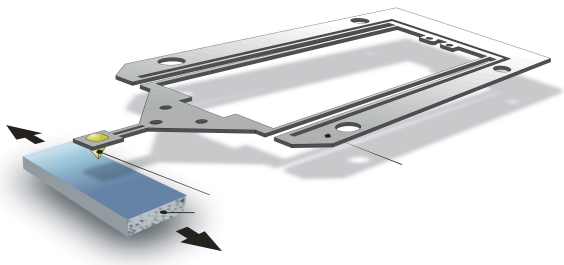
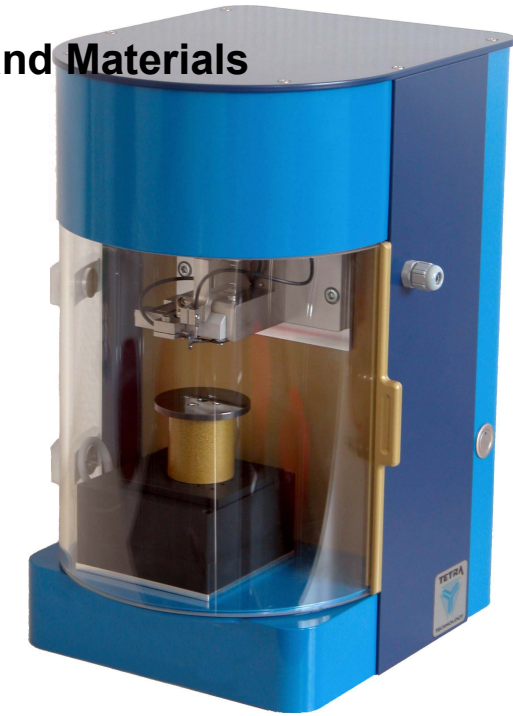
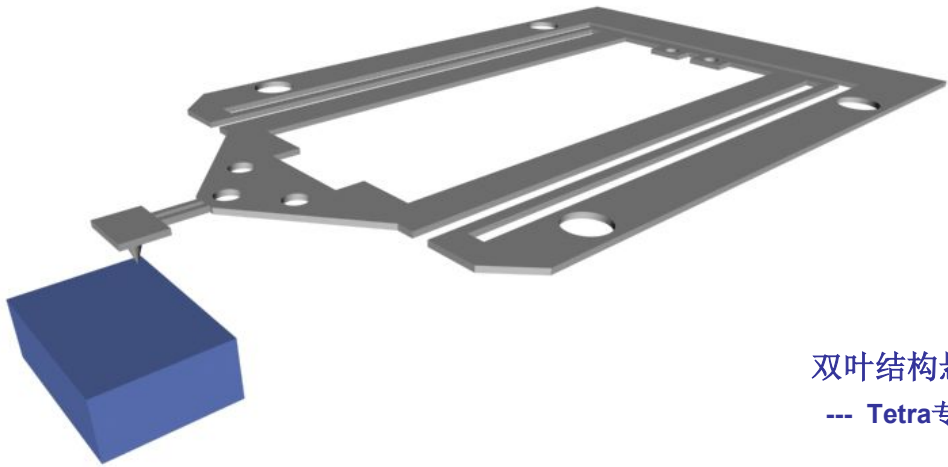
BASALT® -
Devices for Characterisation of Physical Properties of Surfaces and Materials

BASALT系列试验机 - 材料与表面物理特性表征





Functional Principle
功能原理



双叶结构悬臂梁
--- Tetra专利技术

A micro-tool (e.g. a ball or a tip) will be set in contact with the surface to be tested.
微工具（球或尖）与待测样品表面接触。

With the help of a 2D-micro force tranducer (Cantilever) the contact forces (Normal-force and tangential-force) will be measured.
借助二维微力学传感器（悬臂梁结构）测量接触力- 法向力Fn与切向力Ft。

Relative movements can carried out between a micro tool and the sample.
微工具与样品之间实现相对运动。

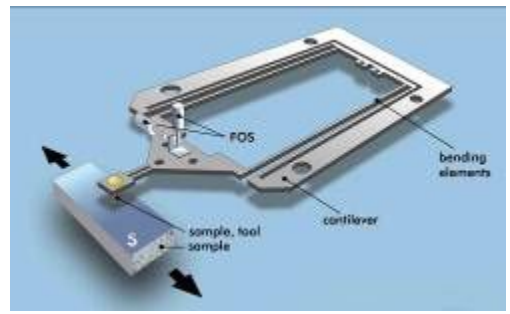
Measurement of the Deflection of the Force Transducer
力学传感器变形测量

For the measurement of the deflection of the force transducer fibre optic sensors (FOS) are used.

特殊的双叶结构悬臂梁设计 （**Tetra**专利技术）

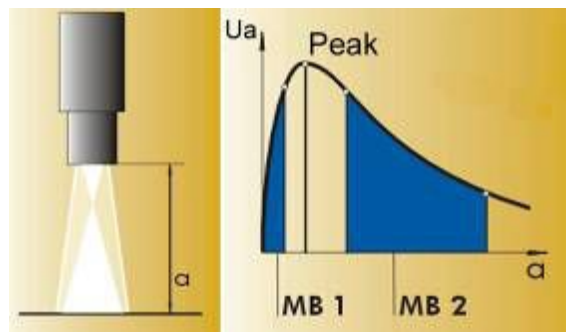
水平方向**X**轴与垂直方向**Z**轴挠度相互独立，

借助纤维光学传感器（**FOS**）检测悬臂梁在法线方向与切向方向的变形位移。

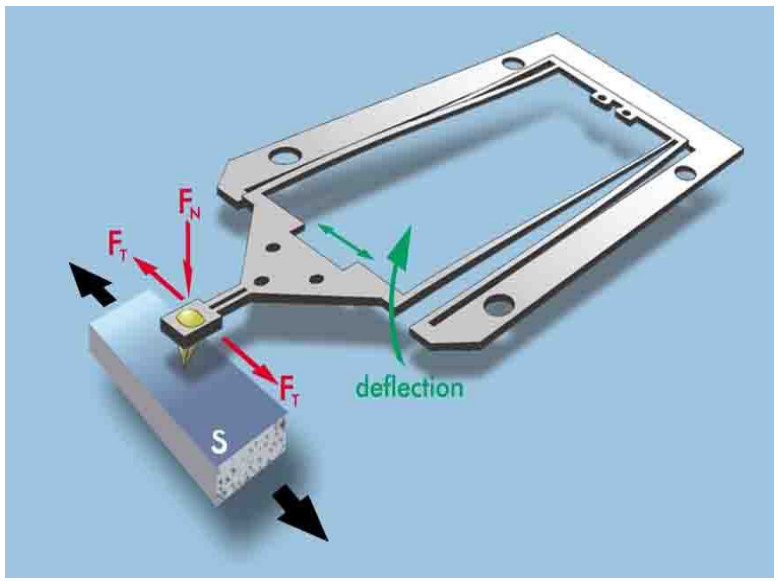


By varying the distance between the sensor tip ad the mirror, which is mounted on the cantilever, the received light will be changed.

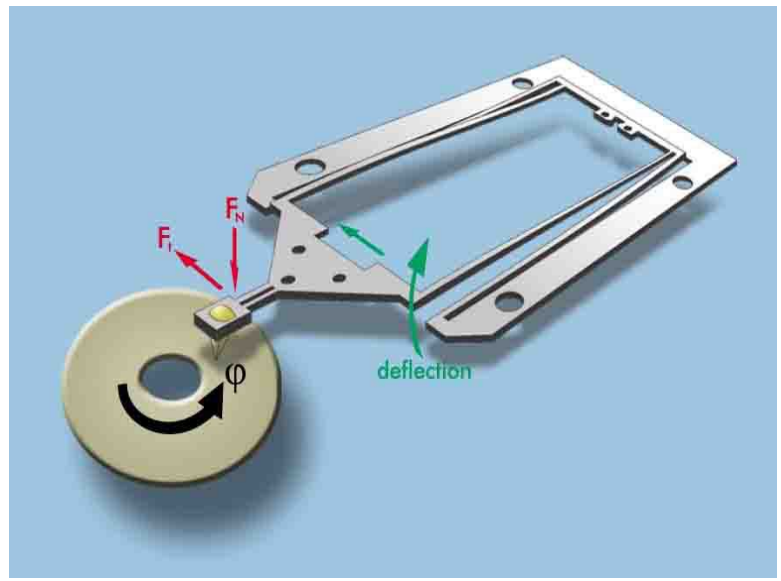
传感器尖与镜面（安装在悬臂梁）间距离变化，接收光改变。



Functional Principle
试验机功能原理图

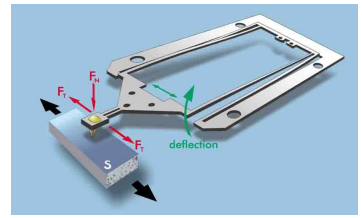


Linear Oscillation
线性往复运动模型



Pin-On-Disc
销盘式运动模型

Definition of measurement modes
测量模式定义



Reciprocating mode
往复运动

■ Friction test
摩擦力测试

The probe/tool/counterbody is continuously in contact with the test sample during the complete forward and backward movements (Continuous recording of Fn, Ft, d and calculation of μ).

样品往复运动过程中，探针/工具/对偶件持续接触测试样品。
持续记录法向力**Fn**、切向力**Ft**与位移**d**，计算摩擦系数μ。

■ Fretting test
微动测试

Similar to the friction test, but usually a wear test. So higher frequency is used and a larger number of cycles are observed (Selective recording of Fn, Ft, d and μ; continuous recording of energy input).

运动模式类似于摩擦力测试，多为磨损试验 - 往复频率更高，试验周期更多。
选择性记录法向力**Fn**、切向力**Ft**，位移**d**与摩擦系数μ，持续记录能量输入。

■ Scratch test
划痕测试

The probe/tool/counterbody is in defined contact with the test sample, only during the forward movement of the bidirectional movement.

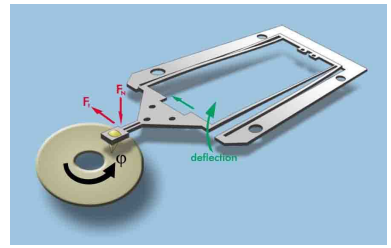
悬臂梁二维力学传感器上的探针/工具/对偶件与待测样品实现特定接触。
只记录双向运动中的向前运动。

■ Adhesion test
附着力测试

A test sample is set up rectangular to the bidirectional movement axis (slow approach and retreat of the probe/tool/counterbody to the test sample; Continuous recording of d and Ft give force-distance curves).

待测样品与双向运动轴垂直相向，探针/工具/对偶件缓慢地推向与退离样品。
持续记录距离**d**（压入深度）与切向力**Ft**（载荷），得到力（载荷）-距离（压入深度）曲线。

Definition of measurement modes
测量模式定义



Pin-On-Disc mode
销盘模式

The probe/tool/counterbody on the 2D force transducer is in a defined contact with the test sample.
The test sample is rotated around central z-axis.

悬臂梁二维力学传感器上的探针/工具/对偶件与待测样品实现特定接触，测试样品围绕中轴旋转。

Approach - retract mode
（探针）接近-离开（样品表面）模式

Probing a surface from the z-direction : vertical indentations, approach to an electrode of isolating particles, scanning indentations, electrical surface property scanning.

从垂直方向（Z轴）探触表面：垂直冲压，靠近绝缘微粒的一个电极，扫描压痕，表面电特性扫描。

Micro Tools
微工具

To realise a defined contact between the micro force sensor and the material or the surface to be tested TETRA offers a lot of different mirco tools.

为实现微力学传感器与待测材料或表面间的特定接触，Tetra公司提供多种微工具：

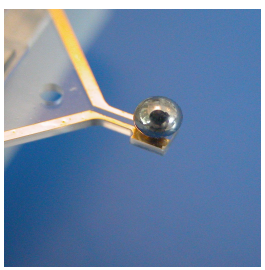
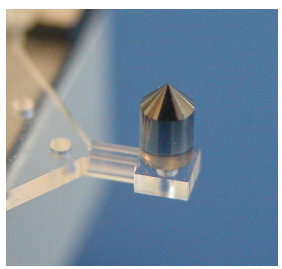
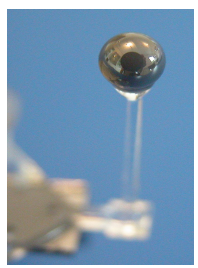
Stainless steel ball
不锈钢球

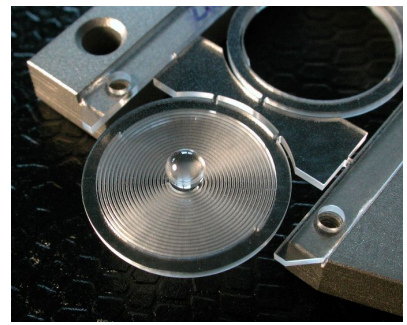
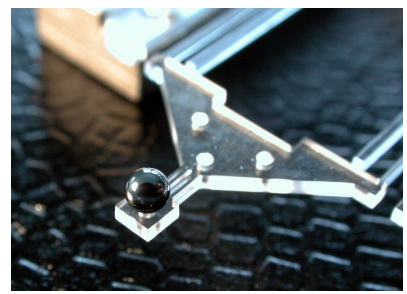
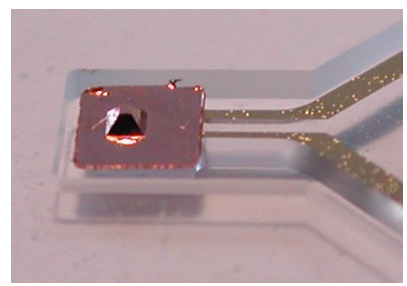
Sapphire ball
蓝宝石球

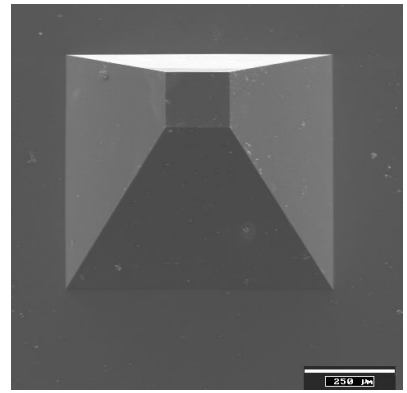
Silicon ball
硅球

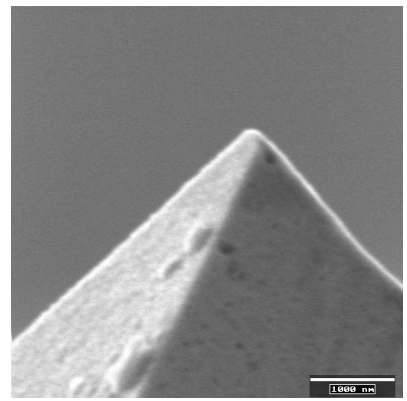
Sapphire con
蓝宝石片

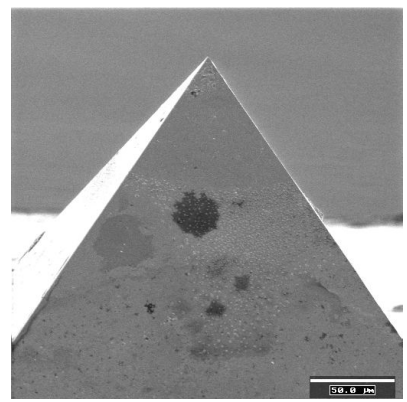
Customized copper tools
客户定制铜质样品

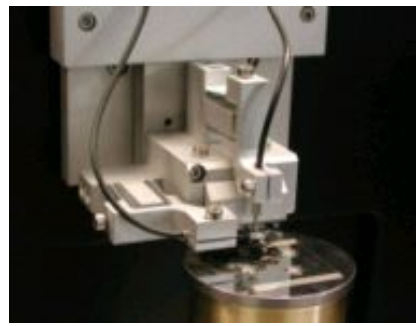




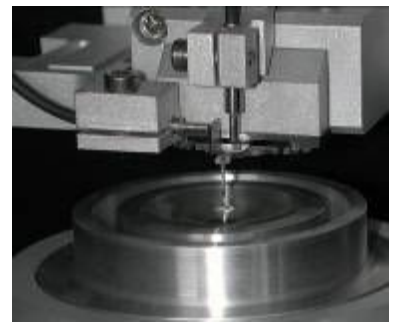






Applications
应用案例





Microtribometer
微摩擦磨损试验机

Scratcher
划痕仪

Adhesion Tester
附着力测试仪

Tester for Electrical Conductivity of Coatings
涂层电导率测试仪

Profilometer
轮廓仪

Viskosimeter
粘度计

Indenter
压痕仪

Applications
应用案例

Contact behavior of insects on surfaces
昆虫与表面的接触行为研究
- new micro grippers and adhesives
  新型微抓爪与粘着剂

Friction of hairs
头发摩擦力研究
- new shampoos and medicaments
  香波与药剂的研发与优化

Hardening behaviour of building substances
建筑材料的硬化行为
- new and optimised building substances
  建筑材料的研发与优化

Scratch test on the surface of glasses
镜片表面的划痕测试
- quality control and new coatings
  质量控制与新涂层研发

Friction behavior of micro structured surfaces
微结构表面的摩擦行为
- soil-resisting coatings
  防尘涂层

Applications
应用案例

Rub and bend behaviors of textile fibers

纺织纤维的擦揉与弯曲行为

- development of new fibers, quality control

  新纤维材质的研发，质量控制

Friction behaivor on ice surfaces

冰面摩擦行为

- material and structure optimization of winter sports equipments

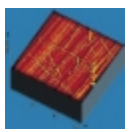
  冬季运动项目设备材料与结构优化

Tension behaviour of soap skins

肥皂肌肤张力

- optimization of detergents

  洗涤剂的优化



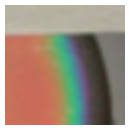
Scratch behaviour on thin layers

薄膜的划痕行为

- basic research surface technology

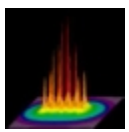
  表面科技的基础性研究

Applications
应用案例



Friction behaviour of lubricants and oils
润滑剂、润滑油的摩擦行为
- material optimization
  材料优化

Measurement of the viscosity of liquids
液体粘度测量
- quality control
  质量控制



Micro scanning of magnetic fields
磁场的微扫描
- development of micro drives and micro magnetic bearings
  微驱动与微磁性轴承的开发

Electrical contacts under the influence of micro vibrations
微振动影响下的电接触
- optimization of the contacts, quality control, electrical coatings
  接触优化、质量控制、电涂层

Customer Advantages
客户优势

Time saving
省时

- leading of series of tests with a variation of different paramete不同参数变化下的系列测试
- extensive expertiment and evaluating software available
  扩展试验与评估软件可选
- measurement results are visible in graphic form
  试验结果图表可视

Cost reduction
成本低

- all test components (2D-force transducer, micro positioning units) are integrated at a standard device
  多种测试组件（二维力学传感器，微定位装置）集成到一台标准设备
- one standard device with a lot of optional moduls
  标准设备+多种可选功能组件
- flexible application possibilities
  灵活的应用可能性
- good cost-benefit ration in relation to AFM
  与AFM相比，性价比超高
- No external PC necessarily
  无需外部PC设备
- universal use in different application areas in the research business 多应用领域通用机型

Effectiveness in the production
高效产出

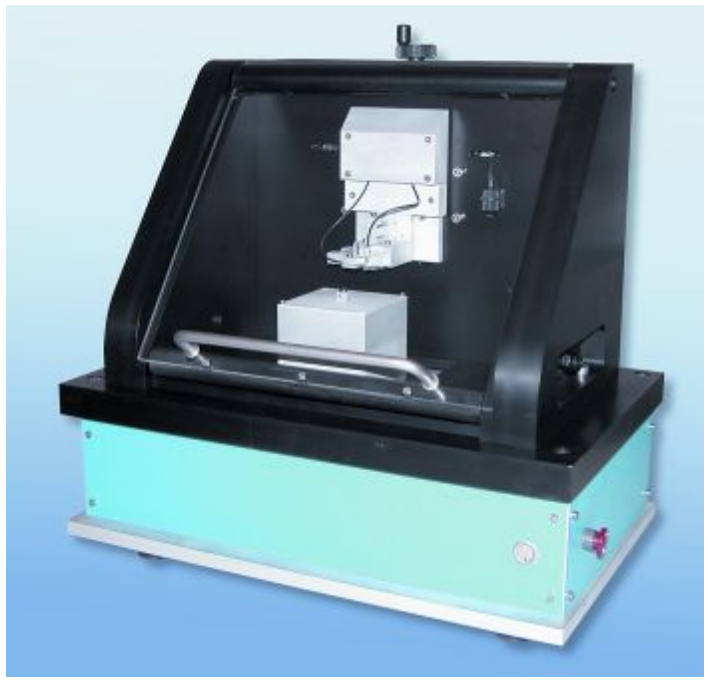
- quality control
  质量控制
- low device size
  设备尺寸小
- optimization of product and process parameters
  产品与工艺参数优化
- quality certificates for customers and supplier
  质量保证

Efficient research tool
高效研究工具

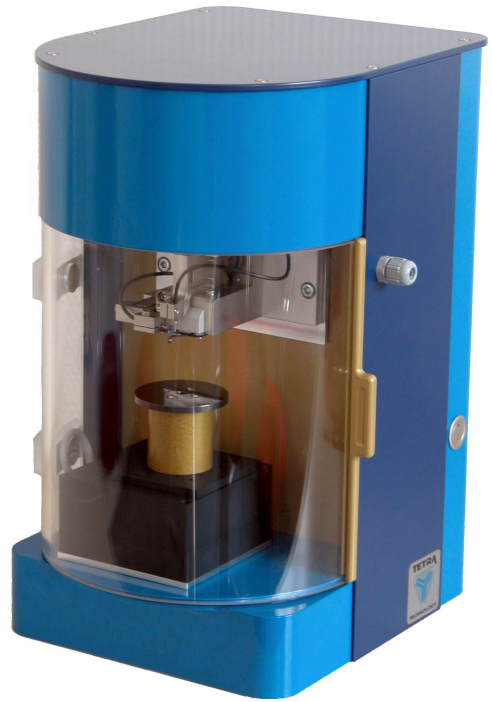
- knowledge profit in the area of the micro and nano technology微纳科技领域技术优势
- examination of physical, chemical and biological phenomena物理、化学与生物现象评估

Devices

Basalt系列试验机机型



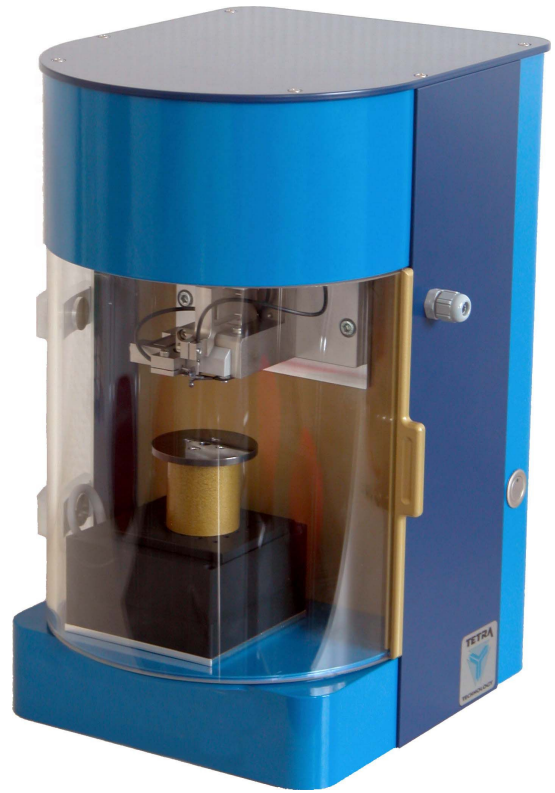
BASALT-PT



BASALT-MUST

Technical Parameters
技术参数

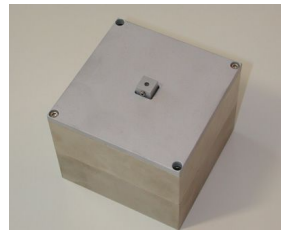
Base-Unit 基座	PARAMETER 技术参数
■ X-Y-Z positioning axis, **X-Y-Z**轴定位 Stepping Motor 步进电机	
Positioning range X-Y 定位范围（水平方向：**X-Y**轴）	20 mm x 20 mm
Positioning range Z 定位范围（垂直方向：**Z**轴）	40 mm
Positioning resolution 定位精度分辨率	1,25 µm
Positioning accuracy 定位精度	10 µm
Positioning speed (X, Y – max) 定位速度 （水平方向**X, Y** 轴最大值）	0,6 mm/s
Positioning speed (Z – max) 定位速度 （垂直方向**Z**轴最大值）	1,6 mm/s
Maximum positioning force 最大载荷力	30 N
■ Z - fine positioning axis 垂直方向**Z**轴精准定位	
type of drive 驱动类型	piezo actuator serial to step motor Z-axis 压电电机系列 - 步进电机（**Z**轴）
positioning range 定位范围	40 µm
positioning resolution 定位精度	0,25 µm
maximum positioning force 最大定位压力	30 N
■ *Control unit* 控制系统	embedded Linux-PC 镶入式**Linux-PC**系统

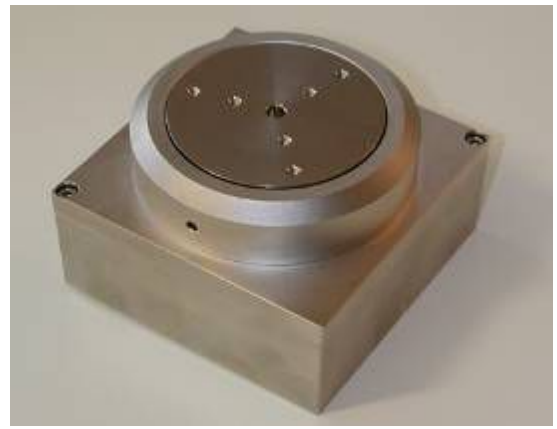


Technical Parameters
技术参数

2D-FM 1N	PARAMETER 技术参数
nominal force F_N (according to 2D-FORCE TRANSDUCER) 法向力 F_N (取决于二维力学传感器)	1 mN, 100 mN, 1 N
tangential force F_T (according to 2D-FORCE TRANSDUCER): 切向力F_T(取决于二维力学传感器)	100 µN, 10 mN, 100 mN
sensor type: 传感器类型	fiber optical sensors for messuring the displacement of force transducer for F_N, F_T 纤维光学传感器 - 测量二维力学传感器（双叶结构悬臂梁）在X轴与Z轴方向上的变形位移， 进而得到法向力（F_N）与 切向力（F_T）
force resolution 力精度	1/5000 of nominal force 1/5000 满量程
overload protection 过载保护	mechanical bedstop

Technical Parameters
技术参数

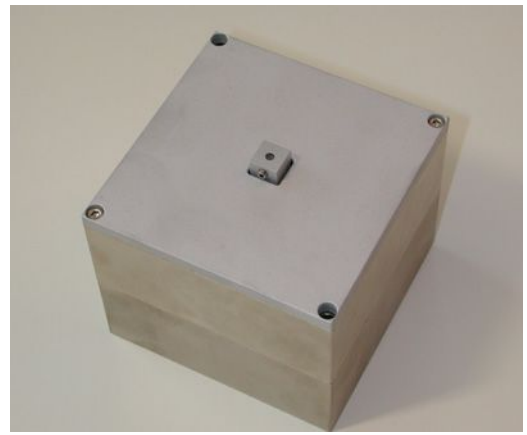


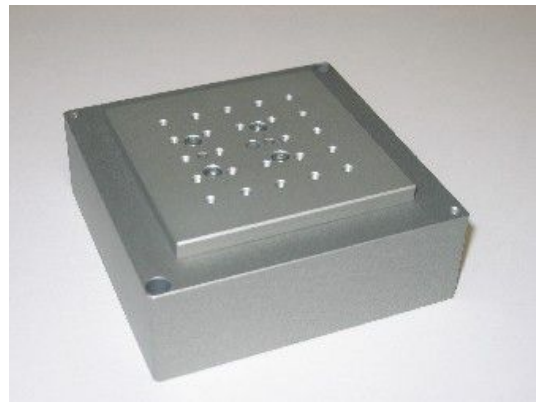


	RM 120	RM 250
■ Rotation axis 转轴	Φ(Z)	Φ(Z)
Drive system 驱动系统	Stepping motor 步进马达	servo motor 伺服电动机
Rotating speed 转速	1…120 rpm	1 … 200 rpm
Positioning resolution 定位精度	0,225°	0,1°
max. Torque 最大扭矩	0,01 Nm	0,5 Nm

Technical Parameters
技术参数

LMP 500	PARAMETER 技术参数
Drive system 驱动系统	Piezo actuator (closed loop control of position) 压电陶瓷执行机构提供循环往复运动模式 （闭环定位控制）
Positioning range 定位范围	500 µm
Positionining resolution 定位精度	0,25 µm
max. Positioning force 最大载荷力	1 N





Technical Parameters
技术参数

LMS 20	PARAMETER 技术参数
Drive system 驱动系统	Electrodynamic actuator (closed loop control of position) 电动力学执行机构 （闭环控制定位）
Motion range 移动范围	20 mm
Motion resolution 移动分辨率	200 nm
Motion accuracy 移动精度	1 µm
Motion velocity 移动速度	0,5 … 100 mm/s
Motion acceleratin 移动加速度	5 m/s^2
max. Positioning force 最大载荷力	1 N

Software
软件系统

The user has to plug a monitor, a keyboard and a mouse.
系统需外接显示器、键盘与鼠标

LINUX - real time operation software
Linux - 实时操作软件

File handling of machine parameters
设备参数文件处理

Parameterisation
参数化

Sensor and actuator checking
传感器与执行机构检查

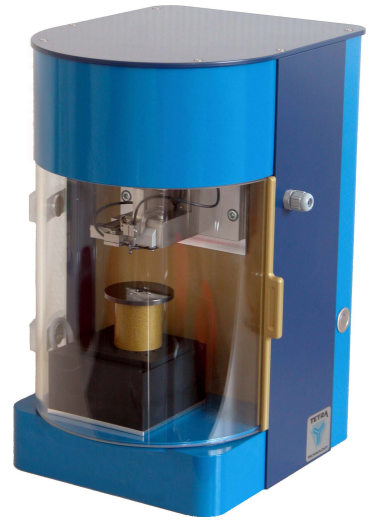
Editing and carrying out the experiment sequences
试验程序编辑与执行

Storaging measurement data
试验数据存储

Displaying measurement data graphically
试验数据图形化显示

Giving help informations, Product informations
帮助信息，产品信息

Basalt Must 典型客户 与 新一代Basalt N2多功能摩擦磨损试验机



Basalt Must 微试验机

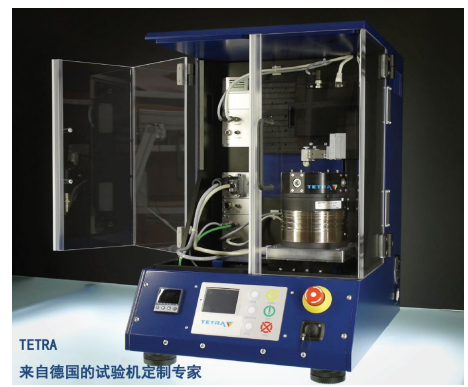
Basalt Must 堪称Tetra历史上最成功的一款经典摩擦磨损试验机。

目前，共有35台Basalt Must试验机服务于欧美科研用户，广受业界赞誉。

典型用户：

德国Kiel大学功能形态学与生物力学系动物学所、英国利兹大学、瑞士智云集（Susos AG）科技有限公司、德国科莫尼茨大学、飞利浦集团、弗劳恩霍夫协会材料力学研究所、德国Gottleb Binder魔鬼粘制造公司 ...

2013年，Tetra公司在Basalt Must 、Basalt N1及Basalt M等经典试验机技术（Tetra专利双叶结构悬臂梁传感器、模块化设计.....）基础上，融合前沿科技（开放平台、直流电机、智能软件.....）推出新款Basalt N2多功能摩擦磨损试验机.



Basalt N2多功能摩擦磨损试验机

详细技术细节请联系Tetra公司中国市场渠道商 - 德国WinWinTec公司

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TETRA®

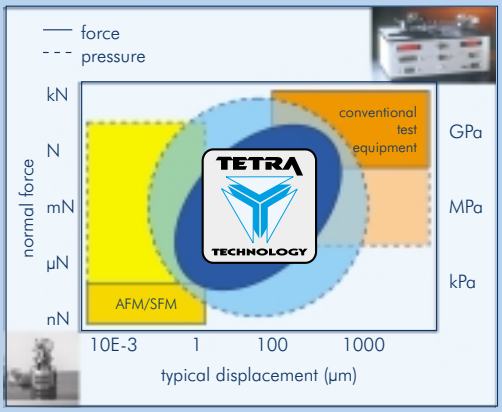
AUTOMATION SENSORIC ROBOTICS

BASALT®-MUST
Modular Universal Surface Tester

PRECISION ENGINEERING
SENSOR AND MECHATRONIC SYSTEMS
ELECTRONIC DEVICE CONTROLS

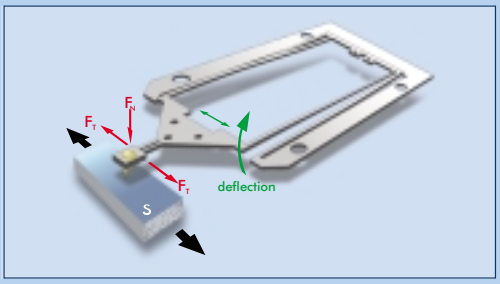
BASALT®-MUST

Modular Universal Surface Tester

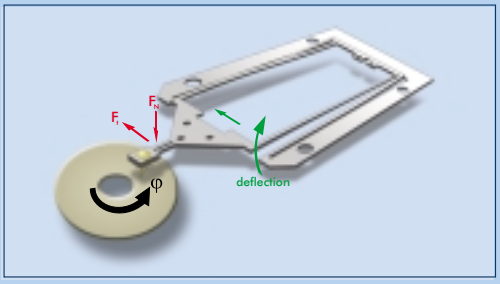


Testing ranges

Applications



Reciprocating mode



Pin-On-Disc mode

General Information

BRIDGING THE GAP

- BASALT®-MUST is a modular and flexible high precision tester to measure surface interactions in a wide force range
- Interchangeable modules for specimen motion in reciprocating and pin-on-disc mode are the basis for various experiments
- Different modules for force measurements from the macro world to the micro world are available
- Embedded PC with real time operating system guarantees high data acquisition rate in equi-distant time intervals
- Easy programming of automatic experiments by standard software (running on the embedded PC)
- Graphical visualisation and analysis of large data sets with TETRA-VIEW® (Windows® PC software)

Applications

- Basic research to elucidate the mechanism of friction, fatigue and wear in materials
- Exploration of haptic properties
- Testing of bio interfaces and structures
- Time response gaging of mixtured materials like glues and varnish
- Analysis of micro electro mechanical systems and connectors
- Micro rheology of thin layers and lubricants
- Study of tribochemical reactions
- Characterisation of thin layers and coatings
- Quality management, process optimisation

Measurement

- Adhesion
- Indentation
- Friction
- Wear
- Scratching
- Hardness
- Viscosity

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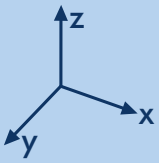
Modular Universal Surface Tester

Module Position Device (x-y-z-axis)

· Motor principle: stepper motor
· Resolution: 1.25 µm
· Velocity: max. 2 mms^{-1}
· Force: approx. 30 N
· Moving range: x 20 mm / y 20 mm / z 50 mm

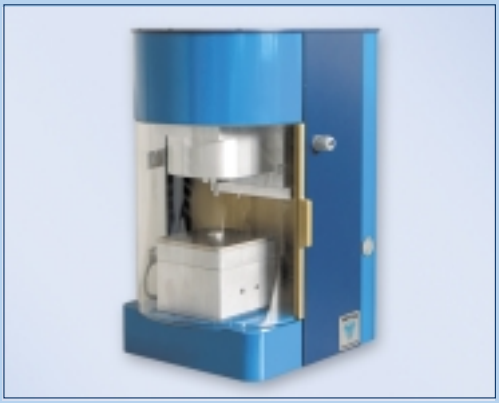


① Base Unit
② Measuring module: Specimen / Tool holder, Indenter, Scratcher, Viscosity sensor …
③ Motion module: Reciprocating / Pin-On-Disc mode including specimen holder Fretting, Friction, Scratching, Indentation, …
④ Measuring module positioning z-axis Travel range: 50 mm
⑤ Motion module positioning x, y Travel range: 20 x 20 mm
⑥ Data acquisition and embedded control unit
⑦ External connectors

Set up 1 N

The combination of Fiber Optical Sensor (FOS) for measuring the deflection of special cantilever and a high precision linear positioning system (LPS) is covering the force range from 1 µN to 1 N. The closed loop position control enables long stroke experiments up to 20 mm with a repeatablity of 50 nm.

A measuring module with strain gage extend the force range up to 10 N. Together with a high frequency motion module based on a voice coil drive facilitate fretting experiments between 2 µm@500Hz and 3 mm@15Hz. The RM120 enables Pin-on-Disc Experiments



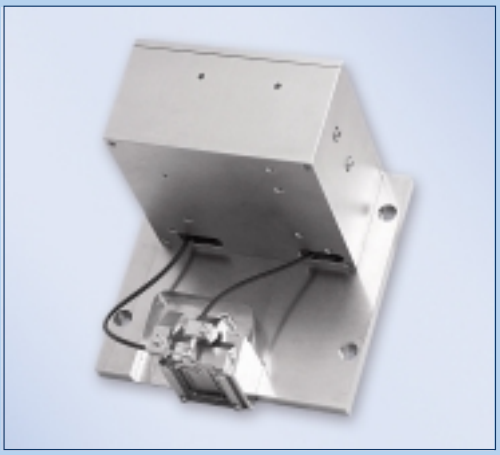
Set up 10 N

The tribo corosion set up allows to measure tribo chemical reactions in a pin on disc mode up to 250 rpm.
To run the experiment in liquids the motion and measuring modul are mounted upside down in the base unit.

Set up Tribo corosion

BASALT®-MUST

Modular Universal Surface Tester



Measuring Module with FOS

2D-FM1N force module

Fiber optic sensors

Measuring Module 1N

2D Force Transducer – Cantilever

- Double leaf spring
- Various materials (glass, different steels, different bronzes, …)
  Advantages of glass:
  - Excellent material properties
  - Easy to combine with other materials
  - Very good long-time stability
- Spring constants down to 0.5 N/m
- Easy handling
- Simple adaptation (geometry, force range) to reach the customers needs

Optical Displacement Sensor

Light emitted from the sensor tip is reflected from the surface of a cantilever.
The reflected light will be received by the same sensor tip and converted in a electrical signal.
The signal is related to the distance between the sensor tip and a reflectiv area on the cantilever.
This provides the possibility to measure the deflection of a cantilever and hence to measure forces.

Due to the nature of the FOS it can be used in two measuring ranges of different sensitivity.
It is possible to measure static and dynamic values such as displacements, extensions and mechanical vibrations.

Characteristics

· Measuring range:	approx. 100 µm (MR1), 1.5 mm (MR2)
· Sensitivity:	1/5000 of range
· Bandwidth (-3 dB):	static up to 30 kHz … 150 kHz
· Diameter of sensor tip:	different diameters from 1.5 mm to 8 mm
· Temperature range of sensor tip:	-25°C … + 80°C
· Length of the fiber bundle:	1500 mm (standard)

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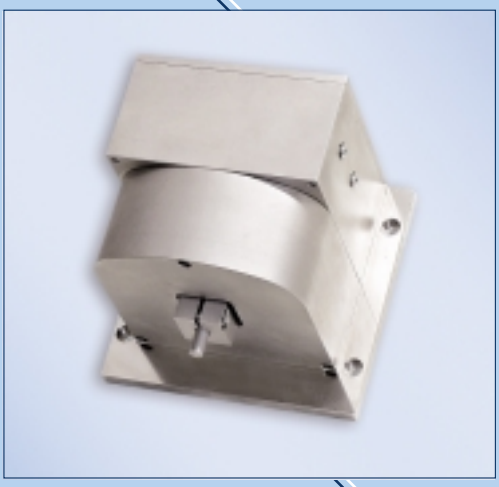
Measuring Module 10N

Measuring principle:	strain gage
Measuring range normal force:	0.1 ... 10 N
Measuring range friction force:	0.1 ... 10 N
Resolution:	1/2000 MR



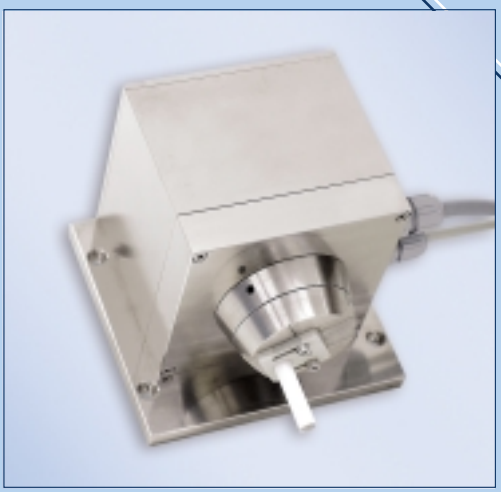
Measuring Module 10N

Measuring Set-up Tribo corosion

Motion Module

Drive principle:	stepper motor
Speed:	0 ... 250 rpm
Speed steps:	1 rpm
Resolution:	0.144°
Torque:	12 Ncm

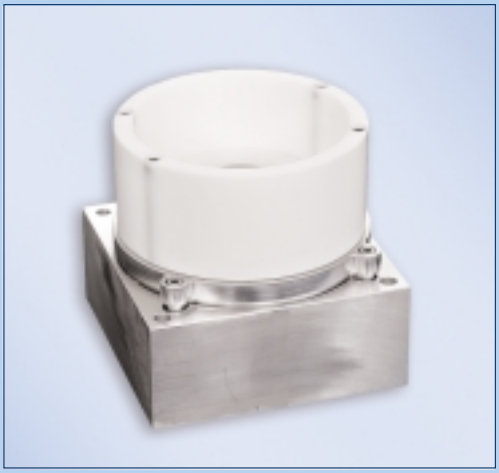
Programmable speed profils
Batch editor for various experiments



Motion Module Tribo corosion

Measuring Module

Measuring principle:	magnetic hall sensor
Measuring range normal force:	0.1 ... 5 N
Measuring range friction torque:	± 7.5 Ncm
Resolution:	1/2000 MR
Specimen misalignment compensation:	± 1.5°



Measuring Module Tribo corosion

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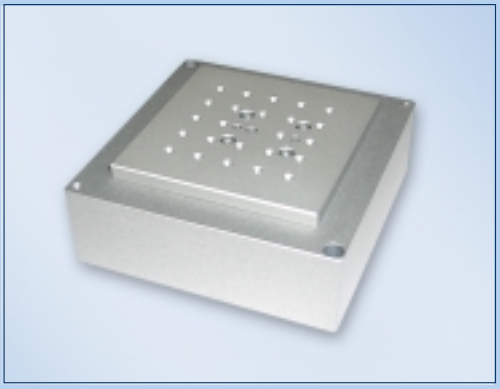
Motion Modules



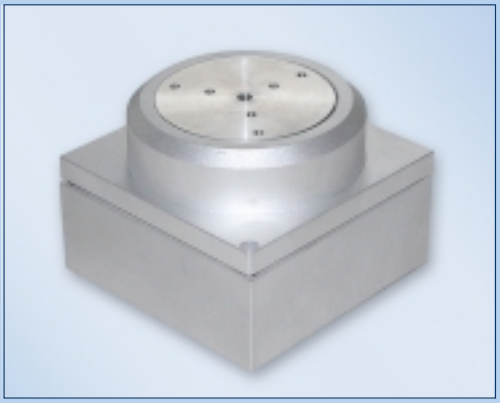
LPS20

Reciprocating Module LPS20

· High precision linear drive
· Closed loop positioning controller

· Drive Principle
The LPS20 is a linear motor based on the electro-dynamic drive principle. The excellent characteristics are a result of the simple design, the highly precise guidance and the drive principle with moved magnets that avoids electrical connections to the actuator element.

· Compact device	
Size:	90 x 90 x 53.5 mm^3
Weight:	730g
· Travel range:	20 mm
· Accuracy:	1 µm
· Resolution:	50 nm
· Maximum load:	250g / 2.5 N (more on request)
· Blocking force:	>1 N
· Acceleration:	5 m/s^2
· Speed:	0.02 … 10 mm/s (max. 30 mm/s)
· Speed error:	18 µm/s (2% for speeds >5 mm/s)
· Operating voltage:	12V



RM120

Pin-On-Disk Module LMR120

· Drive principle:	stepper motor
· Speed:	1 … 120 rpm
· Resolution:	0.225°
· Torque:	0.01 Nm / 1 Ncm
· Size:	90 x 90 x 70 mm^3
· Weight:	approx. 800 g

· Higher torque, resolution and speed on request

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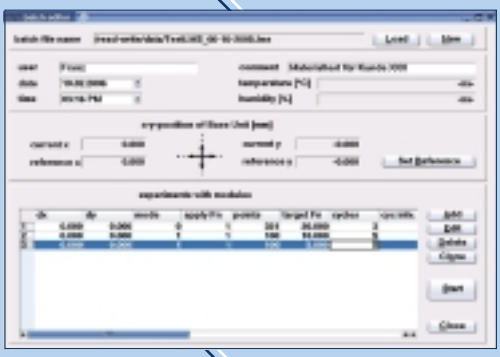
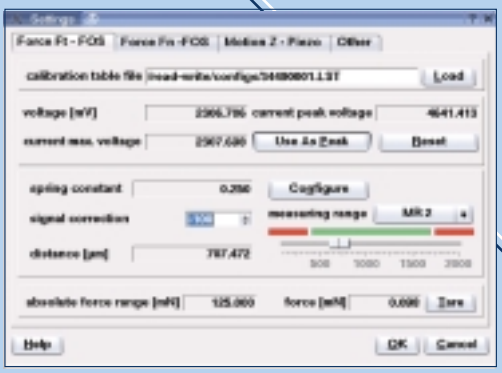
Software Highlights

The batch editor enables the operator to set up many different experiments, while providing the possibility to vary each single parameter like load, number of cycles, speed etc. for each of the experiments.



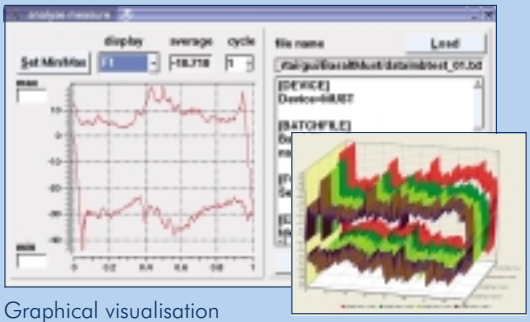
Batch editor

A built in computer with a specially adapted LINUX, capable to acquire real-time sensor signals, offers the possibility to control the tester such as setting up sensors, moving the specimen or the tool without an additional external computer.
External PC (Windows) can be connected by Ethernet for customer specific controls.
The data storage on a USB device or via Ethernet on an external computer allows long term experiments.



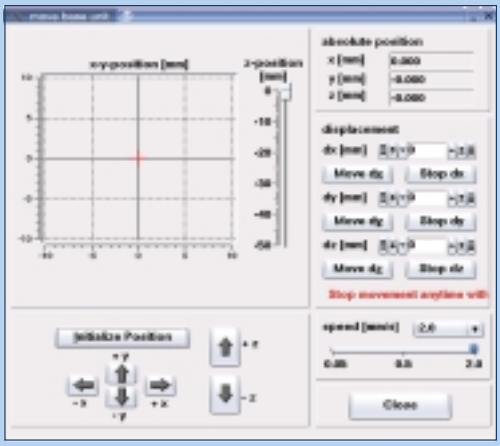
Settings

The BASALT®-MUST facilitates the operator to inspect the measured data within the tester's LINUX application software. For the visualisation and the analysis of large data sets TETRA-View® is available. This PC-software provides several functions which enable an easy generation of 2D- and 3D-charts to interpose them in test reports.



Graphical visualisation
of the measurement data

Direct access to the system's drives offers the possibility to position the specimen and the tools manually to prepare the experiments easily.



Manual control of the postioning system

BASALT®-MUST

Modular Universal Surface Tester

General Parameters

Measuring Modules

2D-FT force transducer	normal force, tangential force: spring constant: tools:	1 µN … 1 N 4 … 20 000 N/m balls, cones, pins (sapphire, steel, silicon, etc)
2D-SG force	normal force, tangential force:	0.1 N … 10 N
Tribo corosion	normal force: torque around z-axis:	0.1 N … 5 N ±7.5 Ncm

Motion Modules

Reciprocating module LPS20	driving principle: travel range: resolution: force:	electro dynamic x = 20 mm x = 50 nm F_x = 1 N
Fretting module	driving principle: travel range: force:	voice coil x = 3 mm@15 Hz, 2 µm@500 Hz F_x = 5 N
Pin-on-disc module (rotationary drive)	driving principle: velocity: torque:	stepper motor 0 ... 120 rpm 1 Ncm
Tribo corosion drive (rotationary drive)	driving principle: velocity: torque: resolution:	stepper motor 0 … 250 rpm 12 Ncm 0.144°

Base unit

x-y-z-axis sample positioning device	motor principle: resolution: velocity: force: moving range: x, y, z	stepper motor 1.25 µm max. 2 mms^{-1} approx. 30 N 20 x 20 mm, 50 mm
z-axis microdrive	moving range:	up to 150 µm (piezo actuator)
Test chamber	registration of air temperature and humidity (optionally)	
	power supply: weight: lenght/width/hight: interfaces:	9 … 14 VDC, 45 W, (via connector IEC 320) 21 kg 260 mm x 200 mm x 360 mm USB, Ethernet

TÜV CERT

DIN EN ISO 9001:2000
Zertifikat: 01 100 75007

TETRA TECHNOLOGY

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Satz/Layout: www.impuls-ilmenau.de

version 11/2007

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