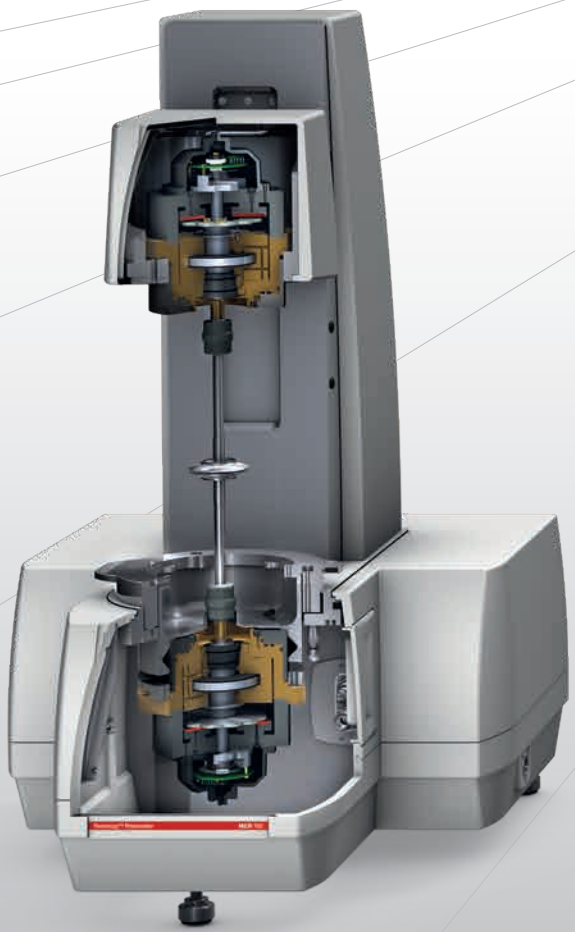
Anton Paar

MCR 702

MultiDrive rheometer



The rheometry revolution

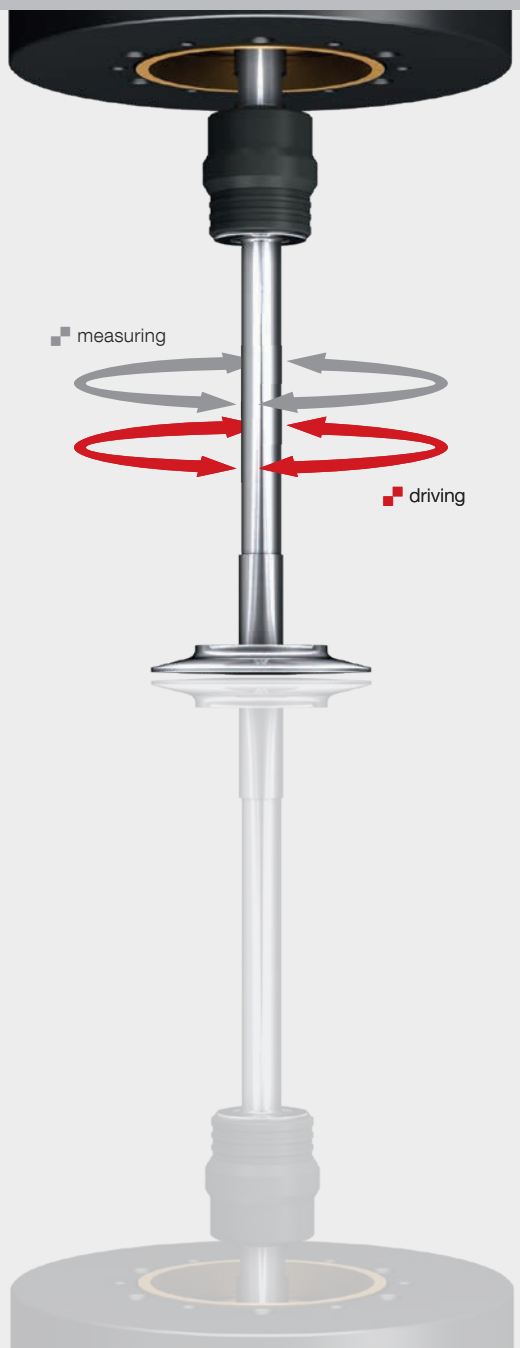
MCR 702 MultiDrive is the most versatile rheometer suitable for work in all standard test modes known from a rheometer and ready to be equipped with an additional lower drive unit. This modular concept enables MCR 702 MultiDrive to perform rheological tests with two torque transducers and drive units at once – flexible and precise enough to deliver the results you need. There are no limitations regarding the used test modes, suitable measuring systems, accessories, and temperature devices and also regarding measurement precision. In short, this is the system of choice to cover all possible rheological applications.

The modes that make it possible

Configuration with one EC drive

This configuration provides you with the vast range of application options that MCR rheometers are known for.

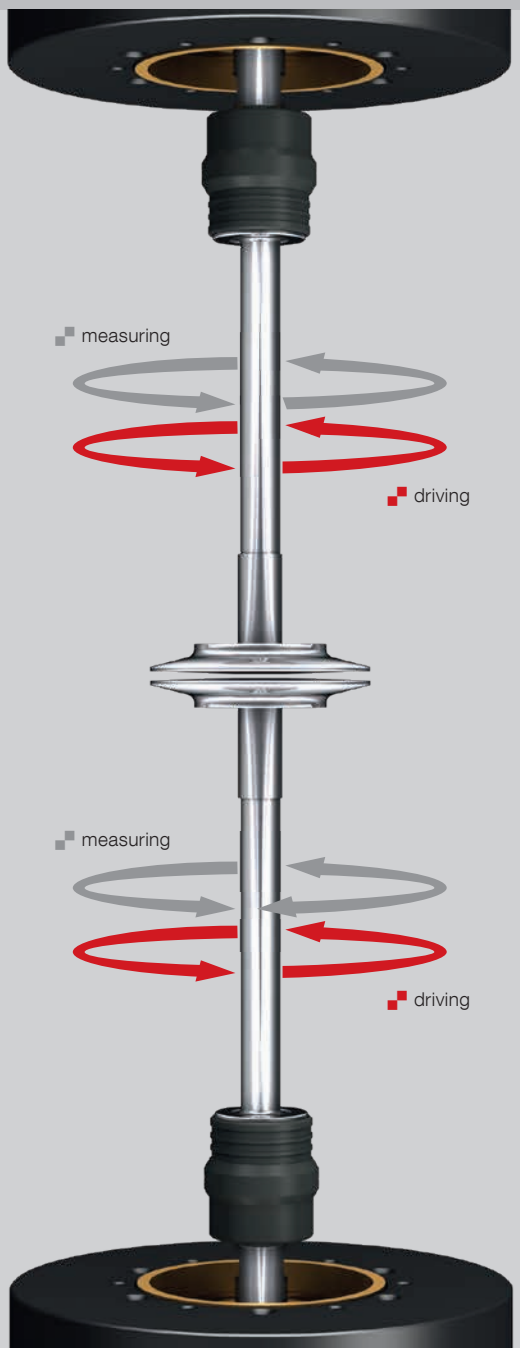
In this configuration MCR 702 is operated in a Combined Motor Transducer (CMT) mode. Using a single air-bearing-supported EC motor unit, you can make the most of the motor's TruStrain™ capability and perform 'classic' stress-controlled tests. The option to either control the shear rate or the shear stress 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.



Configuration with two EC drives

This configuration represents a game change in the world

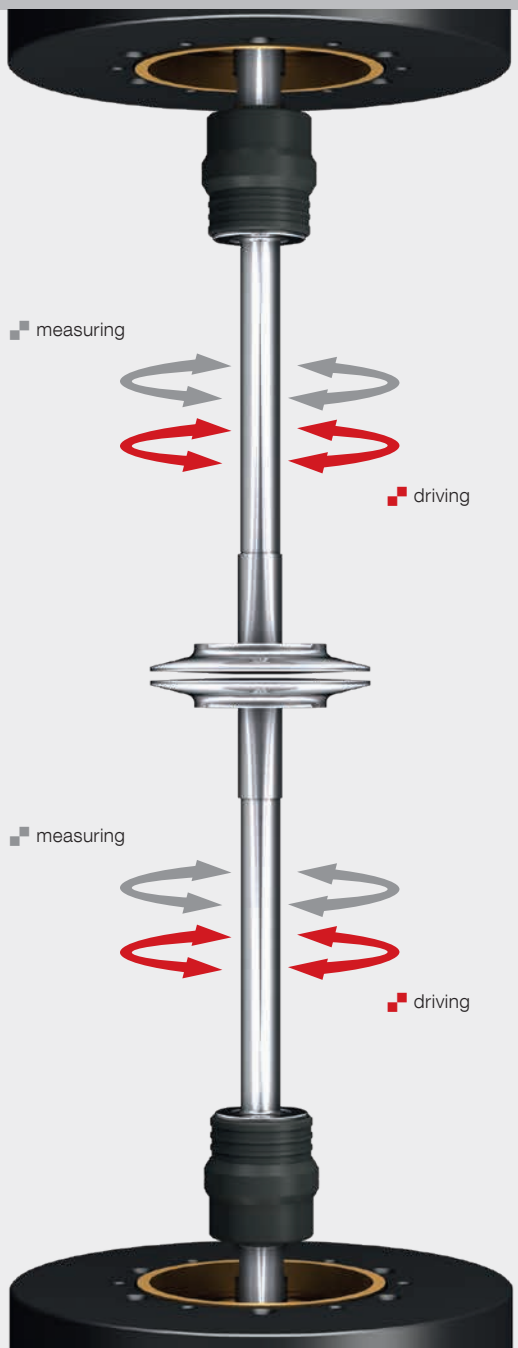
The counter-rotation mode
In the counter-rotation mode, MCR 702 employs both air-bearing-supported EC motors as drive units as well as torque transducers. The two motors are easily set to rotate in opposite directions, with the preset speed divided and shared. This counter-rotation can be used to create a fixed stagnation plane in a sample, which is then easier to investigate microscopically. This mode is also used with UXF 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.



of rheometry, allowing you to break unprecedented new ground in rheological testing.

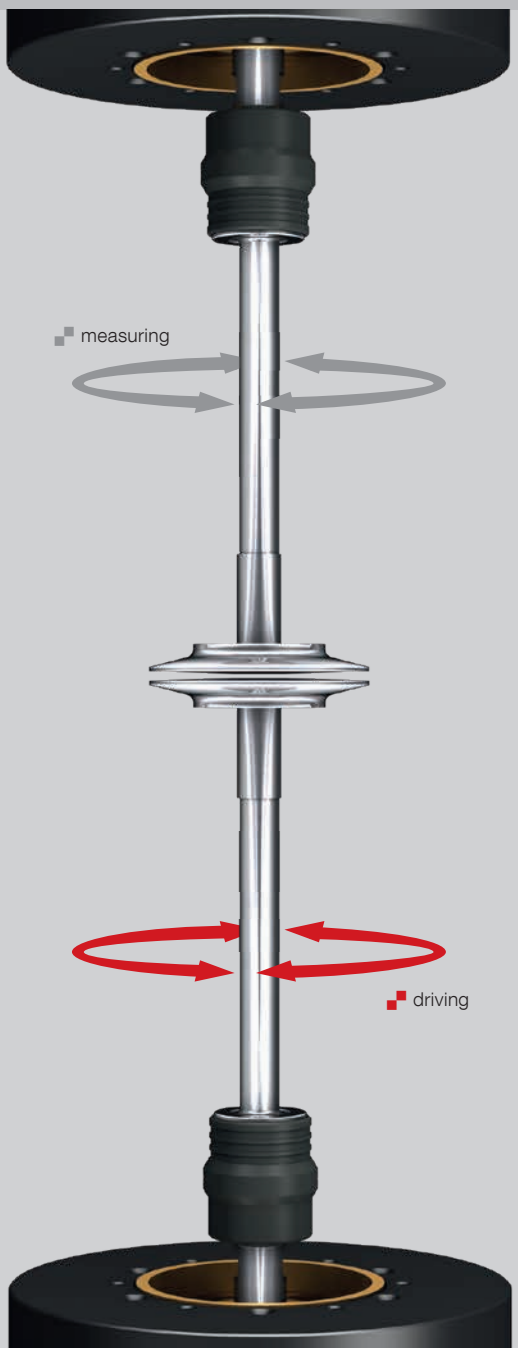
The counter-oscillation mode

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 CMT 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.

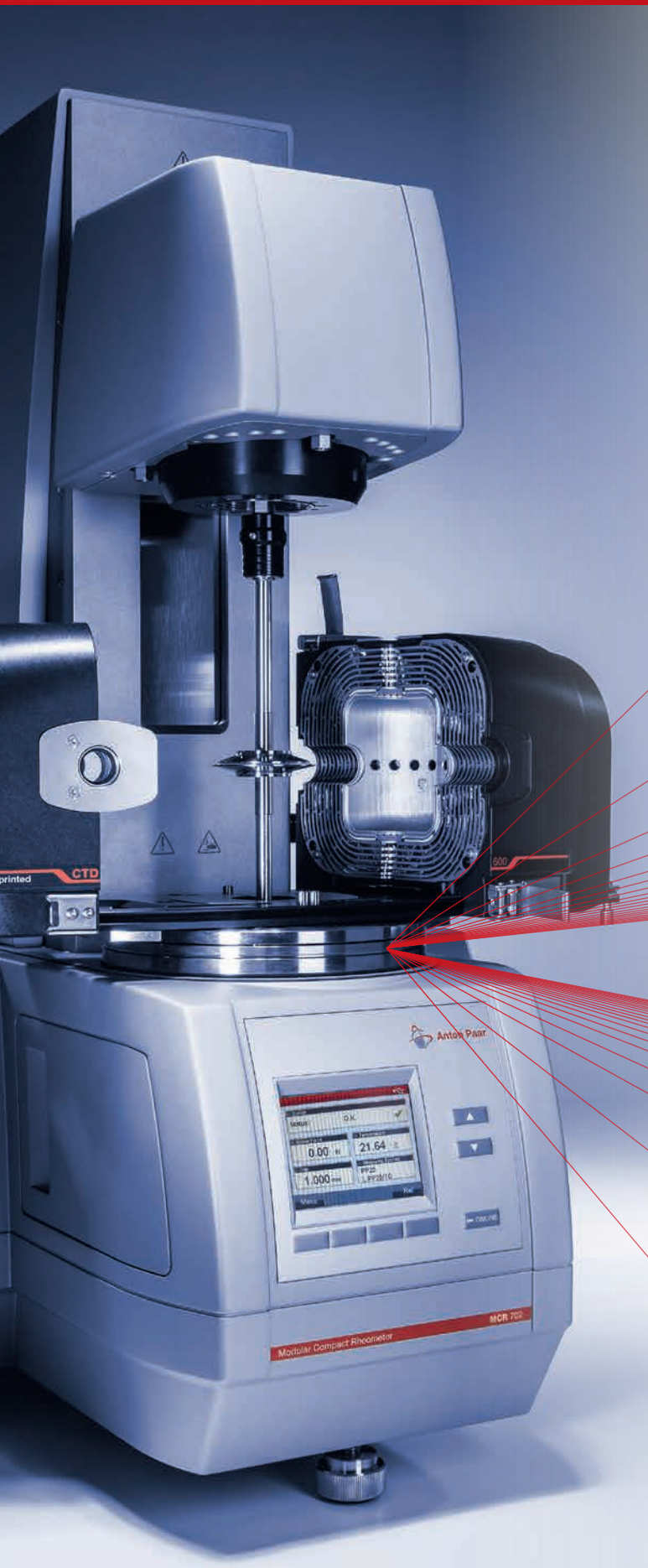


The separate motor transducer mode

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 MultiDrive offers nano-scale precision on several counts – such as low-torque measurements down to a minimum of 0.5 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.

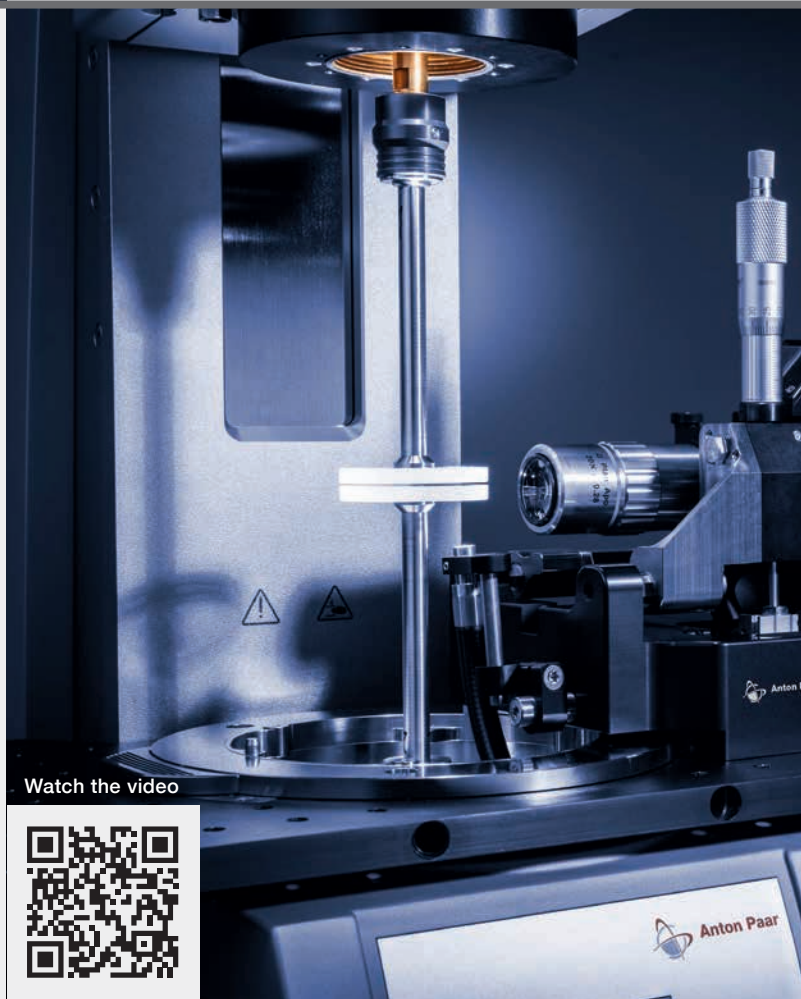
Expand your possibilities: Application-specific accessories for the configuration with two EC drives

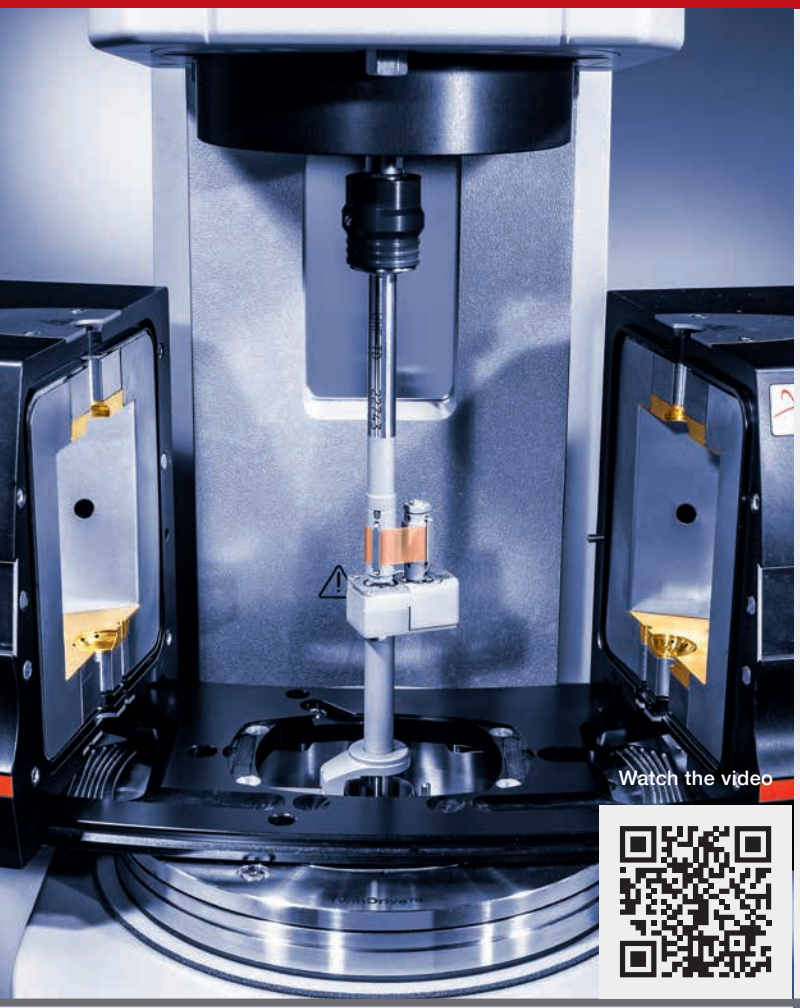
Cone Partitioned Plate

The Cone Partitioned Plate (CPP) has a special design which limits the impact of edge fracture effects when characterizing viscoelastic samples in the separate motor transducer mode. 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.

Rheo-Microscopy

Using the rheo-microscopy setup for the configuration with two EC drives 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.



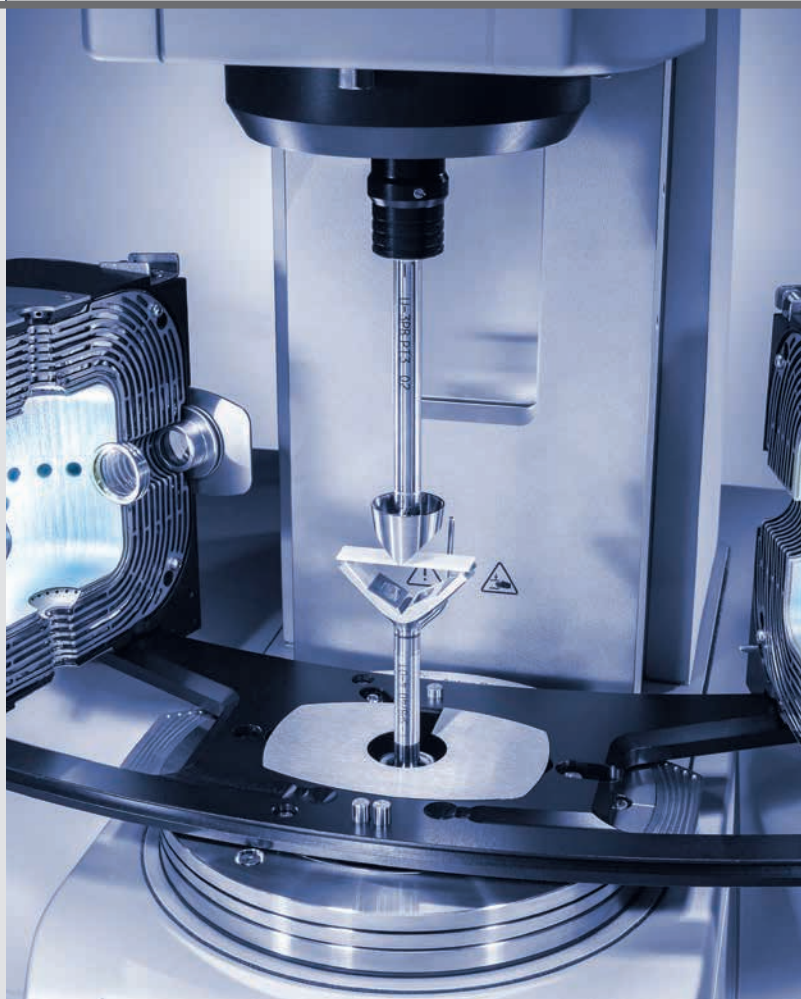


Extensional Rheology Fixture

The Universal Extensional Fixture (UXF) enables extensional rheological measurements with unprecedented torque and strain resolution when using MCR 702 MultiDrive in its counter-rotation mode. While the established SER system is perfectly suitable for extensional tests at high torques, UXF suitable for the configuration with two EC drives 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.

Linear Drive

Various fixtures are available to perform dynamic mechanical analysis on solid bars in torsion using one or two rotational drives in the rheometer. Besides this MCR 702 MultiDrive offers the possibility to use an additional linear drive instead of the lower rotational drive. This enables you to perform dynamic mechanical analysis also in tension, bending, and compression. In combination with three-point bending systems, cantilevers, solid rectangular fixtures, and parallel-plate measuring systems. MCR 702 MultiDrive offers you the method of choice in dynamic mechanical analysis.

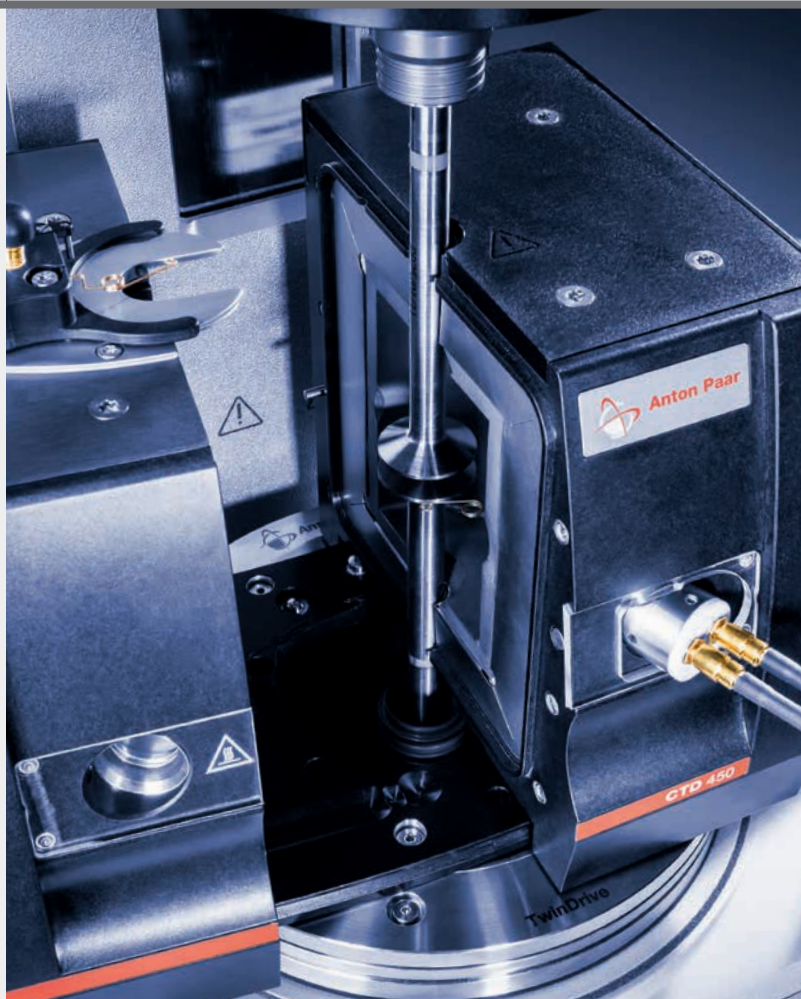


Flow Visualization

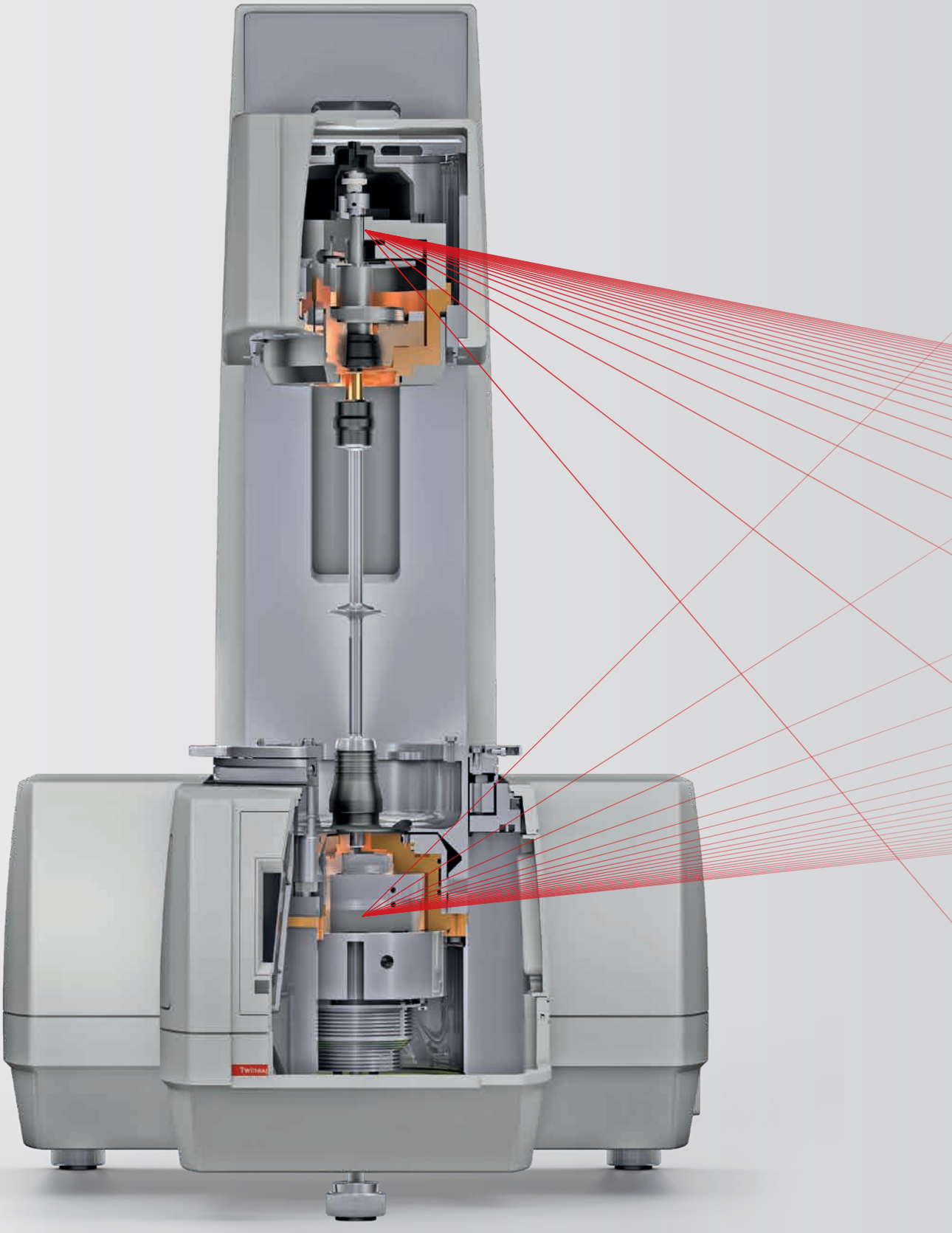
Most rheological calculations are based on the assumption of laminar flow, although more uncommon sample behavior like shear banding is often reported in recent experiments. The visualization of flow is therefore a highly important tool to understand these new flow effects. MCR 702 MultiDrive can be 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) can be used 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. This accessory is suitable for the configuration with one EC drive as well as the configuration with two EC drives.



MultiDrive
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 0.5 nNm.

The rotor of the EC motor drive is equipped with permanent magnets. In the stator, coils with opposite polarity produce magnetic poles. A rotating flux of current in the coils produces a frictionless synchronous rotor movement. 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.

Its rapid, accurate control and its extremely wide torque range make the EC motor the ultimate torque transducer in SMT applications when working with the two EC drives configuration.

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 0.5 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.

The normal force sensor

High sensitivity and sampling rate of the normal force sensor integrated in the air bearing enable normal force measurements during transient and steady-state tests as well as during DMA, tack or penetration tests. The advantage of the sensor's location: Normal force measurements are available for all temperature devices and application-specific accessories, as well as in all applications.

Optoelectronic technology for the highest temperature accuracy

When working with the two EC drives configuration the lower drive features optoelectronic sensor technology. This technology enables contact-free data transmission. It is based on light emission and the photovoltaic effect which is used in combination with measuring systems with integrated temperature sensors to detect the sample temperature. Conventional contactless transfer methods based on electromagnetic induction can affect the measurement and control of torque at the measurement motor. Our optical transfer method, however, detects the true sample temperature without affecting the torque sensitivity of the measuring device for all possible measurements in separate motor transducer mode and also in counter-rotation and counter-oscillation mode.

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.

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 the 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 the active drives. This transparency always gives you an inside look into the rheometer control.

Build on your rheometer: Application-specific accessories for the configuration with one EC drive

Structure analysis

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

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

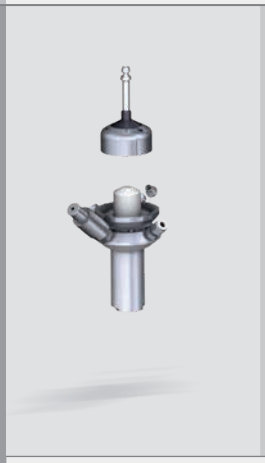
Small-angle light scattering (SALS)

Small-angle X-ray scattering (SAXS)

Small-angle neutron scattering (SANS)

Additional parameter setting

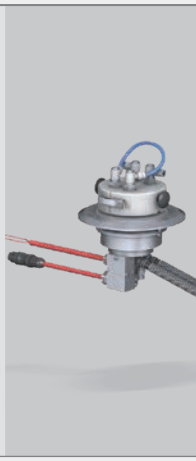
Employ these accessories to set additional parameters together with the temperature for rheological tests.



Pressure cells

UV Curing System

Immobilization Cell

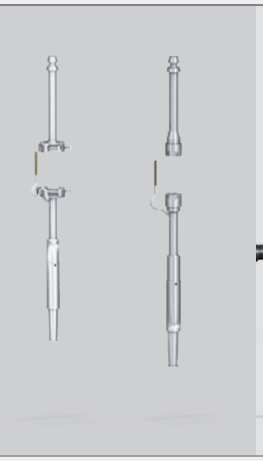


Magneto-Rheological Device

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

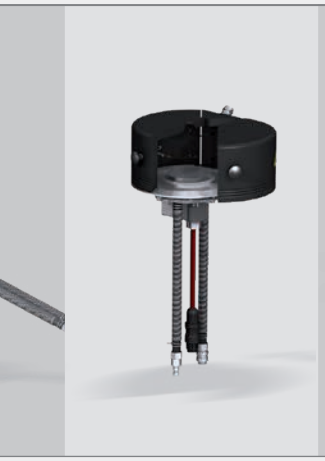
Large-particle rheology

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 MultiDrive	
		Configuration with one EC drive	Configuration with two EC drives
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	-	✓	✓
Optoelectronic technology for precise temperature measurements within the lower moving 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 MultiDrive can be operated with ...

Direct strain, amplitude controller	-	✓
Direct stress, amplitude controller	-	✓
Raw data (LAOS, waveform, ...)	-	✓
Linear Drive (4)	-	○
Digital Eye video option and camera	-	○
Maximum temperature range	°C	-160 to +1000
Pressure range	bar	up to 1000
Structure analysis (Microscope, SALS, SANS, PIV, ...)		○
Additional parameter setting (UV, Magneto- and Electro-Rheological Device, ...)		○
Extended material characterization (Extensional Rheology, Tribology, Powder Rheology, ...)		○
Dynamic Mechanical Analysis in Torsion, Tension, Bending, and Compression (4)		○
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)
(4) Further information regarding general features, measuring systems, accessories, and specifications of MCR 702 MultiDrive using the linear drive for DMA can be found in the brochure Dynamic Mechanical Analyzer MCR 702 MultiDrive

Legend: ○ optional ✕ not available ✓ included

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