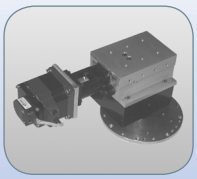
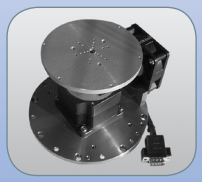




CETR-UMT

- Comprehensive Materials Testing for Mechanical and Tribological Properties

Innovation with Integrity

Tribology and Mechanical Testing

Universal Nano, Micro, and Macro Materials Testers

One Precision Platform with Easily Interchangeable Modules

Applications

- Automotive, Aerospace
- Microelectronics
- Electric Contacts
- Metals, Ceramics
- Bio Materials, Medical
- MEMs, Optics
- Flexible & Hard Media
- Composite Materials
- Lubricants, Additives
- Thin Films, Coatings
- Polymers, Elastomers
- Paper, Fabric

Hardware			
Lower Specimen		**Upper Specimen**	**Data Acquisition**
X-Y Translation	Vacuum Chamber	X Y Z Translation	16 Sensor Inputs
Horizontal & Vertical Rotation	Thermal Control	Rotation	16 Bit Resolution
Fast Oscillations	Humidity Control		200 kHz Data Rate

The Universal Nano+Micro+Macro Tester platform comes in three main configurations:

UNMT-1

For comprehensive nano- and micro-mechanical tests of thin films and nano-structured materials, with a load range of 1 µm to 10 N.

UMT-2

For comprehensive **micro-**mechanical tests of coatings and materials, with a load range of 1 mN to 200 N.

UMT-3

For comprehensive **macro-**mechanical tests of lubricants, metal and ceramic materials, with a load range of 0.1 N to 1 kN.

Parameters Monitored
X, Y, Z Forces
X, Y, Z, Q Positions
X, Y, Z Torques
Wear Depth & Rate, N
Acoustic Emmision
Temperature
Humidity
Electrical Capacitance
Electrical Resistance
Optical Images, Digital Video

Functional Testing

- Scratch
  - Adhesion
  - Delamination
  - Hardness
- Wear
  - Rotary
  - Linear
  - Reciprocating
  - Abrasive
  - Fretting
  - Galling
  - Seizure
- Indentation
  - Young's Modulus
  - Storage Modulus
  - Hardness
- Adhesion
  - Pull-up
  - Striction
  - Scratch
- Friction
  - Static
  - Dynamic
  - Stick-slip
- Fatigue
  - Multi-axis
  - Tension
  - Compression
  - Torsion
- Environmental
  - Temperature
  - Humidity
  - Reciprocating
  - Abrasive
  - Fretting
- Lubricity
  - Hydrodynamics
  - Mixed
  - Boundary
- Strain
  - Elasticity
  - Plasticity
  - Creep

Software		
Data Monitor Recording	**Motion Control**	**Data Presentation**
Real-Time Scope Mode	Programmable Velocities & Positions	Data Analysis
Progammable Filtering	Forces & Torques	Data Statistics
	Synchronized Motions	Charts
		Format Conversions

Technical Highlights

Multiple Tests on nano, micro and macro scales:

- Static and dynamic friction
- Ultra-low-speed (0.1 micro/s) stick-slip
- Adhesive, abrasive and scratching wear
- Pull-off adhesion/striction
- Scratch-adhesion and delamination
- Indentation, hardness and elastic modulus
- Multi-cycle, multi-axis fatigue
- Strain, elasticity, plasticity and creep
- Compression, tension and torsion
- Three-point bending

Multiple Sensors for in situ test monitoring:

- Ultra-precision force sensors of the proprietary technology and patented design (1 μN to 1 kN)
- 6-D sensors for simultaneous measurements of 3 forces and 3 torques in all X, Y and Z axes
- High-frequency acoustic emission sensors of the proprietary design, ultra-sensitive to tiniest cracks and wear
- Wear and deformation sensors of micro (0.5 micron) and nano (20 nm) resolution
- Contact and surface electrical resistance (nOhms to MOhms) for detection of film failure or buildup
- Temperature and humidity sensors
- Integrated vision system for micro-positioning and digital video of the failure dynamics
- Integrated AFM for periodic nano-imaging of test surfaces, wear tracks, indents and scratches

Precision Servo-Control of loads, speeds, and positions for uniquely reproducible data and highly productive tests, e.g., repeatable different loads on different specimen areas for multi-test results from single tests

Multiple Synchronized linear and rotary motions of upper and lower specimens in all X, Y, and Z axes, including oscillations (up to 60 Hz), for sophisticated multi-axis tests, e.g., with spiral, zigzag or butterfly scratch/wear tracks

Multiple Chambers with computer-controlled temperature (–25 to 1000°C), humidity (10 to 95% RH),vacuum (up to 10^{-6} Torr), gases

Interchangeable motion and sensor modules are easily swapped within minutes

disc-on-disc module

pin-on-disk module with 1000°C chamber

block-on-ring module

reciprocation module with 300°C chamber

AFM module

nano-indenter

Test Schematics (Examples)		
Standard	Pin/Ball-on-Disk	Disc/Plate-on-Disc/Plate
	Block/Pin-on-Ring	Indenter-on-Plate
	Crossed-Cylinders	4-Balls
	ISO/ASTM/DIN Standards	
Industrial	Bearings	Razor-on-Hair
	Valves	Brush-on-Teech
	Connectors	Orthopedic Joints
	Commutators	Semicon Wafers
	Contact/Wires	Head-on-Disk
	Screw-in-Nut	Cutting Tools
	Pie-in-Chain	Contact Lenses
	Shaft-in-Seal	Optical Media/Lenses

UMT Drive Modules (Four Types)

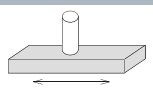
Lower Linear Fast Reciprocation with Upper Linear Motion

Lower Plate:	up to 150 mm
Lower Cylinder/Wire:	1 µm to 25 mm
Reciprocation Frequency:	0.1 to 60 Hz
Reciprocation Stroke:	50 µm to 25 µm
Options:	fluid bath, environmental chamber

Wear & Fretting Tests

Upper Pin/Ball/Block: stationary

Multiple Wear Tracks: auto-positioning, distance 0 to 75 mm, resolution 1 µm



Cross-Cylinder Tests

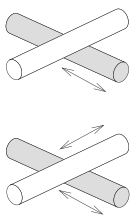
Upper Cylinder: 0.1 to 25 mm

Upper Tensioned Wire/Suture/Fiber: 1 µm to 1 mm

Narrow Wear Track: stationary upper sample

Wide Wear Track: sliding upper sample, 0.001 to 10 mm/s

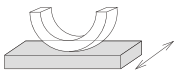
Multiple Wear Tracks: auto-positioning 0 to 75 mm, resolution 1 µm



Engine Tests

Upper Piston Ring: stationary

Lower Cylinder Liner: reciprocating



Lower Rotation (horizontal axis) with Upper Linear or Rotary Motion

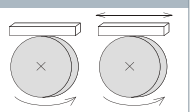
Lower Ring/Bearing:	10 to 80 mm
Rotation:	cw/ccw, 0.1 to 5,000 rpm
Options:	fluid bath, environmental chamber

Block-on-Ring Tests

Upper Block or Plate: 1 to 150 mm

Narrow Wear Track: stationary block/plate, 0.001 to 10 mm/s

Wide Wear Track: sliding block/plate, 0.001 to 10 mm/ss



Ball/Pin-on-Ring Tests

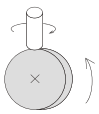
Upper Ball: 1.5 to 25 mm

Upper Pin: 1 to 25 mm, flat, spherical or conical end

Single/Multi-Crater Tests

Upper Ball or Pin: rotating cw/ccw, speeds 0.1 to 1,000 rpm

Positioning on new craters: radial-range 360°, resolution 0.5 µm, axial-range 75 mm, resolution 1 µm

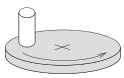


Lower Rotation (vertical axis) with Upper Linear or Rotary Motion

Lower Disc:	up to 150 mm (optional 200 mm)
Rotation:	cw/ccw at two speed ranges: 0.1 to 5,000 rpm or 0.001 to 50 rpm
Upper Ball:	1.5 to 25 mm
Upper Pin:	cylinder 1 to 25 mm, flat, spherical or conical end
Options:	fluid bath, environmental chamber

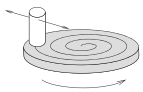
Single-Radius Pin/Ball-on-Disc Tests

Upper Pin or Ball: stationary during test, automatic positioning on disc radii 0 to 75 mm, resolution 1 µm



Spiral-Wear Pin/Ball-on-Disc Tests

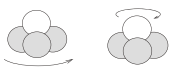
Upper Pin or Ball: sliding radially on lower disc, speeds 0.001 to 10 mm/s, Lower disc angular speed auto-adjusted for constant linear speed



Four-Ball Tests

Upper Ball: stationary in the center

Three Lower Balls: Immersed in fluid bath



Single/Multi-Crater Tests

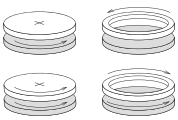
Upper Pin or Ball: rotating cw/ccw, speeds 0.1 to 1,000 rpm

Positioning on new craters: automatic radial positioning, range 75 mm, resolution 1 µm, circumferential positioning, range 360°, resolution 0.5 µm

Disc/Ring-on-Disc Tests

Upper Pin or Ring: up to 150 mm

Stationary or rotating: cw/ccw, speeds 0.1 to 1,000 rpm



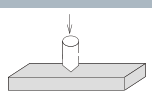
Lower High-Precision Linear with Upper Linear Motion

Lower Plate:	up to 150 mm
Reciprocation Stroke:	75 mm
Positioning Resolution:	1 µm
Linear Speed:	0.001 to 10 mm/s
Options:	fluid bath, environmental chamber

Single/Multiple Indentation Tests

Upper Indenter: Rockwell, Vickers, Berkovich

Positioning on new indents: automatic, resolution 1 µm

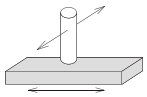


Butterfly Wear-Track Tests

Upper Pin: 1 to 25 mm

Upper Ball: 1.5 to 25 mm

Upper Sliding: synchronous with lower sliding



Bruker Nano Surfaces Division

Campbell, CA · USA
Phone 1.408.376.4040
info@cetr.com

www.cetr.com