to +200 °C



Ball-on-three-plates: (or T-BTP) Extended atmosphere control

This setup allows for measurements in a temperature range from -160 °C to +600 °C or with a relative humidity between 5 % and 95 %. Normal forces as low as 0.1 N can be applied. The stiffness of the measuring system can be adjusted by the patented spring system that transfers the normal forces applied in a vertical direction (Pat. No. AT514726A1).

Unique features:

- Enjoy complete motion and force ranges of the MCR tribometer with added low-force sensitivity
- Enjoy the advantages of the Convection Temperature Device (CTD) for tribological measurements
- Temperature range between -160 °C and +600 °C
- Humidity control 5 % to 95 %
- Spring stiffness adjustable in z-direction offering excellent damping characteristics



Pin-on-disk (or T-PID/44)

The T-PID/44 allows for round-on-flat, flat-on-flat, or line contacts in dry and lubricated conditions. The spring stiffness can be adjusted in the z-direction, which enables optimal damping characteristics. Various specimen materials can be fixed in the upper and lower holder allowing a broad range of applications.

Unique features:

- Contact geometries ranging from flat-on-flat contact to point contact, abrasive contact, line contact, etc.
- Temperature range between -30 °C and +210 °C
- Diverse applications: asphalt, lubes and greases, cosmetics, food and beverages, ice, cartilage, bio-medicine, etc.
- Make use of the flat-on-flat contact geometry for low contact pressure applications
- Possibility to adapt the setup to accommodate a ring-on-disc test configuration

Specifications

MCR tribometer

Temperature control technology	Peltier		Electrical
Measuring cell	T-PTD 200	T-PID/44	T-BTP
Environmental conditions			
Temperature range	-40 °C to +200 °C	-30 °C to +210 °C	-20 °C to +180 °C
Relative humidity level	-	-	5 % to 95 %
Contact conditions			
Normal force range	1 N to 50 N	1 N to 50 N	0.1 N to 70 N
Normal force resolution	0.005 N		
Contact type	Point, Bearing	Point, Line, Flat	Point
Motion conditions			
Continuous rotation			
Speed range	10 ⁻⁶ rpm to 3000 rpm	10 ⁻⁶ rpm to 1000 rpm	10 ⁻⁶ rpm to 3000 rpm
Sliding speed range	10 ⁻⁸ m/s to 3.3 m/s	10 ⁻⁸ m/s to 2.3 m/s	10 ⁻⁸ m/s to 1.4 m/s
Torque range [*]	1 nNm to 300 mNm		
Torque resolution [*]	0.1 nNm		
Oscillatory rotation			
Frequency	10 ⁻⁷ Hz to 100 Hz		
Angular amplitude	1 μrad to ∞ μrad		
Angular resolution	10 nrad		
Additional parameters			
Min. online wear depth	0.65 μm		

^{*)} The friction force range and the friction force resolution depend on the measuring geometry.

MCR tribometer software features:

- Easily set and control tribological measures such as normal force, breakaway torque, speed, deflection, temperature, humidity (optional), etc.
- Enjoy the predefined test-templates for Stribeck tests, static friction tests, wear tests, etc.
- Measurements are clearly defined in individual action blocks
- Use the test designer to guide you through the definition of your own experiment
- Combine several measurement actions with the advantage of comfortable data structure
- Create multi-axis graphs to display the data the way you want
- Run post-test analysis of data and create individual analysis routines
- Automatically export data and reports at the end of the test



“ We're confident in the high quality of our instruments. That's why we provide **full warranty for three years.** ”

All new instruments* include repair for three years. You avoid unforeseen costs and can always rely on your instrument. Alongside the warranty we offer a wide range of additional services and maintenance options.

*Due to the technology they use, some instruments require maintenance according to a maintenance schedule. Complying with the maintenance schedule is a prerequisite for the three-year warranty.

Service and support directly from the manufacturer

Our comprehensive service provides you with the best individual coverage for your investment. You benefit from:



MAXIMUM UPTIME: Regardless of how intensively you use your instrument, we help you keep your device in good shape and safeguard your investment – including a three-year warranty.



THE SHORTEST RESPONSE TIME: We provide a response to your inquiry within 24 hours – from real people, not from bots.



CERTIFIED SERVICE ENGINEERS: The seamless and thorough training of our technical experts, as well as their certification, are carried out at our own facilities.



A GLOBAL SERVICE NETWORK: It spans 86 locations with a total of 350 certified service engineers. Wherever you're located, there is always an Anton Paar service engineer nearby.

