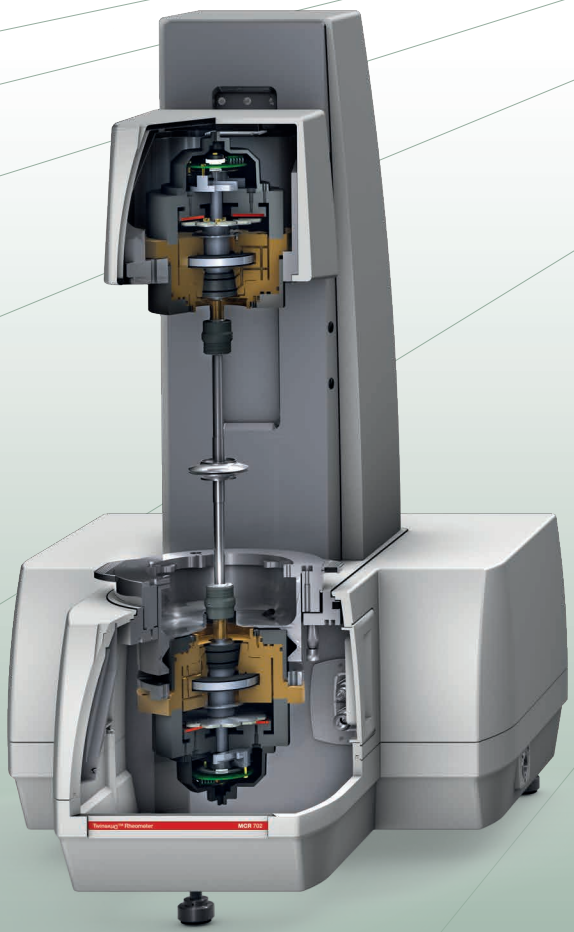
Anton Paar

MCR 702

TwinDrive™ Rheometer

One Rheometer. Two Drives. All Possibilities.
MCR 702 with TwinəʌiɹᗡTM Technology



The rheometry revolution: TwinəʌiɹᗡTM

Anton Paar introduces a ground-breaking high-end rheometer in a class of its own: MCR 702 with TwinəʌiɹᗡTM technology.

For the first time ever in the history of rheometry, you can perform rheological tests with two torque transducers and drive units at once, in a single instrument: Two powerful EC motor units in a combined modular setup – flexible and precise enough to deliver any result you are looking for.

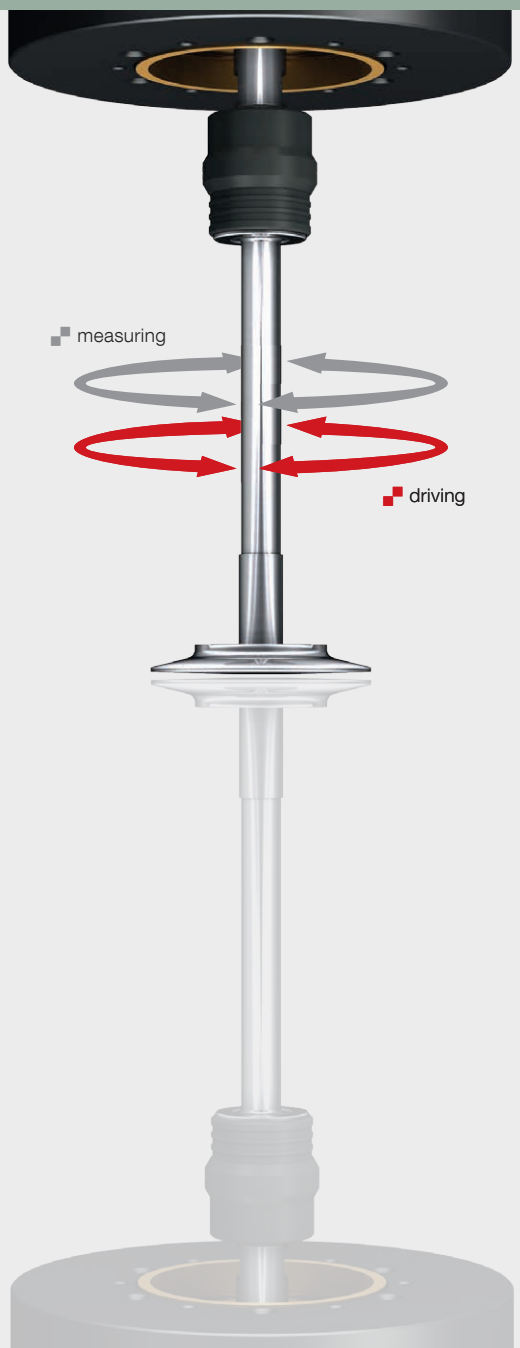
In short, MCR 702 with TwinəʌiɹᗡTM is the first single system to cover all possible rheological applications – past, present and future.

The Modes that Make it Possible

The single-drive mode

The single-drive test mode provides you with the vast range of application options that MCR rheometer are known for.

In this mode, the lower motor is simply removed and MCR 702 is operated as a CMT (Combined Motor Transducer) rheometer. Using a single air-bearing-supported EC motor unit, you can make the most of the motor's TruStrain™ capability and perform 'classic' stress-controlled tests. The option to either control the shear rate or the shear stress opens up countless applications specific to single-motor rheometers. The single-drive MCR 702 is ready for any temperature device and application-specific accessory you may require – and there are more than 35 options to choose from …

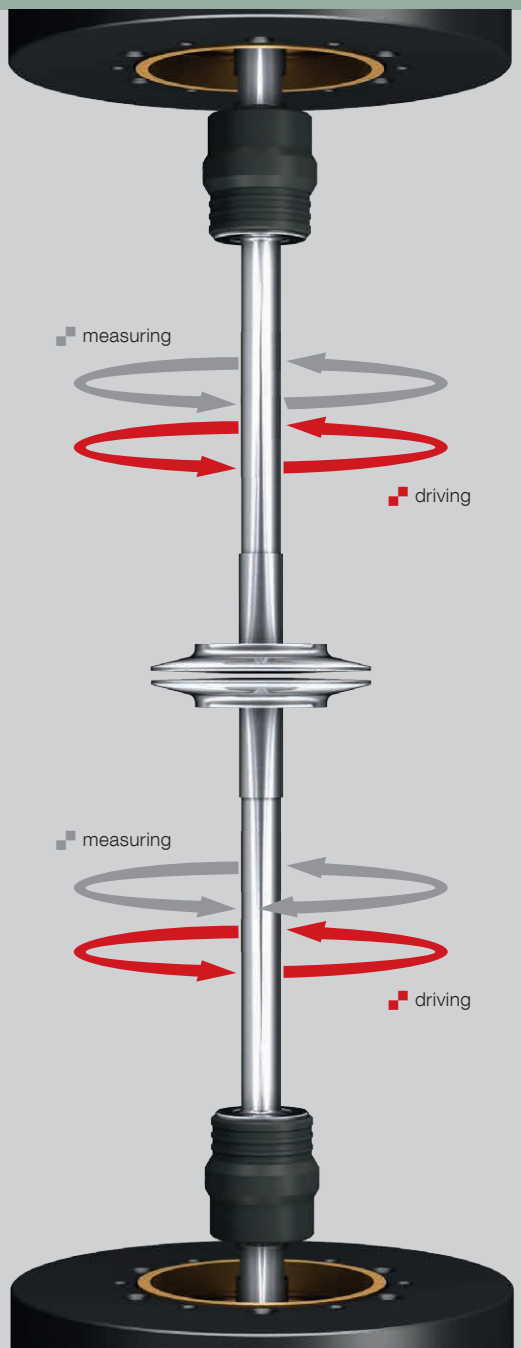


The TwinəʌiɹᗡTM modes

Now anything is possible: The TwinəʌiɹᗡTM modes mark a rheological testing.

The counter-rotation mode

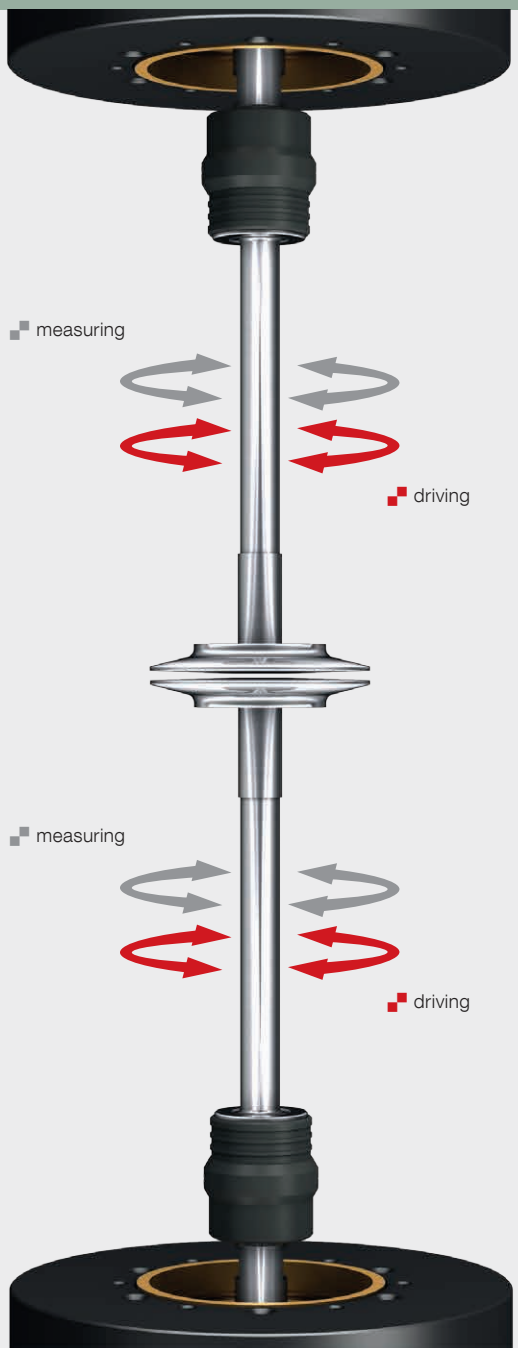
In the counter-rotation mode, MCR 702 employs both air-bearing-supported EC motors as drive units as well as torque transducers. The two motors are easily set to rotate in opposite directions, with the preset speed divided and shared. This counter-rotation can be used to create a fixed stagnation plane in a sample, which is then easier to investigate microscopically. This mode is also used with UXF TwinəʌiɹᗡTM, for extensional tests down to minimal measured torques. Regarding speed, the counter-rotation mode simply 'doubles the score' – up to a maximum speed difference of 6000 rpm.



game change in the world of rheometry, allowing you to break unprecedented new ground in

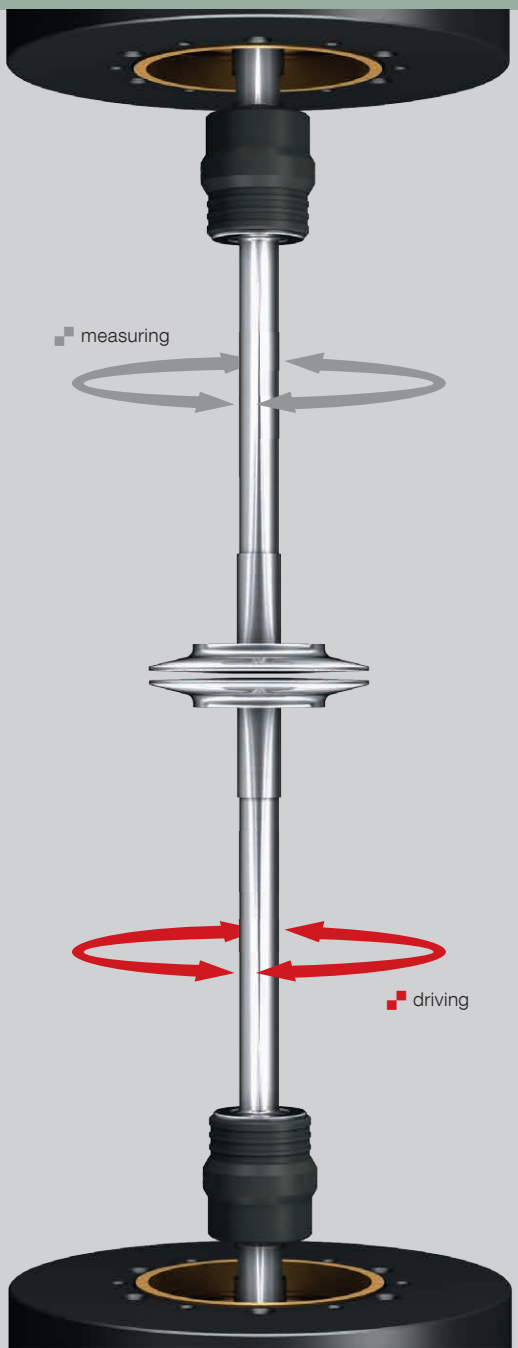
The counter-oscillation mode

In the counter-oscillation mode, MCR 702 also employs both motors as drive units and torque transducers while performing a counter-oscillatory movement. This means that the set strain is divided equally between both motors so that they each move at half of the set strain while maintaining the same frequency. In comparison to the single-drive mode, this movement allows you to measure at higher strains within the sample in order to characterize samples which require torques at the maximum limits of the EC motor. Furthermore, the movement allows the production of a stagnation plane in oscillation, which can be used for optical investigations.

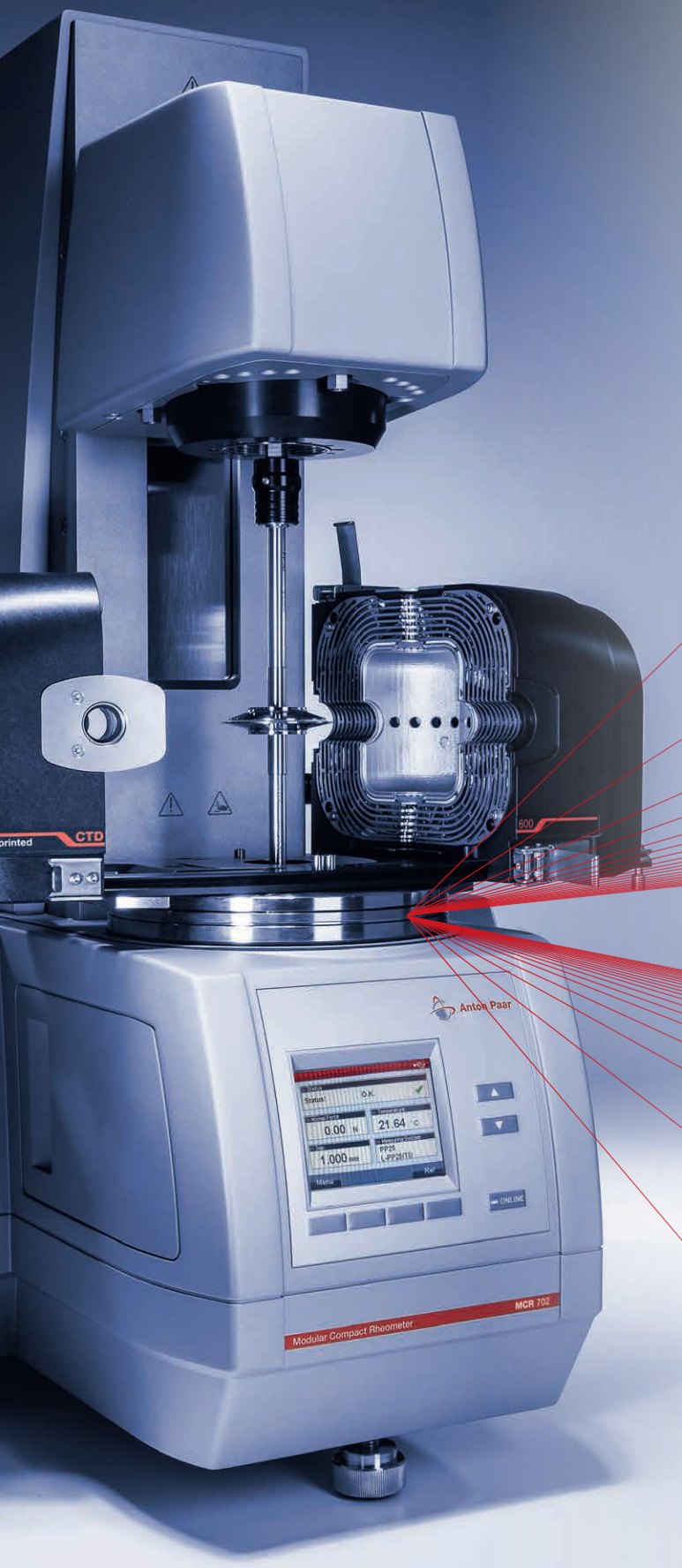


The separate motor transducer mode

The Separate Motor Transducer (SMT) mode enables you to use the motors in a more synchronized fashion, making 'different demands' on each of them. Because of the EC motors' outstanding precision, one motor is easily brought to a fixed position and operated solely as a torque transducer, while the other motor is used as a drive unit only. This turns MCR 702 into the best available SMT rheometer for rotational and oscillatory tests, at the unrivaled torques and normal forces offered by Anton Paar's EC motors only.



Complete Gap Control



IsoLign™: Nano-scale precision

MCR 702 TwinDrive™ is the first rheometer to offer nano-scale precision on several counts – such as low-torque measurements down to a minimum of 1 nNm and the control of angular deflections down to 50 nrad.

Now this peak precision also extends to the system's measuring gap control: The new IsoLign™ Piezo flange performs gap size changes as small as 10 nm. Based on a system of 3 Piezo elements in the flange of the measuring chamber reception, IsoLign™ is reliably employed in all test modes.

Common step-motor-based systems employ a long kinematic chain to translate single motor steps into gap size changes in the micrometer range. Capable of step sizes down to 10 nanometers, IsoLign™ is decades more precise than any other comparable solution for gap size adjustments in rheological tests.

In tests across vast temperature ranges, the measuring gap is kept constant within lower tolerances than ever before.

TruGap™: Consistent gap control

The patented TruGap™ system (US Patent 6,499,336) consistently measures and precisely adjusts MCR 702's measuring gap to the desired position independently of temperature and thermal expansion. Permanent control, documentation and traceability of the actual measuring gap are guaranteed, eliminating the need for regular zero-gap settings.

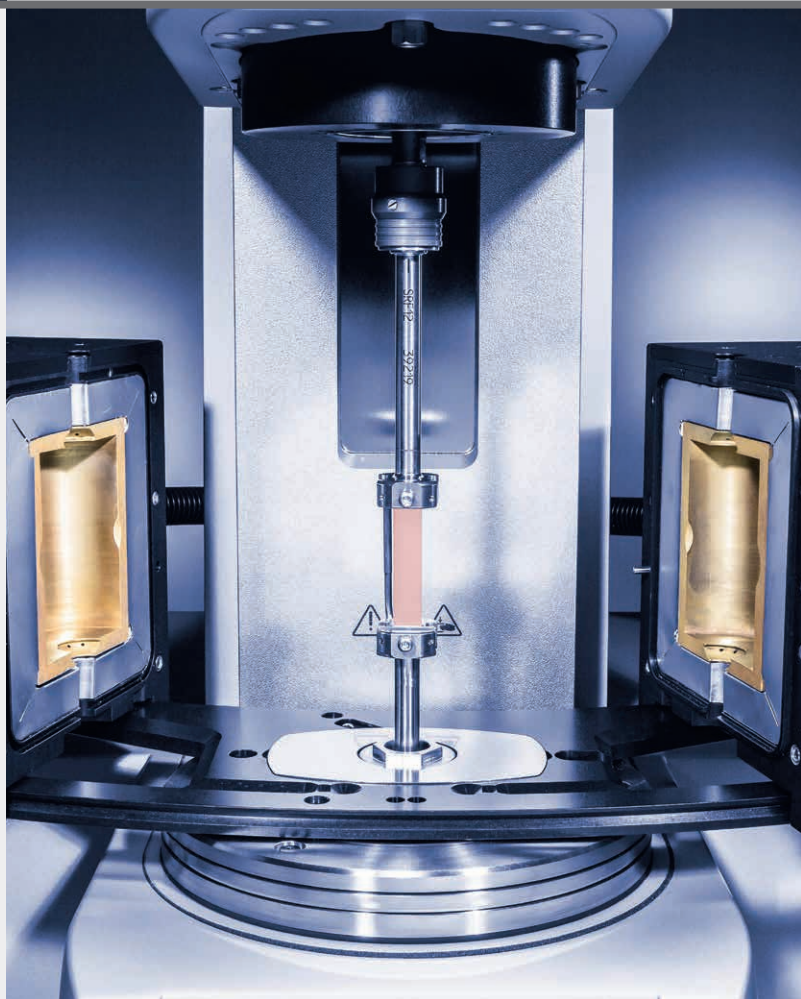
Expand Your Possibilities: Application-specific Accessories for TwinəʌiɹᗡTM Modes

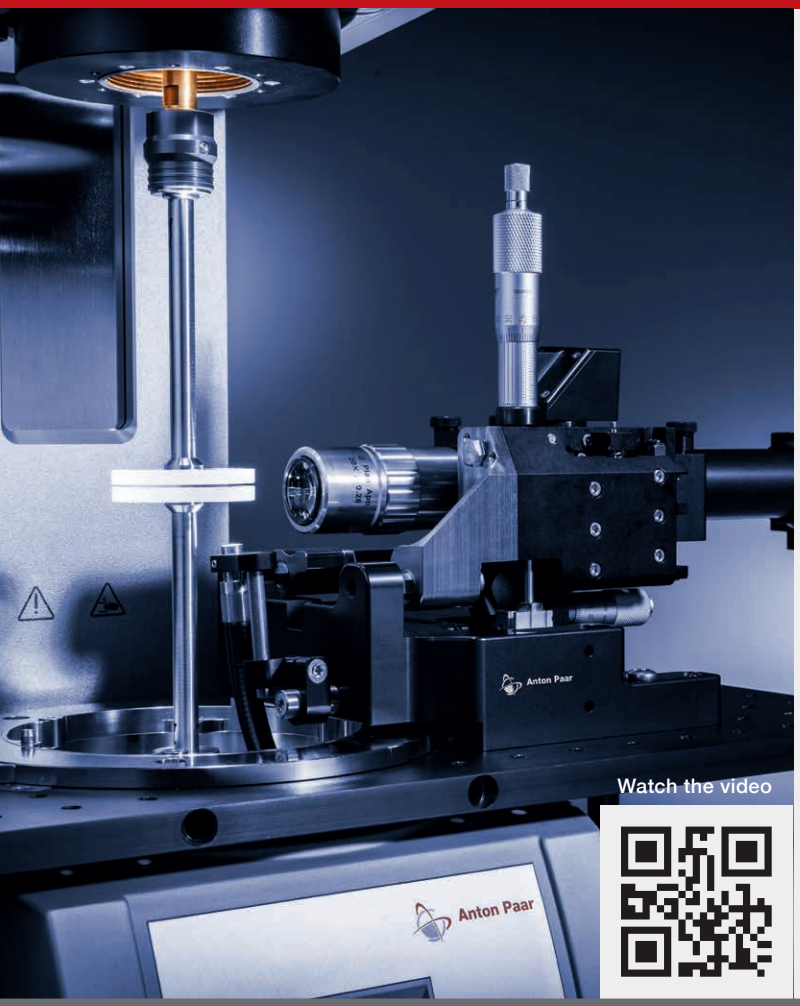
Cone Partitioned Plate

The Cone Partitioned Plate (CPP) for MCR 702 TwinəʌiɹᗡTM has a special design which limits the impact of edge fracture effects when characterizing viscoelastic samples. It enables oscillatory and rotational measurements even at deformations/shear rates which would result in an incomplete filling of the active measuring zone in conventional measuring geometries. It therefore increases the analyzable range of amplitude sweeps (large amplitude oscillatory shear – LAOS), step rate tests, and also flow curves in comparison to the usual parallel-plate or cone-plate geometries.

SRF TwinəʌiɹᗡTM: Solid Rectangular Fixture

The Solid Rectangular Fixture for MCR 702 TwinəʌiɹᗡTM (SRF TD) allows DMA (dynamic mechanical analysis) measurements on solid bars using both motors. This extends the frequency range for some viscoelastic samples due to the fact that the excitation is separated from the torque measurement. Furthermore, the concept offers the characterization of material properties from the glassy to the rubber state including the determination of glass transition temperatures and the onset of melting as accurately as possible.





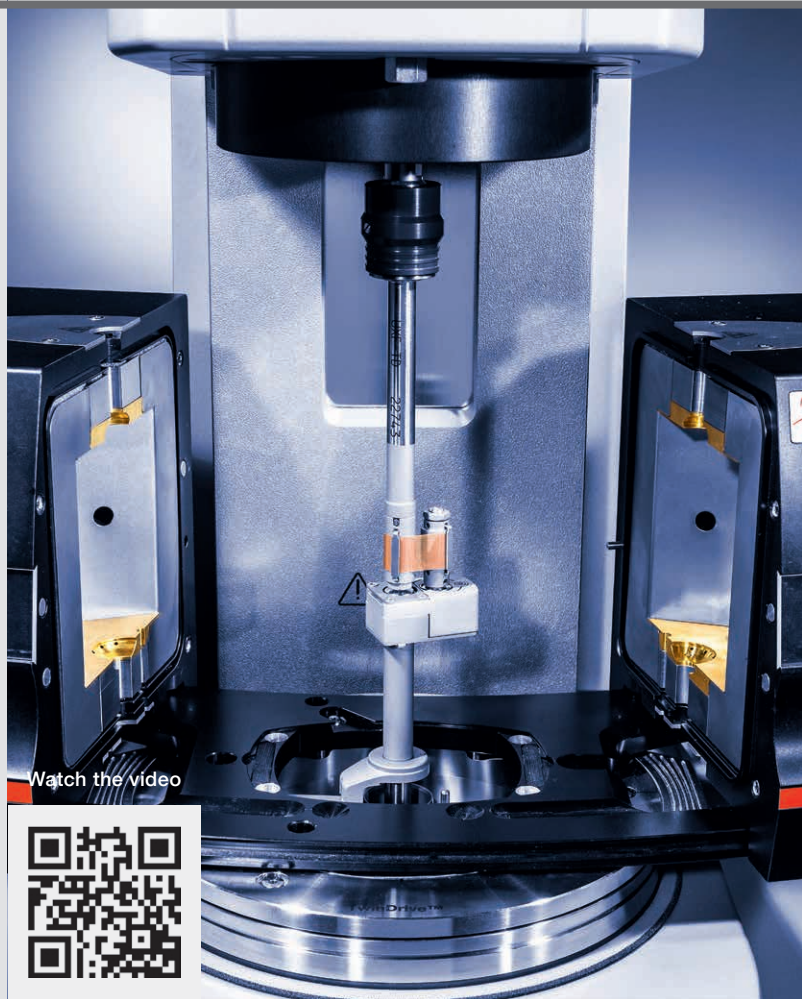
Watch the video

Rheo-Microscopy for MCR 702 TwinəʌiɹD™

Using the rheo-microscopy setup for TwinəʌiɹD™ opens up entirely new views. You can apply the rheometer's counter-rotation mode to produce a stagnation plane in which the observed structure is sheared but remains in a fixed position. This stagnation plane constantly keeps the focused structure in the microscope's field of view while accurate rheological data is obtained. Using the speed balance, you can also change the speed distribution between the two drives and move interesting structures back into your field of view, while keeping the shear rate constant.

UXF TwinəʌiɹD™: Extensional Rheology Fixture

The Universal Extensional Fixture (UXF) enables extensional rheological measurements with unprecedented torque and strain resolution when using MCR 702 TwinəʌiɹD™ in its counter-rotation mode. While the established SER system is perfectly suitable for extensional tests at high torques, UXF TwinəʌiɹD™ opens up new possibilities for measurements of low-viscosity films and fibers and allows for entirely new test procedures such as stress relaxation tests in extension. The obtained data perfectly matches the theory; in addition, the system is sensitive enough to measure the influence of sagging at long relaxation times, which can also be observed using a CCD camera.



Watch the video

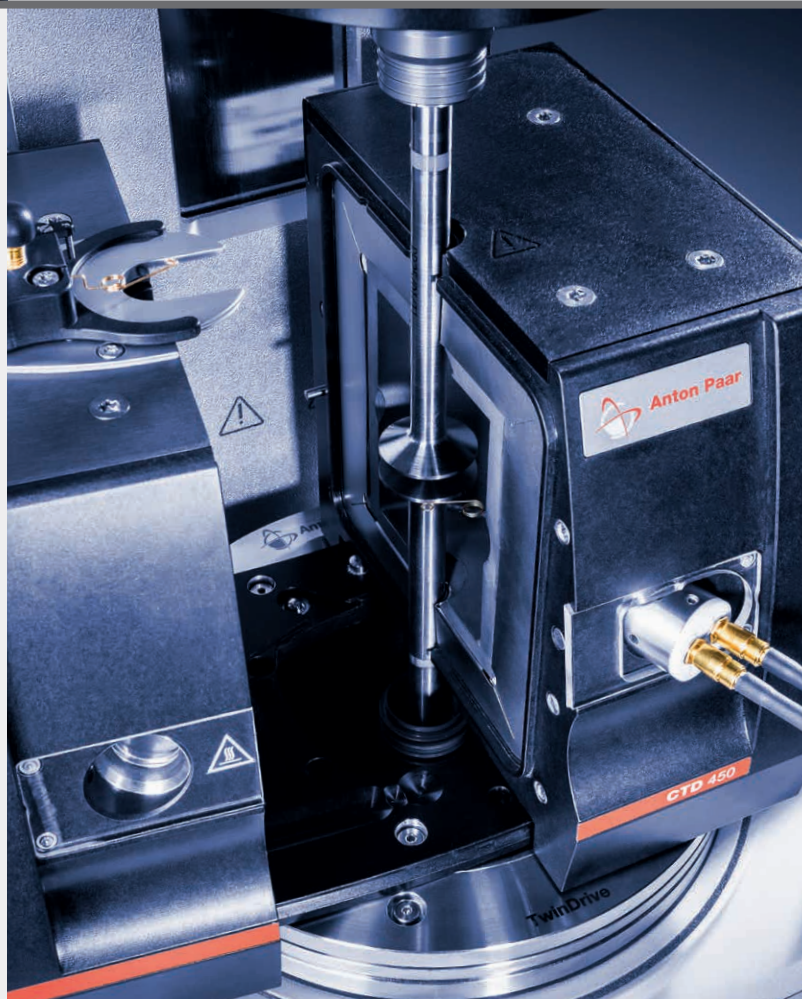
Watch the video

Flow Visualization with MCR 702 TwinəʌiɹC™

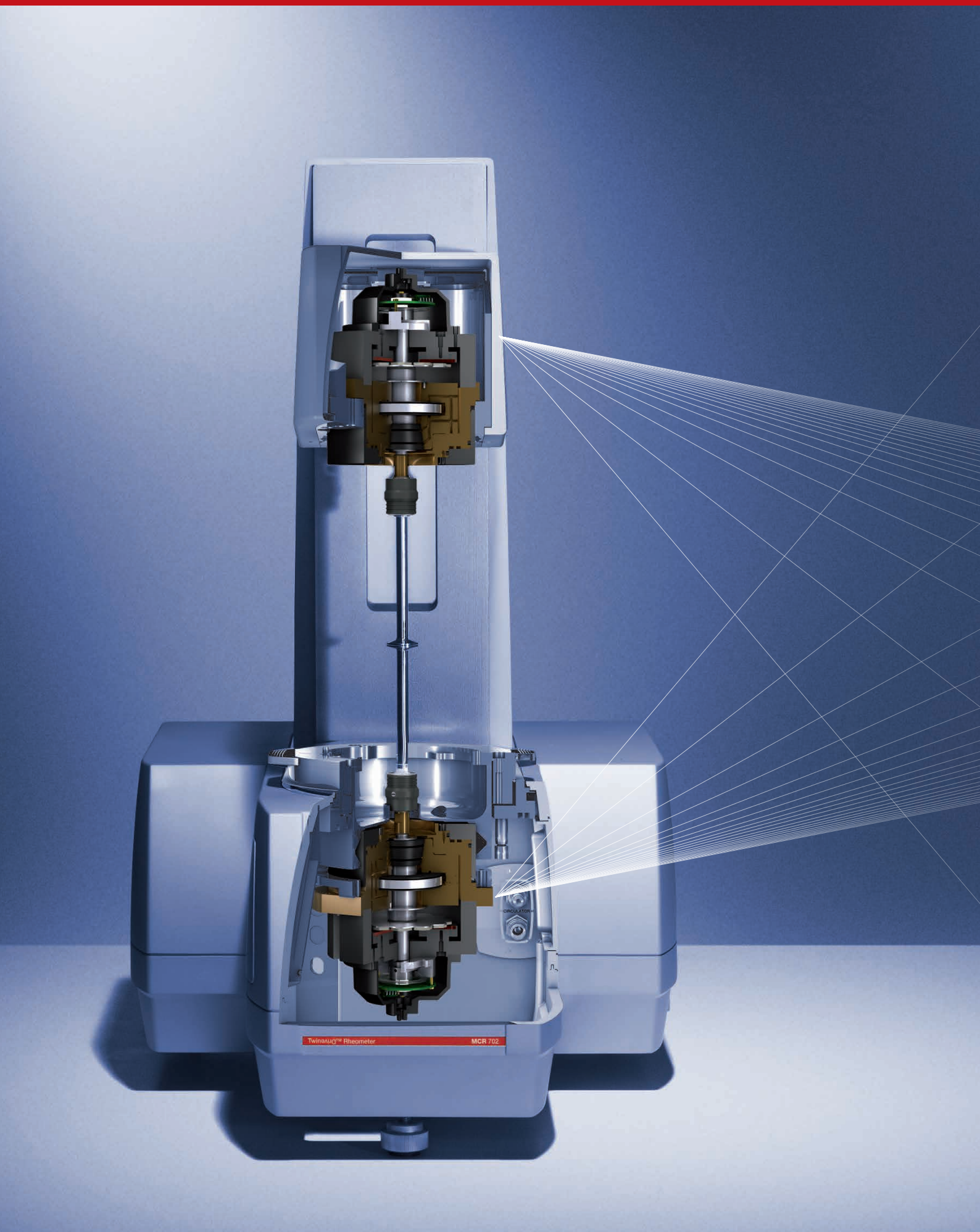
Most rheological calculations are based on the assumption of laminar flow, although more uncommon sample behavior like shear banding is often reported in recent experiments. The visualization of flow is therefore a highly important tool to understand these new flow effects. MCR 702 TwinəʌiɹC™ can be used in all test modes together with a transparent concentric cylinder. This measuring system is a perfect configuration for observing your sample from all sides while sheared. The study of the onset of flow instabilities is therefore an interesting potential application when measuring with such a configuration.

Dielectro-Rheological Device

The Dielectro-Rheological Device (DRD) for MCR 702 TwinəʌiɹC™ can be used in all modes, also in the single-drive mode, for combining dielectric spectroscopy and rheology. The DRD enables you to investigate the influence of mechanical deformation on samples' conductivity, capacity and permittivity. This setup can be used to analyze the influence of flow and deformation forces on the dielectric spectra of your sample and to investigate material properties in a range less accessible to mechanical analysis. The DRD accessory comes with different contact options to allow for use in rotational as well as oscillatory tests.



TwinDrive™
The Key to Accuracy



Rapid control and vast torque capabilities

The air-bearing-supported synchronous EC motor is the key to MCR 702's performance – providing rapid control and vast torque capabilities from 230 mNm down to 1 nNm.

The rotor of the EC motor drive is equipped with permanent magnets. In the stator, coils with opposite polarity produce magnetic poles. The magnets in the rotor and stator coils attract each other, so that a rotating flux of current in the coil windings produces a frictionless synchronous rotor movement. The torque of the motor is set and measured via the input current to the stator coils. Due to its unique design, the EC motor features a linear relation between the torque and the input current to the stator coil – a great advantage for precise torque control and measurement. For increased testing flexibility, the motor is easily and reliably set to move in two respective directions.

Its rapid, accurate control and its extremely wide torque range make the EC motor the ultimate torque transducer in SMT applications.

The air bearing

Two air bearings surround and support each motor:
A radial air bearing centers and stabilizes the shaft; an axial air bearing holds the weight of the rotating parts. Specifically optimized for rigidity, drift stability and robustness, the MCR rheometers' air bearing technology together with improved torque scanning enables low-torque measurements down to a minimum of 1 nNm.

Measuring point durations of 1 ms

The use of the most recent processor technology in MCR 702 increases the speed of data processing and enables measuring point durations of 1 ms, increasing the efficiency of transient tests.

Angular deflections down to 50 nrad

A high resolution optical encoder based on data oversampling technology enables the measurement and control of smallest speeds and angular deflections down to 50 nrad.

The normal force sensor

The high sensitivity and increased sampling rate of the normal force sensor integrated in the air bearing enables normal force measurements during transient and steady-state tests as well as static normal force measurements for gap control and DMTA, tack or penetration tests. The sensor employs an electric capacity method, precisely converting extremely small deflections in the air bearing into the according normal force. Instead of enforcing additional travel, the natural movement already present in the air bearing is used to measure the normal force. The advantage of the sensor's location in the air bearing: Normal force measurements are available for all temperature devices and application-specific accessories, as well as in both motor units in all applications.

TruRate™

The MCR series' TruRate™ sample-adaptive controller intelligently adapts to the sample conditions at hand in rotational tests. Without prior information on the sample, the desired settings for strains and shear rates are achieved in minimum time and without overshoots.

TruStrain™

The system's TruStrain™ functionality allows real-time processing of oscillatory strains. In oscillation, TruStrain™ employs real-time position control based on the Direct Strain Oscillation (DSO) method. This means you are able to preset and control precisely sinus-shaped strains both within the linear viscoelastic (destruction-free) range as well as in LAOS (Large Amplitude Oscillatory Shear) conditions.

Full transparency about both drives in software

The software for the MCR rheometers not only allows you to display all rheological data, it also provides full transparency regarding all physical parameters of both active drives. This transparency always gives you an inside look into the rheometer control.

Build on Your Rheometer: Application-specific Accessories for the Single-drive Mode

Structure Analysis

Gather sample structure information by combining these optical and dielectric methods with rheology.

Rheo-Microscopy (Fluorescence, Polarized, Non-Polarized)

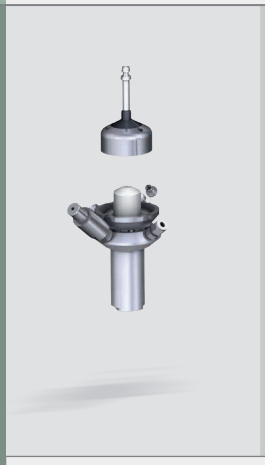
Small-angle light scattering (SALS)

Small-angle X-ray scattering (SAXS)

Small-angle neutron scattering (SANS)

Additional Parameter Setting

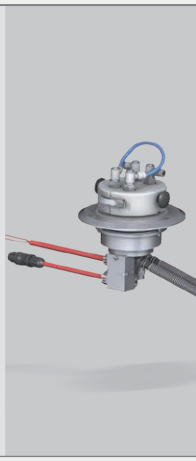
Employ these accessories to set additional parameters together with the temperature for rheological tests.



Pressure cells

UV Curing System

Immobilization Cell

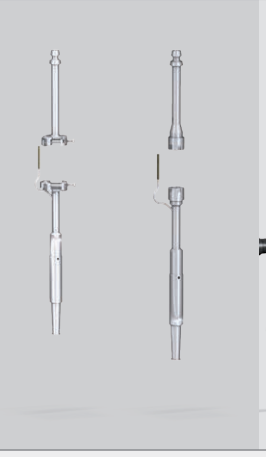


Magneto-Rheological Device

Extended Material Characterization

These accessories transfer the MCR rheometer's measuring capabilities into other material characterization applications.

Extensional rheology

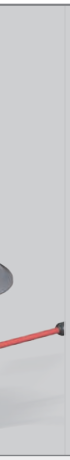


Dynamic mechanical thermal analysis (DMTA)

Starch rheology

Large-particle rheology

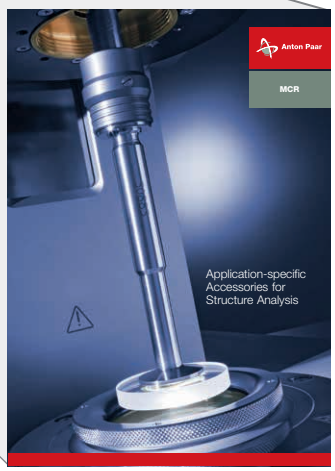
Obtain additional structure information, set additional parameters or employ the rheometer's functionality for further material characterization: This wide range of application-specific accessories is easily integrated into your MCR rheometer.

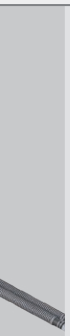


Particle image velocimetry (PIV)

Polarized Imaging

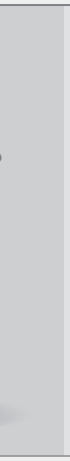
Dielectro-Rheological Device (DRD)

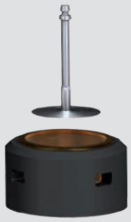




Electro-Rheological Device

Humidity Option for CTD 180





Interfacial rheology

Tribology:

Ball on three plates
Pin on disk
Four ball

Powder Cell

New Paths for Your Applications
The RheoCompass™ Software

Your rheometer opens up a constantly growing number of measurement opportunities. This calls for a navigation tool that gives you the complete overview as well as the exact insights you require: Anton Paar's new RheoCompass™ software, the most innovative and up-to-date rheometer software available on the market.

Designed for intuitive use, RheoCompass™ enables application-oriented template filtering, customized test and analysis definitions, highly simplified data retrieval and much more.

Specifications

	Unit	MCR 702 TwinəʌiɹD™	
		Single-drive Mode	TwinəʌiɹD™ Mode
EC motor (brushless DC) with high resolution optical encoder and air bearing	-	✓	✓
Permanent torque (60 min), no signal drift	-	✓	✓
Controlled shear rate and shear stress	-	✓	✓
IsoLign™ Piezo flange - Gap size change	nm	10	10
Maximum torque	mNm	230	230
Minimum torque, rotation	nNm	1	5 (SMT)
Minimum torque, oscillation	nNm	0.5	1 (SMT)
Angular deflection, set value	µrad	0.05 to ∞	0.05 to ∞
Step rate, time constant	ms	5	5
Step strain, time constant	ms	10	10
Step rate, time to reach 99 % of set value (independent of sample)	ms	30	30
Minimum angular velocity, controlled (1)	rad/s	10^{-9}	10^{-9}
Maximum angular velocity, controlled	rad/s	314	2 x 314
Minimum angular frequency (2)	rad/s	10^{-7} (3)	10^{-7} (3)
Maximum angular frequency	rad/s	628	628
Normal force range	N	0.005 to 50	0.001 to 50
Counter-rotation		○	✓
Counter-oscillation		○	✓
Toolmaster™ (US Patent 7,275,419), measuring system and measuring cell (wireless detection and transmission of measuring system and calibration parameters)	-	✓	✓
QuickConnect for measuring systems, screwless	-	✓	✓
Electronic trim lock for the measuring system	-	✓	✓
TruRate™	-	✓	✓
TruStrain™	-	✓	✓
Normal force and velocity profiles, tack, squeeze	-	✓	✓
Automatic gap control/setting, AGC/AGS	-	✓	✓
Dimensions	mm	753 x 444 x 586	753 x 444 x 586
Weight	kg	47	56
Depending on your application and test mode, MCR 702 TwinəʌiɹD™ can be operated with ...			
Direct strain, amplitude controller	-	✓	
Direct stress, amplitude controller	-	✓	
Raw data (LAOS, waveform, ...)	-	✓	
Digital Eye video option and camera	-	○	
Maximum temperature range	°C	-160 to +1000	
Pressure range	bar	up to 1000	
Structure Analysis (Microscope, SALS, SANS, Birefrigence, PIV, ...)		○	
Additional Parameter Setting (UV, Magneto- and Electro-Rheological Device, ...)		○	
Extended Material Characterization (DMTA, Tribology, ...)		○	
Connections		USB, Ethernet, 4 analog interfaces, 2 auxiliary inputs, Pt 100 and thermocouple interfaces	

(1) Depending on measuring point duration and sampling time practically any value is achieved
(2) Set frequencies below 1.0E-04 rad/s are of no practical relevance due to the measuring point duration > 1 day
(3) Theoretical value (duration per cycle = 2 years)

Legend: ○ optional ✕ not available ✓ included

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