The Tribometer provides highly accurate and repeatable wear and friction testing compliant to ISO and ASTM standards. Designed, at the core, with a self-tuned high quality motor with a 20bit internal speed and a 16bit external position (>0.006°) encoder, the Tribometer provides an unmatched range of rotational speeds from 0.01 to 5000rpm. Because of the quick feedback control, these speeds can be changed almost instantly in either a stepwise jump or at a continuous rate. This is specifically useful to obtain continuous Strubeck curves or to study static coefficient behaviors. Contrary to systems that use a torque sensor, the Nanovea Tribometer uses a high precision load cell that measures accurately and separately friction forces. The Tribometer can be provided with a full range of environment modules to meet the requirements of specific applications. To precisely measure wear track volume and calculate wear rates in situ, a 3D non-contact optical profiler module allows calculation of the total wear volume of the entire track. Because wear tests can be of long durations, a dedicated Tribometer is an essential part of any tribology research laboratory. The robust high quality open design of the Nanovea Tribometers ensures longevity with low cost of ownership.
The T50 Tribometer is designed for loads from 100mN to 60N. All Nanovea Tribometers are equipped with a solid coated 20mm steel plate attached to the main rotating shaft supported by high quality bearings for maximum stiffness, smooth rotation and longevity of use. A state of the art motor equipped with a 20bit internal speed and a 16bit external position (>0.006°) encoder provides an unmatched range of rotational speeds from 0.01 to 5000rpm. Friction is directly measured independently using an accurate load cell that is easy and quick to calibrate. All Nanovea load cells are compensated in temperature which ensures accuracy when the high temperature oven is used. All Nanovea Tribometers are designed and equipped with an integrated heat sink part of the main shaft. This allows cooling using only air when the high temperature module is used. Block on ring is an additional configuration to the standard Rotative module. Nano Wear and friction option is also available at Nanovea for loads down in the micron range.

**MODULE OPTIONS**

- **Rotative**
  - Temperature
  - Corrosion or Liquid
  - 3D or 2D In Situ Wear Rate

- **Linear**
  - Spacious, open & durable platform
  - Removable enclosure with environment control options
  - Precision load cell
  - Automatic X table control
  - LVDT or optical profiler depth sensing

- **60 x 39 x 62cm**
  - In-situ optical profiler integration
  - Pin, ball or flat holder
  - Rotative or linear with optional temperature or liquid modules
  - Low friction bearing

- **Precision motor**

---

**T50**
The T500 Tribometer is designed with an advanced motor equipped with a 20bit internal speed and a 16bit external position (>0.006°) encoder which provides an unmatched range of rotational speeds from 0.01 to 5000rpm. In addition, it provides very high torque capability up 18 N*m for speed of 0.01 to 1500rpm and up to 9N.m at higher speeds. With the high loads of up to 500N and extremely slow moving speeds, the T500 can be used to measure static coefficient of friction at high contact pressures. Superior to torque measuring systems because of higher accuracy, friction is measured directly with a separate load cell in contact with the continuous stiff arm. As it is for all Nanovea Tribometers, the system is equipped with an X motorized table used to change the radius automatically before the test or during the test for zigzag or spiral tests. The quick feedback control on speed allows constant linear speed during spiral tests to be achieved. Block on Ring, Ring on Ring and 4Ball Testing are additional configurations to the standard Rotative module.

### MODULE OPTIONS

- **Rotative**
  - Spacious, open & durable platform
  - Strengthened removable enclosure with environment control options
  - Precision load cell
  - Pin, ball or flat holder
  - Low friction bearing with high load capacity
  - LVDT or optical profiler depth sensing
  - In-situ optical profiler integration
  - Automatic X table control
  - Emergency shut off
  - Precision motor
  - Rotative or linear with optional temperature or liquid modules
  - Testing shield
  - Solid steel arm construction with low friction pivot bearings
  - 94 x 94 x 50cm
  - Low friction bearing with high load capacity
  - 3D or 2D In Situ Wear Rate
  - In-situ optical profiler integration

- **Linear**
  - Precision motor
  - Vibration isolation feet or floor mounting
  - Pin, ball or flat holder
  - Low friction bearing with high load capacity
  - LVDT or optical profiler depth sensing
  - In-situ optical profiler integration
  - Automatic X table control
  - Emergency shut off
  - Precision motor
  - Rotative or linear with optional temperature or liquid modules
  - Testing shield
  - Solid steel arm construction with low friction pivot bearings
  - 94 x 94 x 50cm
  - Low friction bearing with high load capacity
  - 3D or 2D In Situ Wear Rate
  - In-situ optical profiler integration

- **Temperature**
  - Precision motor
  - Vibration isolation feet or floor mounting
  - Pin, ball or flat holder
  - Low friction bearing with high load capacity
  - LVDT or optical profiler depth sensing
  - In-situ optical profiler integration
  - Automatic X table control
  - Emergency shut off
  - Precision motor
  - Rotative or linear with optional temperature or liquid modules
  - Testing shield
  - Solid steel arm construction with low friction pivot bearings
  - 94 x 94 x 50cm
  - Low friction bearing with high load capacity
  - 3D or 2D In Situ Wear Rate
  - In-situ optical profiler integration

- **Liquid**
  - Precision motor
  - Vibration isolation feet or floor mounting
  - Pin, ball or flat holder
  - Low friction bearing with high load capacity
  - LVDT or optical profiler depth sensing
  - In-situ optical profiler integration
  - Automatic X table control
  - Emergency shut off
  - Precision motor
  - Rotative or linear with optional temperature or liquid modules
  - Testing shield
  - Solid steel arm construction with low friction pivot bearings
  - 94 x 94 x 50cm
  - Low friction bearing with high load capacity
  - 3D or 2D In Situ Wear Rate
  - In-situ optical profiler integration
3D or 2D Optical Profiler | A full non-contact optical profiler can be integrated on the Tribometer platform to precisely measure the wear track. In 2D, rapid scans allow for accurate calculation of wear rates from as many 2D profiles as requested distributed across the full wear track. During a single test, it is possible to stop temporarily the test at different times to obtain the wear rate versus wear time. In 3D, the full volume of the wear track can be obtained for the most accurate wear rate calculation. This 3D image also allows more in-depth study of the wear process. The profiler, which has extended capability, can also be used for roughness, dimensions and many other surface topography studies. For more information on the advantage of the technique use, please consult documents from our 3D Non-Contact Profilometer line. Additionally, a flexible mobile zoom imaging capture can be moved by hand to conveniently allow zoom-in microscope capability while recording for play back review. This feature is especially useful for later review of surface wear. Zoom from 5x to 200x is available.
Rotative wear friction test reproduces the rotational motion found in many real-world tribology mechanisms. A flat, pin or ball tip is loaded onto a test sample with a precise weight and at a specific position from the center of rotation. As the sample starts rotating, the tip creates a rotational wear track. Friction coefficient is accurately measured by the deflection of a load cell, precisely calibrated. Because of the integrated 16bit external position encoder, friction can be displayed for any specific position or zone for each cycle pass. Additionally, the internal 20bit speed encoder ensures smooth or quick changes of speed of rotation from 0.01 to 5000rpm during a single test providing accurate friction coefficient versus speed. The speeds down to 0.01rpm are essential to study friction in the static zone and to better understand the transition between static and kinetic coefficient of friction. Wear rates for the sample can be calculated from 2D profile at chosen positions or from the actual full 3D profile of the entire wear track. A spiral test can be performed with constant linear speed (changing rotative speed) at any point for comparable friction data across the full length of the test.

**Standards:**
- ASTM G99
- DIN 50324
- ASTM D3702
- ASTM D2266
- ASTM D4172
- ASTM G132

**Properties Analyzed During Rotative Wear Friction Test:**
- Friction Coefficient
- Wear Rates
- Failure Points
- Electrical Resistance
- Lubrication & Corrosion Studies
- Friction vs Speed
- Stribeck Curve
- Scratch Hardness
- Static Coefficient of friction and many others

**Rotative Wear Friction Test Software Features:**
- Continuous Stribeck Curve
- Export Raw Data and Images
- Real Time Display
- Automatic Reporting
- Multi-Language Support
- Scratch Hardness Calculation
- Macros with variation of speed
- Spiral Test at constant linear speed
- Fixed Cycle View
- 360° Cycle Compare View
- Automatic Wear Calculation
- Semi-Linear (microns or degree)
- Variable Speed Control during Test and many others

**Tips:** (Diamond, WC, Rubber and many other materials)
- 3, 6, 10 and 25mm ball
- Custom ball sizes
- Custom Pins
- Flat Plate
- Custom geometries

**Environmental Conditions:**
- Fully Removable 1200°C Oven
- Cooling down to -150°C
- Liquid Cup & Liquid Heating to 150°C
- Lubrication Drop by Drop
- Humidity Control
- Various Gases
- Vacuum

**Sample(s) Holders:**
- Standard Clamp
- Clip Mounting on Base Plate
- Custom Holders for varied geometries
Linear wear friction test reproduces the linear reciprocating motion found in many real-world tribology mechanisms. A flat, pin or ball tip is loaded onto a test sample with a precise weight. The test samples can be of varied shape (such as cylindrical) as long as there is a flat zone of a certain length in the direction of movement. The length of the track can be adjusted prior to the start of measurement. As the test starts, the tip creates a linear wear track (zigzag pattern also possible). Friction coefficient is accurately measured during the test by the deflection of, the easy and quick to calibrate, load cell. Friction forces are recorded for both forward and backward movements of the stroke. The velocity of movement follows a sine wave with maximum speed in the middle of the track. Friction therefore will vary at each position across the track according to the velocity and direction of movement. Because of the integrated 16bit external position encoder, friction can be displayed for any specific point for each pass. This is essential to accurately study the trend of friction across the full length of the test. Wear rates for the tip and the sample are calculated from the volume of material lost.

**Standards:**
- ASTM G133 • ASTM G171 • ASTM F732

**Properties Analyzed During Linear Wear Friction Test:**
- Friction Coefficient • Wear Rates • Failure Points • Electrical Resistance
- Lubrication & Corrosion Studies • Friction vs Speed • Scratch Hardness and many others

**Linear Wear Friction Test Software Features:**
- Export Raw Data and Images • Real Time Display • Automatic Reporting
- Multi-Language Support • Macros with variation of speed • Fixed Cycle View
- Cycle Compare View • Scratch Hardness Calculation • Automatic Wear Calculation • Variable Speed Control • 3D or 2D In-situ Wear Analysis and many others

**Tips:** (Diamond, WC, Rubber and many other materials)
- 3, 6, 10 and 25mm ball • Custom ball sizes • Custom Pins • Flat Plate • Custom geometries

**Environmental Conditions:**
- 450°C Heating Oven • Liquid Cup and Liquid Heating up to 150 °C
- Lubrication Drop by Drop • Humidity Control • Cooling Chamber -40 °C
- Corrosion Testing Cup • Various Gases • Vacuum

**Sample(s) Holders**
- Standard Clamp • Clip Mounting on Base Plate • Other Sample Holders available for varied geometries
Temperature plays a critical role on the extent of wear damage to materials. The Nanovea Tribometer conducts wear experiments at elevated temperatures up to 1200°C for the rotative test and up to 450°C for the linear test. The contact of the wear process is totally enclosed in a large oven which ensures uniform and stable temperature surrounding the sample and the counter material during the wear test. The thermal couple is either set up to be very close to the point of contact or directly touching the back on the ball inside the ball holder to achieve the best accuracy of the temperature reading. The removable oven allows users to perform other types of testing by adding supplementary modules. The unique heat sink design on the main shaft of the rotative motor makes air supply sufficient for cooling electronics in the bottom enclosure during the wear test. The load cell is self calibrated for high temperatures to ensure accurate data. A cooling Unit and chamber allows test down to -40°C allowing the complete range of conditions for applications such as tire rubber or other parts either subjected to colder temperatures.

**Standards:**
- ASTM G99 - ASTM G133

**Properties Analyzed During Temperature Wear:**
- Wear Rates - Friction Coefficient - Temperature Wear Behavior

**Software Controls During Temperature Wear:**
- Wear & Friction at Different Temperatures - Variable Speed Control during Test and many others

**Environment Controls During Temperature Wear:**
- Different Atmosphere (Air, N2, Inert Gas etc.) - Various Temperature

**Tips:** (Diamond, WC, Al2O3 and many other materials)
- 3, 6, 10 and 25mm ball - Custom ball sizes - Custom Pins - Flat Plate - Custom geometries

**Sample(s) Holders:**
- Standard Clamp - Clip Mounting on Base Plate - Other Sample Holders available for varied geometries

Sample and pin completely enclosed in the oven

Evolution of wear track depth at different temperatures

Scratch Hardness evaluation at different temperatures and Wear Rate comparison at different temperatures
Nanovea Tribometer provides the liquid/lubricant linear and rotative cup modules to carry out wear and friction experiments in liquids or lubricants. Different liquid solutions can be used to simulate the wear process for realistic applications. The wear and friction of materials in liquids or lubricants is critical for various industrial applications. For example, the biomaterials for biological replacements such as joints, stents and dental roots, require excellent long term resistance and adequate strength in a liquid environment. The parts in the motor engines should be protected by proper lubrication to reduce wear and friction and extend lifespan. During the wear test, the evolution of coefficient of friction provides insight in different stages of the wear development. Combining with the precise control of speed and continuous change of speed, a continual Stribeck Curve for the test lubricant can be measured. A liquid heating coil is available to heat the liquid in the cups up to 150°C. An accessory to the cup is the drop by drop lubrication option which allows lubrication test even at very fast rotation speed of 5000rpm.

**Standards:**
- ASTM G99 - ASTM G133

**Properties Analyzed During Liquid Wear:**
- Wear Rates • Coefficient of Friction • Friction versus speed • Stribeck Curve
- Coefficient of friction or wear versus temperature

**Software Controls During Liquid Wear:**
- Variable Speed Control during Test

**Environment Controls During Liquid Wear:**
- Various Solutions to Simulate Realistic Applications

**Tips:** (Steel, Diamond, WC, Al2O3 and many other materials)
- 3, 6, 10 and 25mm ball • Custom ball sizes • Custom Pins • Flat Plate • Custom geometries

**Sample(s) Holders:**
- Standard Clamp • Clip Mounting on Liquid Cup • Other Sample Holders available for varied geometries

Evolution of coefficient (COF) of friction at different stages of wear and COF of different polymers in liquid conditions.
Tribocorrosion is a surface degradation process resulting from simultaneous tribological and electrochemical actions in a corrosive environment. Tribocorrosion test conducts wear and corrosion experiments simultaneously using a sliding ball-on-plate configuration, where the contact of the wear process is totally immersed in the test electrolyte. The tribocorrosion module is a three-terminal electrochemical cell installed on the sample stage, with the sample, a platinum wire and a Ag/AgCl, NaCl (sat’d) electrode acting as working, counter and reference electrodes, respectively. The open circuit potential (OCP) is measured in situ to monitor the evolution of the tribocorrosion process. The reduction of OCP works as an indicator for the failure of the protective films. The change of coefficient of friction (COF) also provides insight in different stages of the wear development. The wear tests can also be carried out under anodic or cathodic polarization conditions to either accelerate or inhibit the corrosion process, in order to investigate the effect of corrosion reactions on the tribocorrosion rate.

**Standards:**
- ASTM G133

**Properties Analyzed During Tribocorrosion:**
- Wear Rates  
- Friction Coefficient  
- Corrosion Resistance  
- Tribocorrosion Behavior

**Software Controls During Tribocorrosion:**
- Wear at Open Circuit Potential  
- Wear at Anodic/Cathodic Potential  
- Electrochemical Impedance Spectroscopy Analysis  
- Potentiodynamic Polarization  
- Variable Speed Control during Test and many others

**Environment Controls During Tribocorrosion:**
- Various Solution to Simulate Realistic Applications  
- Accelerated/Decelerated Corrosion Rate

**Tips: (Steel and other conductive materials)**
- 3, 6, 10 and 25mm ball  
- Custom ball sizes  
- Custom Pins  
- Flat Plate  
- Custom geometries

**Sample(s) Holders:**
- Standard Clamp  
- Clip Mounting on the Tribocorrosion Cell  
- Other Sample Holders Available for Varied Geometries

**Open circuit potential, anodic and cathodic potential**

**Wear tracks after dry/corrosive wear and Electrochemical Impedance Spectroscopy (EIS) analysis**
**BASE**

<table>
<thead>
<tr>
<th>Feature</th>
<th>T50</th>
<th>T500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min/Max Load</td>
<td>100mN - 60N</td>
<td>1N - 200N</td>
</tr>
<tr>
<td>Frictional Force Maximum</td>
<td>+/-20N</td>
<td>0.001mN (24Bit)</td>
</tr>
<tr>
<td>Motor Max Torque up to 1500rpm</td>
<td>1.27 Nm</td>
<td>0.6 Nm</td>
</tr>
<tr>
<td>Intermittent Max Torque up to 1500rpm</td>
<td>4.4 Nm</td>
<td>14.0Nm</td>
</tr>
<tr>
<td>20Bit Speed and 16bit Position Encoders</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>Instrument Dimension (Table top)</td>
<td>60 x 39 x 62cm</td>
<td>94 x 95 x 58cm</td>
</tr>
<tr>
<td>Weight</td>
<td>=67Kg</td>
<td>=185Kg</td>
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</table>

**ROTATIVE**

<table>
<thead>
<tr>
<th>Feature</th>
<th>T50</th>
<th>T500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Rotational Speed</td>
<td>2000</td>
<td>5000rpm</td>
</tr>
<tr>
<td>Min Rotational Speed</td>
<td>0.01</td>
<td>0.05rpm</td>
</tr>
<tr>
<td>Speed Acceleration (0 to 1000rpm)</td>
<td>0.06</td>
<td>0.45s</td>
</tr>
<tr>
<td>Disk Size (Mounting Area)</td>
<td>100mm</td>
<td>100mm</td>
</tr>
<tr>
<td>Optional Geometries</td>
<td>Block on Ring</td>
<td>Block on Ring, 4Ball Testing, Ring on Ring</td>
</tr>
</tbody>
</table>

**LINEAR**

<table>
<thead>
<tr>
<th>Feature</th>
<th>T50</th>
<th>T500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Stroke Range</td>
<td>25mm</td>
<td>25mm</td>
</tr>
<tr>
<td>Maximum Frequency (Up to 5mm stroke)</td>
<td>40</td>
<td>60Hz</td>
</tr>
<tr>
<td>Mounting Area</td>
<td>62 x 76mm</td>
<td>62 x 76mm</td>
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</table>

**TEMPERATURE**

<table>
<thead>
<tr>
<th>Feature</th>
<th>T50</th>
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</tr>
</thead>
<tbody>
<tr>
<td>High Temp Oven</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounting Area</td>
<td>78cm²</td>
<td>78cm²</td>
</tr>
<tr>
<td>Rotative Ball/Sample Temperature</td>
<td>1200°C (2122°F)</td>
<td>1200°C (2122°F)</td>
</tr>
<tr>
<td>Linear Ball/Sample Temperature</td>
<td>450°C (842°F)</td>
<td>450°C (842°F)</td>
</tr>
<tr>
<td>Cold Temp Enclosure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold Air Temperature Enclosure</td>
<td>-10°C (14°F) to room temperature</td>
<td>-10°C (14°F) to room temperature</td>
</tr>
<tr>
<td>Cold/Hot Air Temperature Enclosure</td>
<td>-40°C (-40°F) to 225°C (437°F)</td>
<td>-40°C (-40°F) to 225°C (437°F)</td>
</tr>
<tr>
<td>Cryogenic Module (Liquid Nitrogen)</td>
<td>-150°C (-238°F)</td>
<td>-150°C (-238°F)</td>
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**LIQUID**

<table>
<thead>
<tr>
<th>Feature</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Linear Liquid Cup (Mounting Area)</td>
<td>80 x 45 x 25mm</td>
<td>80 x 45 x 25mm</td>
</tr>
<tr>
<td>Rotative Liquid Cup (Mounting Area dia.)</td>
<td>78 x 25</td>
<td>100 x 30mm</td>
</tr>
<tr>
<td>Drop by Drop (With or w/o outflow)</td>
<td>Available</td>
<td>Available</td>
</tr>
<tr>
<td>Liquid Heating</td>
<td>room to 150°C (300°F)</td>
<td>room to 150°C (300°F)</td>
</tr>
<tr>
<td>Humidity Control</td>
<td>10 - 95% RH</td>
<td>10 - 95% RH</td>
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**CORROSION**

<table>
<thead>
<tr>
<th>Feature</th>
<th>T50</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Maximum Sample Size (dia.)</td>
<td>50 mm thick</td>
<td>50 x 8mm thick</td>
</tr>
<tr>
<td>Open Circuit and Anodic/Cathodic Potential</td>
<td>Available</td>
<td>Available</td>
</tr>
<tr>
<td>Electrochemical Impedance Spectroscopy</td>
<td>Available</td>
<td>Available</td>
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</table>

**VACUUM**

<table>
<thead>
<tr>
<th>Feature</th>
<th>T50</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Levels</td>
<td>&lt;10^{-7} Torr</td>
<td>&lt;10^{-7} Torr</td>
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</tbody>
</table>

**IN-SITU 3D PROFILER**

<table>
<thead>
<tr>
<th>Feature</th>
<th>T50</th>
<th>T500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Height</td>
<td>100μm</td>
<td>100μm</td>
</tr>
<tr>
<td>Max Scan Range (Diameter circle)</td>
<td>100nm</td>
<td>100nm</td>
</tr>
</tbody>
</table>

---

*Nano loads with Nanovea Mechanical Tester (Nano module) apply sub mN up to 4N **Specifications continuously improving, please contact Nanovea for latest.*
Firmly aligned with our vision, Nanovea aims to simplify advanced measurement technologies to stimulate materials engineering for the common good. Ease of use, advanced automation and the dedication to superior accuracy are the driving forces behind its full range of precision instruments. As a Trusted Quality Manufacturer, our Profilometers, Mechanical Testers & Tribometers can be found internationally in distinguished educational and industrial organizations ranging from automotive to cosmetic, biotechnology to medical devices and from microelectronics to space applications. Thousands of clients rely on our accurate & honest solutions, superior instruments and experienced laboratory and consulting services.

The Profilometers are designed with leading edge Chromatic Confocal optical technology (axial chromatism) both ISO and ASTM compliant. Only Nanovea's Nano and Micro module on the Mechanical Testers have all modes of testing including indentation, scratch and wear; no interchange of modules needed. In order to give accurate and repeatable data, the Nanovea modules are designed with high quality leading edge technologies. This ensures durability with low cost of use. While the Tribometer provides highly accurate and repeatable wear and friction testing compliant to ISO and ASTM standards. Designed, at the core, with a self-tuned high quality motor with a 20bit internal speed and a 16bit external position (>0.006°) encoder, the Tribometer provides an unmatched range of rotational speeds from 0.01 to 5000rpm.