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TECHNOLOGY GROUP

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Thermo Scientific
HAAKE RheoStress 6000

The Universal Rheometer

Part of Thermo Fisher Scientific

Thermo SCIENTIFIC

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Thermo Scientific HAAKE RheoStress 6000

As a pioneer in the field of rheology, we are well-known for our leading HAAKE viscometer and rheometer lines. These instruments precisely analyze a materials's rheological properties, temperature-related changes, and the material's processability.

The Thermo Scientific HAAKE RheoStress 6000 is the latest generation in the successful RheoStress series, which is focused on standard applications in research & development and quality control. The HAAKE RheoStress 6000 is fully compatible with existing accessories of previous RheoStress models such as temperature control units, measuring geometries and application oriented measuring cells. The new modular HAAKE RheoStress 6000 combines proven technology plus the latest innovations from the high end Thermo Scientific HAAKE MARS rheometer. This makes it easier to upgrade to the new generation in Rheology without making a huge investment. Thanks to the Thermo Scientific HAAKE MARS technology inside, our customers can now benefit from the latest developments in user-friendly measuring software and firmware.

Selection of HAAKE RheoStress models:



HAAKE RheoStress 100
(1992)



HAAKE RheoStress 150
(1997)



HAAKE RheoStress 6000
(2007)

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Thermo Scientific
HAAKE RheoStress 6000 Design



Fixed measuring head consisting of:

- Drag cup motor with the lowest available inertia (10 µNms²)
- High resolution optical encoder (12 nrad)
- Patented 4th generation air bearing system*
- Temperature-compensated, normal-force sensor, based on strain-gauge technology for positive and negative normal force measurements

Adapter for upper measuring geometries

Optional display/control unit. Monitoring data online even without a PC.
The display/control unit of the HAAKE RheoStress 6000 facilitates manual operation of lift movement and gap setting as well as starting measuring and evaluation jobs with or without a PC. The colour display monitors rheological and instrument-specific data online.

Receiver for temperature control units and application oriented measuring cells

Compact design by one-column aluminum frame with integrated control and power electronics

Glass plate with high resistance against chemicals for easy cleaning

** DE 10 2004 050 753 A1; US 7,181,956 B2*

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Temperature Control Units

A variety of temperature control units is available to reliably and accurately handle temperatures ranging from -80 up to 500°C.

Peltier, electrical or liquid temperature control units for coaxial cylinders, plate/plate and cone/plate as well as special measuring geometries are available for the HAAKE RheoStress 6000. All temperature control units from previous HAAKE RheoStress models (600, 300, 150, 100, ..) can still be used.

Overview of Temperature Control Units	Temp. min. °C	Temp. max. °C	Heating rate K/min	Cooling rate K/min
Liquid temperature-controlled cylinder unit	-40*	200	2*	1*
Liquid temperature-controlled cone & plate unit	-80*	350	3*	2*
Electrically heated cylinder unit	30	300**	8*	1*
Electrically heated cone & plate unit	-80*	500	15*	2*
Peltier controlled cone & plate unit	-60*	200	40*	40*

* Depending on cooling medium and bath temperature.
** Using suitable measuring geometries.

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Universal Temperature Control Unit (UTC)

The UTC consists of a universal controller box to regulate different temperature control units for cone and plate measuring geometries – Peltier as well as electrical. A Peltier unit covering a temperature range from -60°C up to 200°C enables quick and accurate responses to temperature changes. The electrical temperature control unit, comprising a lower and an upper heater, can be converted to a measuring chamber with a tempered glass ring. This allows measurements up to 500°C under visual control and inert gas.

Liquid temperature-controlled units

A temperature control unit for cone & plate measuring geometries and two units with different coaxial cylinder diameters are available. Liquid temperature-controlled units require either a circulator or cryostat and a bath liquid specific to the application. The Thermo Scientific product portfolio is based on many years of experience in temperature control to ensure a fit with your requirements.



Liquid temperature-controlled unit for coaxial cylinders



Electrically heated temperature control units: upper cone heating system, cylinder and lower plate unit



Powerful Thermo Scientific HAAKE Phoenix II temperature control unit to be used for liquid temperature controlled units

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Measuring Geometries for Thermo Scientific HAAKE Rheometers

Our comprehensive accessory portfolio contains coaxial cylinders, plate/plate and cone/plate measuring geometries, custom-tailored dimensions, and made of various materials. Standard titanium measuring geometries have a low mass and therefore a low inertia. For measurements at higher temperatures, geometries with a ceramic shaft are available. These geometries are characterized by a reduced heat transfer to the measuring head and a limited temperature gradient within the sample. To avoid sedimentation or slippage, measuring geometries with serrated or sand-blasted surfaces are available. Disposable coaxial cylinder and plate/plate measuring geometries are available for cross-linking and curing materials.

Description	Type	Shear rate (s^{-1}) standard	Shear rate (s^{-1}) high shear option	Recommended viscosity range (mPas)**
Double gap cylinder system	DG41	0.007 - 11 415	34 245	0.5 - 10 000
Cylinder Ø 40 mm ISO 3219	Z40 DIN	0.001 - 1 931	5 793	5 - 100 000
Cylinder Ø 20 mm ISO 3219	Z20 DIN	0.001 - 1 931	5 793	50 - 1 000 000
Cylinder Ø 10 mm ISO 3219	Z10 DIN	0.001 - 1 931	5 793	500 - 10 000 000
Cylinder Ø 41 mm DIN 53018	Z41	0.002 - 3 500	10 500	10 - 100 000
Cylinder Ø 38 mm DIN 53018	Z38	0.001 - 1 400	4 200	30 - 500 000
Cylinder Ø 31 mm DIN 53018	Z31	0.0005 - 660	1 980	50 - 1 000 000
Profiled cylinder Ø 38 mm DIN 53018	Z38/S	0.001 - 1 500	4 500	50 - 100 000
Disposable cylinder Ø 41 mm ISO 3219	Z41DIN/E	0.001 - 1 931	5 793	10 - 100 000
Disposable cylinder Ø 25 mm ISO 3219	Z25DIN/E	0.001 - 1 931	5 793	50 - 1 000 000
High shear cylinder 25 µm gap	HS25	0.1 - 69 200	207 600	5 - 100
High shear cylinder 100 µm gap	HS100	0.1 - 15 000	45 000	5 - 100
Double cone Ø 60 mm, 1° angle	DC60/1	0.006 - 9 000	27 000	1 - 50 000
Cone Ø 60 mm, 1° angle*	C60/1	0.006 - 9 000	27 000	2 - 100 000
Cone Ø 35 mm, 1° angle*	C35/1	0.006 - 9 000	27 000	100 - 1 000 000
Cone Ø 20 mm, 1° angle*	C20/1	0.006 - 9 000	27 000	1 000 - 1.0 E+08
Plate Ø 60 mm	PP60	0.003 - 4 700	14 100	2 - 100 000
Plate Ø 35 mm	PP35	0.002 - 2 700	8 100	100 - 1 000 000
Plate Ø 20 mm	PP20	0.001 - 1 570	4 710	1 000 - 1.0 E+08
Plate Ø 35 mm serratetd	PP35/S	0.002 - 2 700	8 100	100 - 1 000 000
Plate Ø 20 mm serratetd	PP20/S	0.001 - 1 570	4 710	1 000 - 1.0 E+08

* Cones with angles of 0.5° and 2.0° are available as well.
** Theoretical minimum viscosity value at lowest torque and highest shear rate.
Theoretical maximum viscosity value at highest torque and lowest shear rate.

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Selection of measuring geometries



Coaxial cylinders according to DIN 53019 in different sizes



Titanium geometries with measuring plate cover with same diameter for optimized gap filling; sample cover with integrated solvent trap



High-temperature geometries with ceramic shaft at different diameters



Selection of special measuring geometries with serrated surfaces to prevent slippage, with helical groovings to prevent sedimentation, vane rotors and rotors with glass covers

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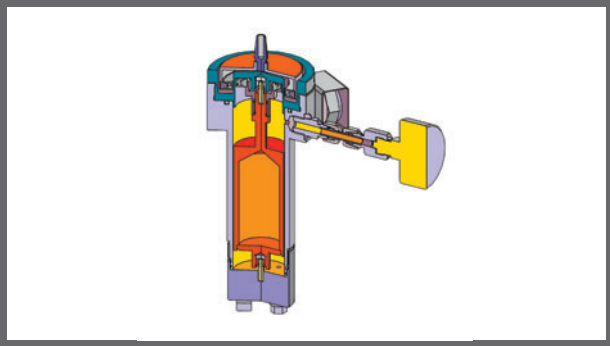


Selection of application oriented accessories

Pressure cell

Different versions of pressure cells for pressures up to 400 bar and temperatures up to 300°C are available. A Hastelloy® version can be used with corrosive samples.

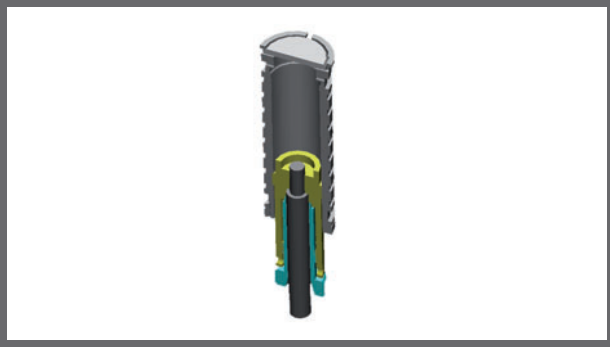
Application examples:
Crude oil, drilling fluids, food



UV cell

For tests on UV-hardening materials UV cells are available: a standard version and an individual measuring cell with freely configurable distances for optical components such as light guides, condensors and glass plates.

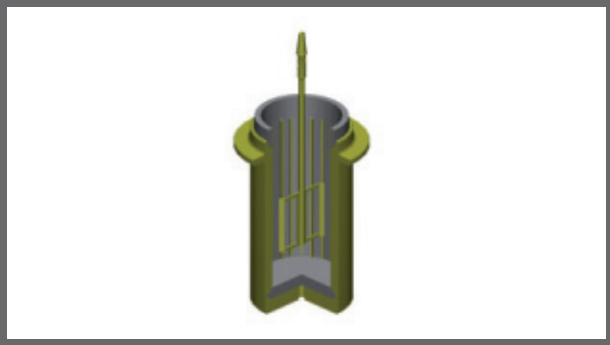
Application examples:
Coatings, dental material, contact lenses



Measuring cell for construction materials

A special measuring cell with a flexible profile for measurements on building materials is offered. Thanks to the interchangeable profile lamellas the measuring cell can be easily and quickly adapted to new materials. The design avoids slippage layer formation.

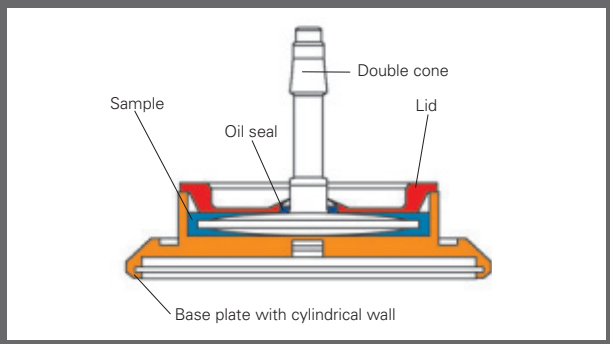
Application examples:
Cementitious pastes and mortars, samples with big particles



Double cone geometry

Highly sensitive measuring cell consisting of base plate, cone and cover designed as solvent trap using oil as sealing.

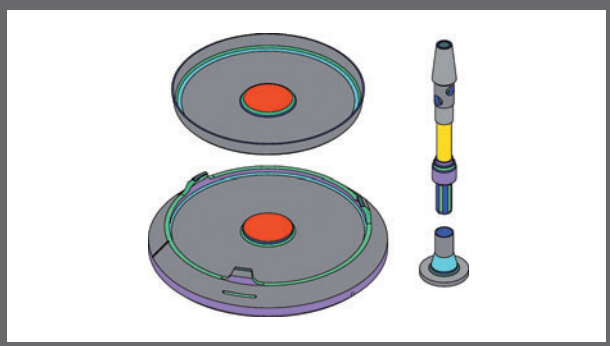
Application examples:
For low viscous materials available in small quantity only or with a tendency of evaporation



Disposable measuring geometries

Plate/plate measuring geometries with different diameters and coaxial cylinders out of aluminium are available in a disposable version.

Application examples:
Samples which are difficult to remove, e.g. cross-linking and curing material



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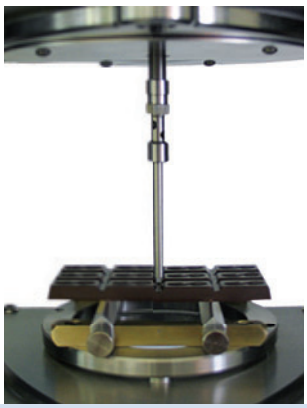


Universal holder for individual containers

Holder with individually adjustable clamps for sample containers like glass jars, cans, beakers and cups.

Application examples:
Paints, inks, food





3 point bending tool

Sample fixture to investigate the bending and breaking behaviour of a wide range of materials.

Application examples:
Food



We are committed to offering comprehensive product and application solutions.
Our application specialists will be glad to assist and consult with you.

Selected Application Notes:

V-217	Rheological properties of fresh building materials
V-222	Breaking Strength of Chocolate
V-225	Rheological characterization of asphalt binders

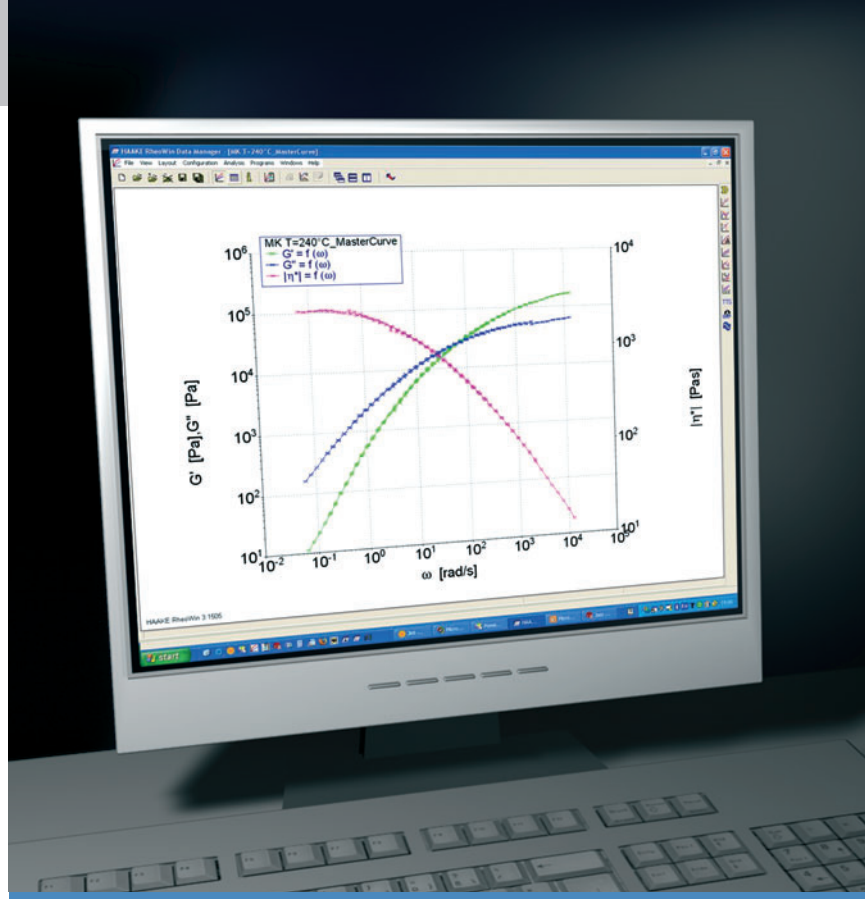
Selected Product Information:

P-1	Investigation of Curing Behavior with a Newly Designed Ring Rotor
P-2	Sample loading tool for measurements on pellets and powders using a plate/plate- or cone/plate-measuring geometry
P-3	Trimming tool to remove overfilling in a plate/plate- and cone/plate-measuring geometry

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Thermo Scientific HAAKE RheoWin 3 Software

We work closely with our customers to provide the most user-friendly software for rheological instruments. HAAKE RheoWin software is continuously aligned to customer needs and requirements. The comprehensive software can be used for all HAAKE viscometers and rheometers. The software is customized to offer convenient operation with default settings for beginners and full access to all relevant measuring parameters for advanced rheologists.



Components

- RheoWin JobManager for manual instrument control, automated measuring routines ("jobs") and report printout or export
- RheoWin DataManager for interactive evaluation of measured data as well as sophisticated tools for creating reports and generating templates for graphs, tables and screen views
- RheoWin UserManager for comprehensive user management regarding user access control and assignment of specific access rights



Functionality

- Manual control for preliminary testing, for displaying selected parameters and for saving manually acquired data
- Convenient creation and customization of measuring jobs using predefined measuring and evaluation elements via "drag and drop" techniques
- Fully automated measuring, data evaluation and documentation within a job
- Real multitasking – simultaneous measurements using several instruments and data evaluation
- Freely configurable data export (ASCII, Excel, etc.)
- Filing graphs in various formats (pdf, etc.)
- Numerous algorithms for data analysis (e.g. interpolation, regression and automated quality control)
- Automated backup file generation for retrieval of configuration data
- Availability of saving the raw data and numerical values for quality control purposes

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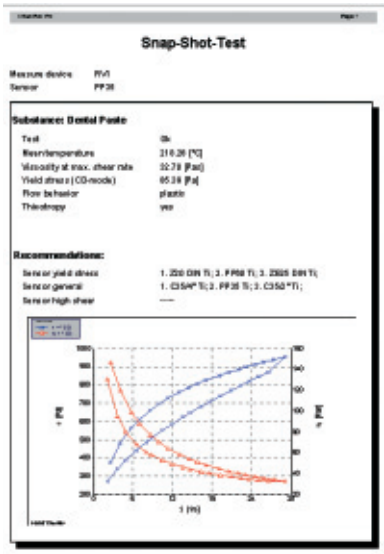
Customization

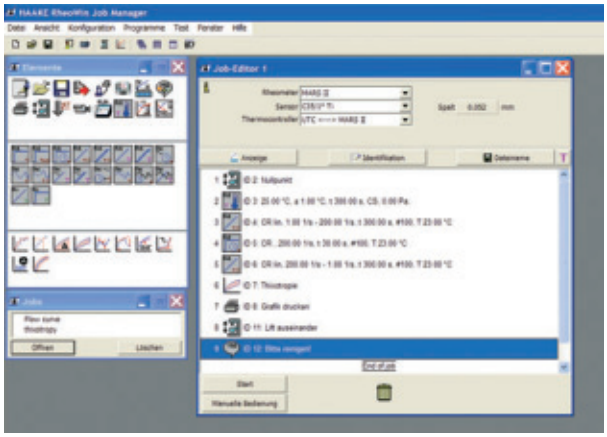
- User-defined definitions of paths and subdirectories for data filing
- Push-button selection of one out of 12 languages
- Modular generation of a file name and automated filing in a predefined subdirectory
- Selectable units and arbitrary labeling of axes
- Links to data bases (SAP, LIMS, etc.)
- Online display of all corrections to improve measuring data (Micro Stress Control)
- Snap-shot-test for quick characterization of an unknown sample
- RheoWizard help feature for expert knowledge to set up a measuring job
- Customizable report templates to permit the use of custom logos and text

Optional tools

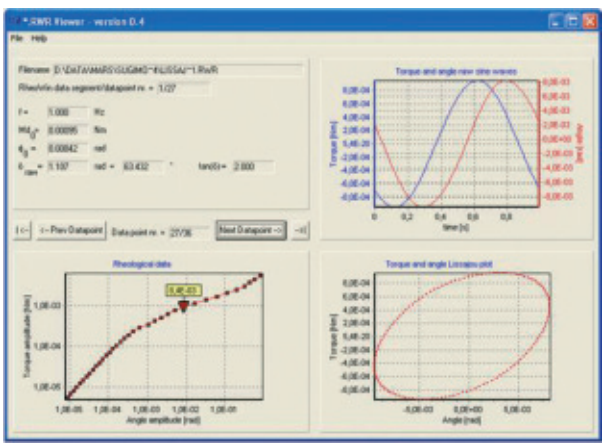
- Efficient tool to make RheoWin compliant with FDA 21 CFR Part 11
- Polymer software consisting of TTS (Time Temperature Superposition) to generate master curves, spectra and MWD (Molecular Weight Distribution)

The latest version of the HAAKE RheoWin software is provided free-of-charge at www.thermo.com/mc.





Definition of a measuring and evaluation procedure



Data evaluation using Lissajous plots



MARS Technology

The HAAKE RheoStress 6000 includes the latest innovations from the HAAKE MARS:

- **CR (controlled rate) mode:** Optimized speed control loop and a low motor inertia (I=10 µNms^2) for fast speed steps within a few milliseconds without significant overshoot
- **CS (controlled stress) mode:** Advanced patented air-bearing technology plus accurate torque correction (MSC = Micro Stress Control) for measurements at low torque limit
- **CD (controlled deformation) mode:** Self-learning deformation control loop based on neural network technology for fast parameter adaptations
- **Combinations of measuring modes:** Flexible software and firmware for creative job definitions
- **Normal force measuerments:** Robust and very sensitive normal force sensor based on extremely sensitive and robust strain gauges for measurements between – 50 N and + 50 N



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Thermo Scientific
HAAKE RheoStress 6000 Specifications

Min. torque rotation CS	200 nNm
Min. torque rotation CR	200 nNm
Min. torque oscillation CS	200 nNm
Min. torque oscillation CD	200 nNm
Max. torque	200 mNm
Torque resolution	0.5 [a] nNm
Motor inertia	10 µNms^2
Angular resolution	12 [b] nrad
Min. angular velocity CS	10^{-7} min^{-1}
Min. angular velocity CR	10^{-5} min^{-1}
Max. angular velocity	1500, 4500 [c] min^{-1}
Min. oscillation frequency	10^{-5} Hz
Max. oscillation frequency	100 Hz
Min. Normal force	0.01 N
Max. Normal force	50 [d] N
Normal force resolution	0.001 N
Min. lift speed	0.2 µm/s
Max. lift speed	7 mm/s
Lift positioning accuracy	0.5 µm
Temperature range	-80 to +500 [e] °C
Dimensions (W x D x H)	400 x 400 x 780 mm
Weight	42 kg

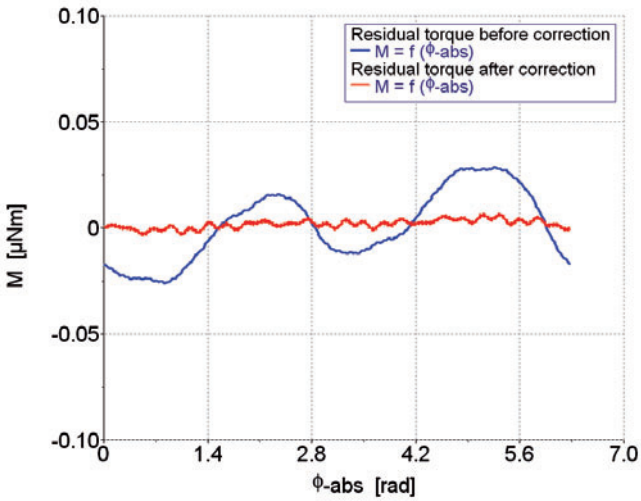
(a) at the lowest torque
(b) internal resolution
(c) high shear option
(d) in both positive and negative direction
(e) depending on temperature control unit

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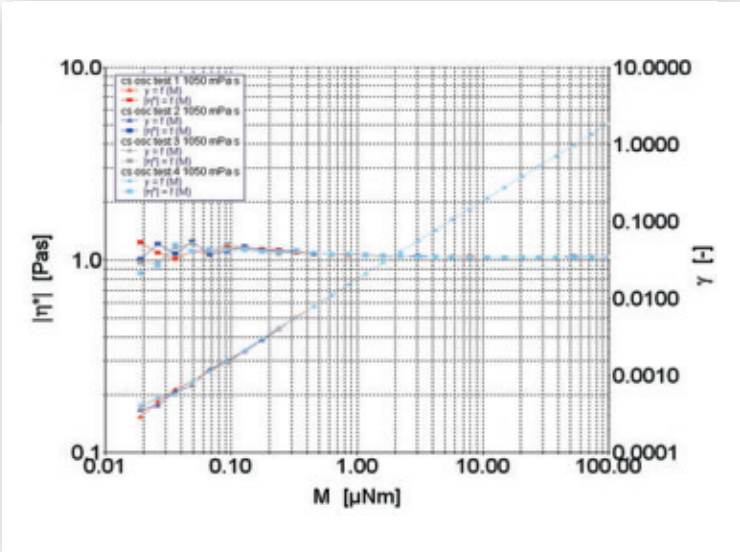
Selected Measurements

Low torque measurements

The 4th generation diffusion air-bearing is the result of 25 years of development and manufacturing experience. Our latest advances in air-bearing technology plus accurate residual torque correction (MSC = Micro Stress Control), allow for measurements down to 200 nNm.



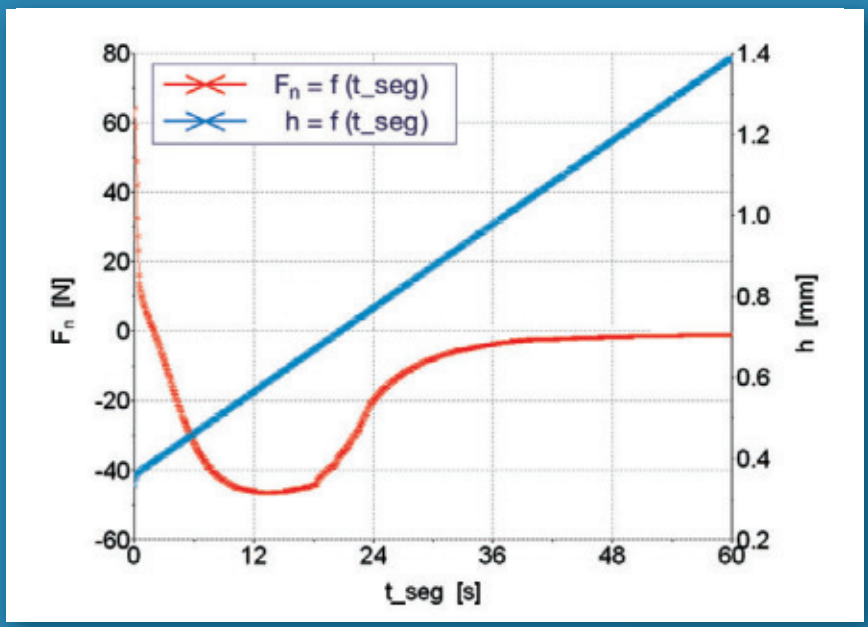
HAAKE RheoStress 6000 – Air-bearing performance



CS-Mode: Amplitude Sweeps
Sample: 1 Pas Oil

Normal force and tack measurements

The HAAKE RheoStress 6000 is equipped with a new normal force sensor based on robust and very sensitive strain gauges with integrated temperature compensation and a measuring range from 0.01 N to 50 N in positive and negative directions. This sensor measures normal force differences in shear experiments or compensates for changes in sample volume. An axial force can be applied so that the HAAKE RheoStress 6000 can be used as a very precise "tack" instrument.

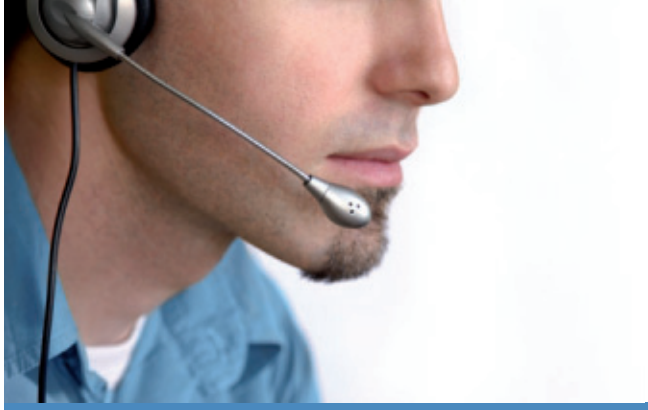


Measuring Tack: Sample: Double-sided tape

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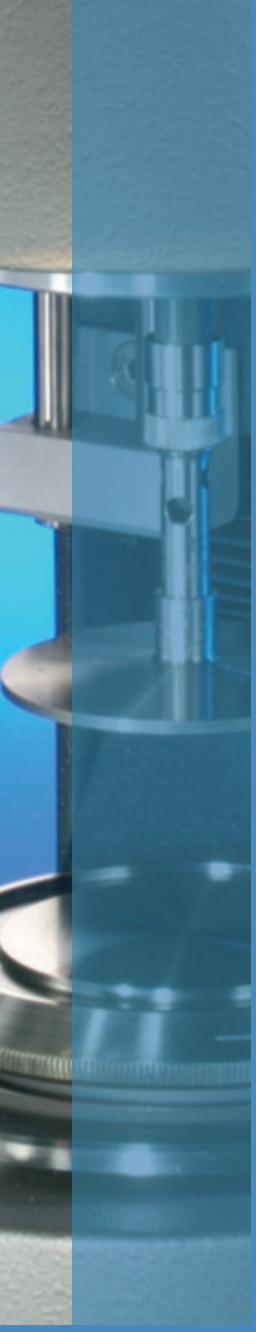
Application laboratories
Our fully equipped laboratories reflect our applications expertise and commitment to innovation. Our laboratories are in constant demand for testing customer samples and developing and optimizing pioneering applications.



Seminars and training courses
Customers are offered a comprehensive training program and selected courses in our international training center in Karlsruhe, Germany. Basic and advanced rheology seminars and training on special applications are held worldwide. In-house seminars are also offered to our customers.

Services to meet individual requirements
We offer a wide range of professional services to a variety of industries to help our customers improve their productivity and decrease costs. Individual solutions to support our customers and maintain their instruments are a standard service. Additional service packages, warranty enhancements or premium service packages, which can be bundled, allow our customers to plan and budget for maintenance and service support. All service is provided by skilled and certified service engineers.

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Thermo Fisher Scientific successfully supports a wide range of industries with its comprehensive Thermo Scientific solutions for Material Characterization. Material Characterization products analyze and measure viscosity, elasticity, processability and temperature-related mechanical changes of plastics, food, cosmetics, pharmaceuticals and coatings, plus a wide variety of liquids or solids. Detailed information is provided at www.thermo.com/mc.

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