

NETZSCH

Proven Excellence.

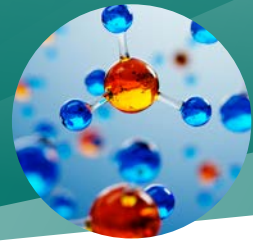


Kinexus Prime Series

More Rheology, Less Effort.

Analyzing & Testing

The Importance of Rheology



Phase Behavior, Microstructure,
Molecular Weight



Formulation, Fillers,
Additives



Kinexus Prime
Rotational Rheometer



PERFORMANCE



Product Application, Spreadability,
Aesthetics, Mouthfeel, Levelling,
Sag Resistance, Tack, Adhesion



In-Use Processes, Product Dispensing,
Pouring, Sprayability, Curing

Rotational and Capillary Rheology

WITH OVER 14 DECADES OF SHEAR RATE



Processing, Extruding,
Injection Moulding

Rosand
Capillary Rheometer

THE HEART OF
FORMULATION
AND PRODUCTION



Product Appearance, Particle
Suspending Capability, Stability,
Homogeneity

FROM FORMULATION AND
PROCESSING TO END-USE
PRODUCT PERFORMANCE

Kinexus Prime Series

NETZSCH Invites You to Join the Power of Prime

NETZSCH combines a 60 year legacy of thermal analysis with 40 years of rheometry experience to bring you the revolutionary Kinexus Prime series.

The Power of Prime offers sophisticated rheology test methods and solutions to gain unique insight into your rheological data. Unmatched ease-of-use and modularity, combined with the ultimate intuitive, flexible software.

NETZSCH are always striving to bring you the latest innovations, manufactured to German engineering standards with an unparalleled reputation for worldwide support and expertise.

An investment in a NETZSCH rheometer is an investment into your research, your product and your time. Kinexus Prime integrates innovative instrument design with a revolutionary software interface, delivering a solution that will not only enhance productivity but also elevate understanding and success.





EasySwap –
Temperature Cartridges are easily
and quickly interchangeable

- Rheological measurements **made easy**
 - Shear stress and shear rate controlled viscometry (transient and steady-state)
 - Shear stress and shear strain controlled oscillation rheometry
 - Creep test/creep recovery and stress relaxation
- Unprecedented vertical travel and gapping capabilities with **ultra-responsive and highly sensitive Normal Force** for class-leading performance
- **Sophisticated software. rSpace is your space, customizable to you.** The intuitive rSpace software offers over 200 inbuilt, customizable measurement sequences in 6 languages, including supporting application notes and educational tips
- **Complete sample history** from loading to unloading is available in the data files as standard. Reliable rheology data for many materials actually starts before a measurement takes place!
- **Over 200 *EasySwap* geometries and customizable accessories.** Rheologist designed tools for characterization of complex fluids and soft solids, including dispersions, emulsions, polymer melts, polymer and protein solutions, pastes, adhesives and gels
- **Intelligent geometry recognition** with full auto-configuration and user feedback on system status to ensure robust data for all measurements
- **Unique plug and play** cartridge system for all *EasySwap* temperature cartridges – easily and quickly interchangeable
- Multifunctional accessory design **featuring true modularity** – *EasySwap* temperatures cartridges with interchangeable geometries and accessories provide a cost-effective solution addressing the widest application coverage

Prime Properties
Engineered to be Better

A Revolution in Shear and Vertical (Axial) Test Control

The unique combination of Kinexus Prime hardware technology and rSpace software gives the user the ability to configure three critical rheometer functions independently:

- Rotational (shear) control: torque, speed and position
- Vertical (axial) control: gap and normal force
- Temperature control: isothermal, ramp or table

Offering the ultimate in rheological test flexibility for both industry and academia, Kinexus Prime enables:

- All rotational shear-based testing
- Advanced vertical (axial) measurements including squeeze flow and tack testing
- A combination of shear and vertical actions for revolutionary process-relevant measurements: Tangential and normal forces can be applied to the sample at the same time

The most sensitive normal force control of any rheometer, while still robust to 50 N

Lift speed up to 35 mm/s!

Ultrafine resolution gap control to 0.1 μm

Controllable speed and/or normal force profiles over full range of vertical travel

Ultra-fast, constant streaming data rate of 5 kHz for all raw instrument variables



Unprecedented Dual-Action Capabilities

Using Synchronized Torque, Displacement, Gap and Normal Force Data at Ultra-High Rates

Gap Control

- Exceptional vertical travel range of 230 mm for maximum user access and flexibility of the test setup
- Unmatched vertical speed range from 0.1 $\mu\text{m/s}$ to a maximum of 35 mm/s
- Controllable speed and normal force profiles over full range of vertical travel – linear, exponential and max/min limited
- Gap measured to a resolution of 0.1 μm over full range
- Optimal sample loading for all material types – from sensitive strain-critical structures to rapid curing systems

Normal Force

- High sensitivity and rapid response times from a novel strain gauge design of the normal force option
- Ultra-fast, constant streaming data update rate of 5 kHz for all instrument variables, including gap and normal force – synchronized with rotational and temperature data



EasySwap and High Temperature Cartridges

- All cartridges are compatible with the entire Kinexus suite of rotational rheometers
- Exclusive plug and play cartridge design
- *EasySwap* cartridges feature quick, easy and robust insertion
- Featuring mechanical, power, communication and fluid connections in one action
- Automatic cartridge recognition and configuration
- Peltier-based systems provide high heating and cooling rates with excellent temperature stability
- High-accuracy temperature sensor in close proximity to the sample
- Temperature resolution to 0.01°C
- Easy-to-clean designs
- Efficient integrated solvent trap design for accurate measurements of rapidly drying samples or materials with volatile components

Peltier-Plate Cartridge (-40°C to 200°C)



Easy Swap Environmental controller for cone-plate and plate-plate measuring systems

- Interchangeable lower plates enable optimal geometry choice, e.g. matching lower pedestal diameter for self-supporting samples, without compromising thermal performance
- *EasySwap* enables you to change the lower plate within seconds, as no screws are needed
- Disposable plate option for curing materials (see page 10)

Peltier-Plate Cartridge with Active Hood (-40°C to 180°C)



Easy Swap Environmental controller with active hood for minimized thermal gradients for cone-plate and plate-plate measuring systems

- Applicable to the measurement of highly thermally-sensitive samples, and for temperature-critical testing where the temperature range is significantly above or below ambient
- Designed using components with low thermal mass enabling high heating and cooling rates
- Sample environment can be modified using the built-in gas inlet

Peltier-Cylinder Cartridge (-25°C to 200°C)

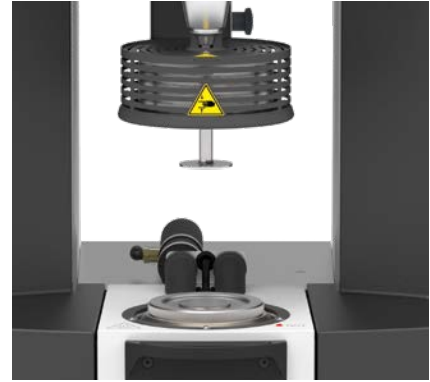


Easy Swap Environmental controller with concentric cylinder-type measuring systems

- Twin Peltier design provides rapid temperature change, quick adjustment of thermal equilibrium and minimized thermal gradients
- Interchangeable lower cups with removable base for ease of cleaning
- Cups include a level indicator for easier sample loading

Special plate insert option provides a cost-effective solution enabling conversion to a plate configuration

HTC Prime Cartridge (5°C to 450°C)



Cutting-edge temperature control in HTC Prime, inspired by thermal analysis technology

- Boost cooling for time-efficient sample management
- Homogeneous sample temperature distribution through optimized forced convection and conductive heating
- Smart cooling air control for perfect sample temperature homogeneity
- Thermally optimized design with low thermal mass and isolation
- Active thermal management system

Designed for Rheological Testing of Complex Fluids, Polymers and Soft Solids



Measuring Systems

- *Quick-Connect* geometries with intelligent auto-recognition
- Geometry constants and test preferences automatically configured
- Specified geometry activated sequencing in rSpace to minimize operator errors
- Automated geometry lock via software for ease of trimming
- Extensive material and surface finish options
- Solvent trap compatible
- Disposable upper and lower plate geometry options for curing materials
- Coaxial cylinders (cup and bob) to DIN standard
- Coaxial double gap geometry
- Vane tool options
- Geometry adapter allows use of custom geometries

See our Kinexus accessory brochure for our full range of geometries and accessories

Accessories

Disposable Plates

The disposable plate system is a perfect solution for studying samples that cure or set during testing such as thermosets, adhesives and paints. The upper disposable plates are available in various sizes and are easy to remove and dispose of following a measurement.

Stainless steel (316 Grade) lower plate mount and clamp are designed for optimized thermal properties and mechanical alignment. The disposable plates feature *quick-connect* engagement and release mechanism, including a solvent trap cover location ring on the lower plate to be used with the Peltier plate cartridge.



Disposable plate system



Disposable lower plates, 0.5 mm

Solvent Trap

The Kinexus solvent trap is an essential accessory when working with volatile samples prone to evaporation and drying. Providing thermal insulation from ambient conditions, the passive solvent trap KNX2513, also allows atmospheric gases to be purged across the sample via gas inlets. KNX2513 is compatible with both plate and cylinder cartridges. For measurements with an active hood cartridge the low profile KNX2514 should be used.



Solvent trap



Kinexus Prime ultra+ equipped with the UV Curing System (KNX5007 and system stand KNX5010)

UV Curing System

UV-curable materials are widely used in coatings, adhesives and dental compounds. When these materials are exposed to UV radiation, a fast cross-linking reaction occurs, typically within less than a second to a few minutes. Rheometers are used to monitor the curing process and measure the modulus change of the material.

The Kinexus UV-measuring cell utilizes the open base designs of the Kinexus platform and cylinder cartridge (KNX2002-E), enabling the required optical train to be used when shear is applied to the material.

The Kinexus UV curing system enables the rheological properties of a UV-curing material to be monitored over time during the application of UV light. The rSpace software includes an intuitive interactive guide during operation of the UV curing accessory. UV light intensity can be controlled and programmed within the software.

Twin Dispersion Paddle

The twin dispersion paddle is designed to be used for materials prone to sedimentation or multi-part systems requiring mixing. The upper shaft is insulated with PEEK in order to prevent heat flux during mixing at higher temperatures. There are two different paddle size options available to cover a wide range of material viscosities and formulations. There are different cups that can be used with the twin dispersion paddle, including smooth, roughened and splined surface finishes to prevent slippage.



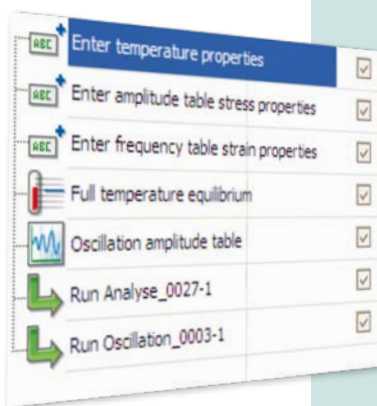
Twin Dispersion Paddle

rSpace Software



Experience the Ultimate in Test Flexibility with Sequence-Driven Rheometer Control

The unique sequence-based rSpace software combines the requirements of quality assurance with completely open programming and raw data access; meeting the research demands of both university and industry. You don't need to be an expert to start generating good data with rSpace!



The rSpace software is driven by sequences – consisting of fundamental rheological actions (or test building blocks). These can be linked together with other test actions, to build intelligent tests.

Sequence Features in Kinexus Prime

- Drag and Drop actions and Import subsequence functionality
- Sequences can be designed to include:
 - user choices and questions
 - calculate values
 - loops
 - triggers
 - pass/fail reporting
 - models
 - cross-over points
 - peak and valley analysis
 - automatic report generation
 - prompts using imagery
 - specific user inputs and instructions during a measurement

Standard Operating Procedure (SOP)-Driven Tests for Reliable Rheological Measurements

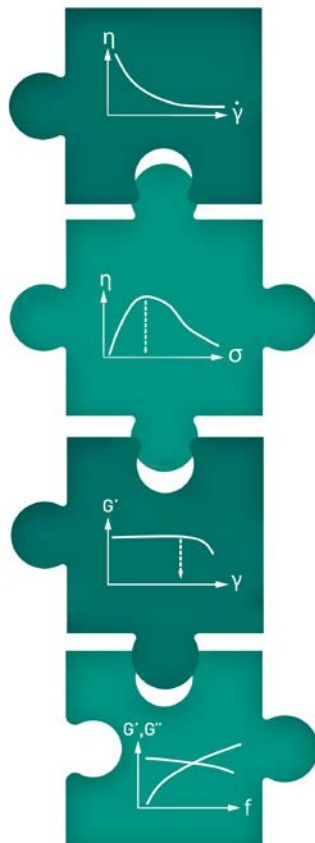
Over 200 inbuilt, customizable measurement sequences offering Toolkit tests in 6 languages:

- Continuous feedback and user guidance
- Availability for use company-wide
- Consistent and reliable measurements
- Extensive rSolution and rSupport notes included



Rheology Toolkit

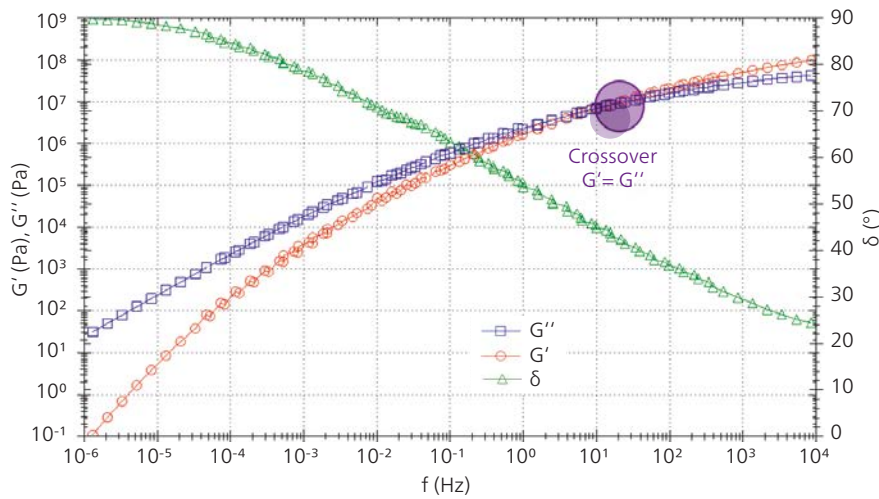
- Series of fundamental rheological tests available in rSpace at the click of a mouse
- Easy access with reliable rheology testing
- Fully configured SOP-driven tests incorporating educational and informative descriptions



Toolkit Tests to Solve Your Material Puzzles:

- Build an overall rheology picture of your material
- Find an answer to material formulation, application or process problems
- Targeted optimization of a key material characteristic, or implementation of a critical diagnostic test

Prediction of the Long-Time Behavior of a Polymer Modified Bitumen Binder – Master Curves Reduce Measurement Time

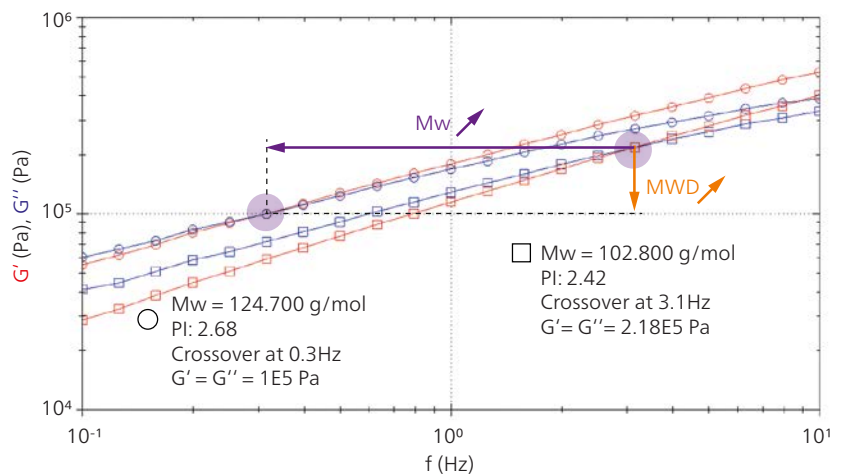


Viscoelastic spectrum of a polymer modified bitumen binder showing elastic G' (red), viscous G'' (blue) and phase angle (δ , green) vs. frequency (Hz)

The viscoelastic properties of polymers may change over time. Oscillation measurements at very low frequencies determine their long-time behavior. However, such analyses can be extremely time consuming. Instead of performing interminable tests, the measurements can be carried out at different temperatures over the usual frequency range and a master curve may be automatically created using time-temperature superposition (TTS). The graph shows a master curve created with measurements on a polymer modified bitumen binder at 5 different temperatures using 25°C as a reference temperature. At low frequencies, the polymer reaches a phase angle of 90° (a viscoelastic liquid). Therefore, it does not exhibit a yield stress and flow will occur at any stress applied.

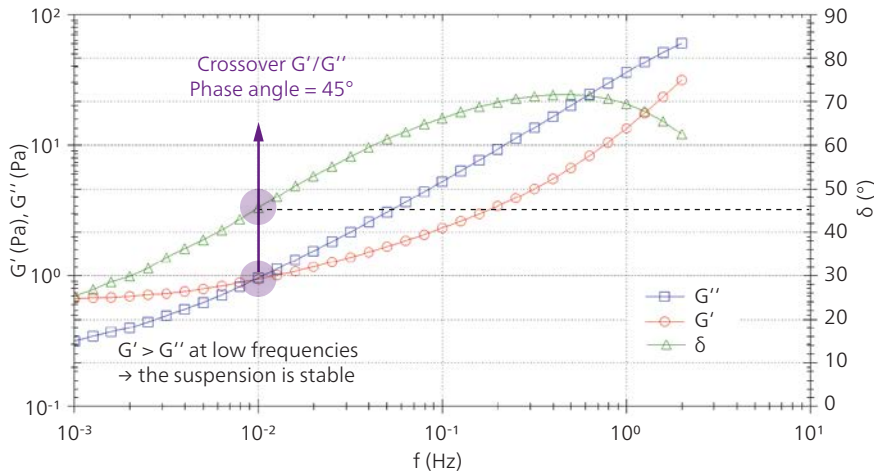
Rheology and Molecular Weight

The molecular weight of a polymer influences its processing and the mechanical properties of the final product and is therefore of great importance. The position of the G'/G'' crossover obtained during a frequency sweep is indicative of the molecular weight and the molecular weight distribution of a polymer. The measurements here show two frequency sweeps carried out on PA12 materials with glass fillers differing from each other only by molecular weight. An increase of the molecular weight by 20% leads to a decrease in the crossover frequency by one decade! Moreover, a small increase of the polydispersity index ($PI = M_w/M_n$) leads to a decrease of the shear modulus detected at the crossover.

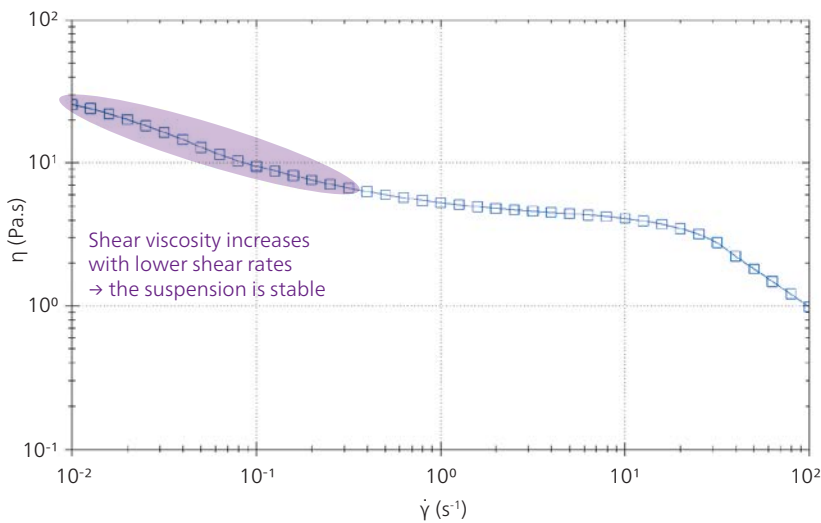


Oscillation: Frequency sweep of two polyamide samples with different molecular weights; elastic modulus (G' , red); viscous modulus (G'' , blue) vs. frequency (Hz)

Is My Suspension Stable?



Oscillation data of a shower gel containing particles showing elastic modulus G' (red), viscous modulus G'' (blue) and phase angle (delta, green) vs. frequency (Hz); geometry was a C25 cup and bob, 2 Hz – 10⁻³ Hz down, 1% strain



Viscosity flow curve of a shower gel with particles; shear viscosity (Pa.s) vs. shear rate (1/s); geometry: cup and bob 25 mm; temperature: 25°C; shear rates: 0.01 s⁻¹ to 100 s⁻¹

Many sauces, medicines and cosmetics are in the form of a suspension, consisting of particles dispersed within a liquid medium. A challenge when formulating a suspension is to avoid sedimentation. To determine if your samples are rheologically stable, two different tests can be performed, as shown here on a shower gel containing suspended particles.

- **Oscillation (frequency sweep):**

In the upper plot, at higher frequencies the viscous modulus is greater than the elastic modulus, indicating that the shower gel flows when vibrated or pushed quickly. However, this behavior inverts at frequencies below 0.01 Hz, where the phase angle is below 45° and the elastic modulus is higher than the viscous modulus. This means we can determine that this shower gel is a viscoelastic solid, meaning that the "solid-like" properties will be dominant when the material is at rest. Therefore, the particles contained in the shower gel will not settle.

- **Viscosity Flow Curve:**

This is a step up through a range of shear rates to measure the equilibrium viscosity at each rate. A higher shear viscosity at low shear rates indicates better sedimentation stability of the dispersion.

Applications

Technical Specifications

Kinexus Prime			
	ultra+	pro+	lab+
Rheometer platform	High-end rheometer for highest demands	For research and development	Quality control with SOP ⁴⁾
Operating modes	Direct strain control, shear rate control, shear stress control		
Torque range – viscometry ¹⁾⁴⁾	1.0 nNm - 250 mNm	5.0 nNm - 225 mNm	10 nNm - 200 mNm
Torque range – oscillation ²⁾⁴⁾	0.5 nNm - 250 mNm	1.0 nNm - 225 mNm	5.0 nNm - 200 mNm
Torque resolution	0.05 nNm	0.1 nNm	0.1 nNm
Position resolution	$< 1.8 \cdot 10^{-9}$ rad	$< 1.8 \cdot 10^{-9}$ rad	$< 1.8 \cdot 10^{-9}$ rad
Angular velocity range	1 nrad ^s ⁻¹ to 500 rad ^s ⁻¹	1 nrad ^s ⁻¹ to 500 rad ^s ⁻¹	10 nrad ^s ⁻¹ to 325 rad ^s ⁻¹
Step position control in strain control	< 10 ms	< 10 ms	< 10 ms
Bearing type	Air bearing		
Frequency range	6.28 μrad ^s ⁻¹ to 942 rad ^s ⁻¹ (1 μHz to 150 Hz)	6.28 μrad ^s ⁻¹ to 942 rad ^s ⁻¹ (1 μHz to 150 Hz)	6.28 μrad ^s ⁻¹ to 628 rad ^s ⁻¹ (1 μHz to 100 Hz)
Motor type	Electronically commutated (EC) drag cup motor		
Motor inertia	12 μN·m·s ²	12 μN·m·s ²	12 μN·m·s ²
Normal force range	0.001 N - 50 N	0.001 N - 50 N	0.001 N - 50 N
Normal force resolution	0.5 mN	0.5 mN	0.5 mN
Normal force response time	< 10 ms	< 10 ms	< 10 ms
Vertical lift speed	0.1 μm ^s ⁻¹ to 35 mm ^s ⁻¹	0.1 μm ^s ⁻¹ to 35 mm ^s ⁻¹	0.1 μm ^s ⁻¹ to 35 mm ^s ⁻¹
Vertical lift range (measurable)	230 mm	230 mm	230 mm
Gap resolution ³⁾	0.1 μm	0.1 μm	0.1 μm
Fully configurable vertical profiles	By speed and Normal Force		
Raw instrument variables	5 kHz constant streaming data		
Complete sample history	Acquisition of raw data from loading to unloading as standard		
Interface	USB2 – plug and play		
rSpace software	Site-wide user license, sequence-driven user interface enabling Standard Operating Procedure (SOP)-type test functionality and fully customizable test designs		
Dimensions and weights	D x W x H (weight): 485 mm x 490 mm x 680 mm (47 kg)		
Power supply	100 - 240V, 15A		

1) Shear rate and shear stress controlled
2) Shear strain and shear stress controlled

3) Specification of accuracy over full vertical lift range
4) Note the relationship between shear stress, torque and measuring geometry.

Understanding the application under consideration, and the associated rheological test requirements, is a key factor in selecting the most appropriate rheometer system.

If you are unsure how to specify an appropriate rheometer model for your application, we recommend contacting us for further advice and/or a sample measurement including an evaluation report.

Kinexus Prime			
	ultra+	pro+	lab+
Measuring geometries			
Quick-connect geometries	Plug and Play; auto-recognition and configuration by the software		
Material	Stainless Steel 316 (British Steel BS) as standard Other options are available, e.g., for chemical compatibility (titanium or Hastelloy)		
Plate and cone diameter	20 mm throughout 60 mm as standardized range – other diameters on request Plates with 4 mm, 8 mm and 25 mm specifically designed for asphalt testing		
Cone angle	Variants with 0.5°, 1°, 2° and 4° – other angles on request		
Interchangeable lower plates	Varying diameters and surface finishes (to match upper geometries)		
Concentric cylinders	C14 (DIN), C25 (DIN), C34 as standard		
Interchangeable cups	Quick release/engage mechanism, optional with removable base and fill-up mark		
Surface finish option	Smooth, sand blasted, serrated, splined or grooved		
Vane tools	Type C14 and C25		
Disposable option	Upper and lower disposable plates for the investigation of curing materials		
Environmental controllers			
Quick-Connect cartridge system	Plug and play; auto-recognition and configuration by the software		
Peltier-plate cartridge	Temperature range: -40°C to 200°C Maximum heating rate*: 30°C/min Maximum cooling rate*: 30°C/min		
Peltier-plate cartridge with active hood	Temperature range: -40°C to 180°C Maximum heating rate*: 30°C/min Maximum cooling rate*: 20°C/min		
Peltier-cylinder cartridge	Temperature range: -25°C to 200°C Maximum heating rate*: 15°C/min Maximum cooling rate*: 15°C/min		
HTC Prime	Temperature range: 5°C** to 450 °C Max. heating rate*: 30°C/min Max. cooling rate*: 15°C/min Max. boost cooling rate: 20°C/min		
Temperature resolution	0.01°C		
Temperature stability	Better than ± 0.1°C		

* Temperature range dependent

** At 6 bar Vortex cooling air pressure (5°C at 5.5 bar Vortex cooling air pressure)

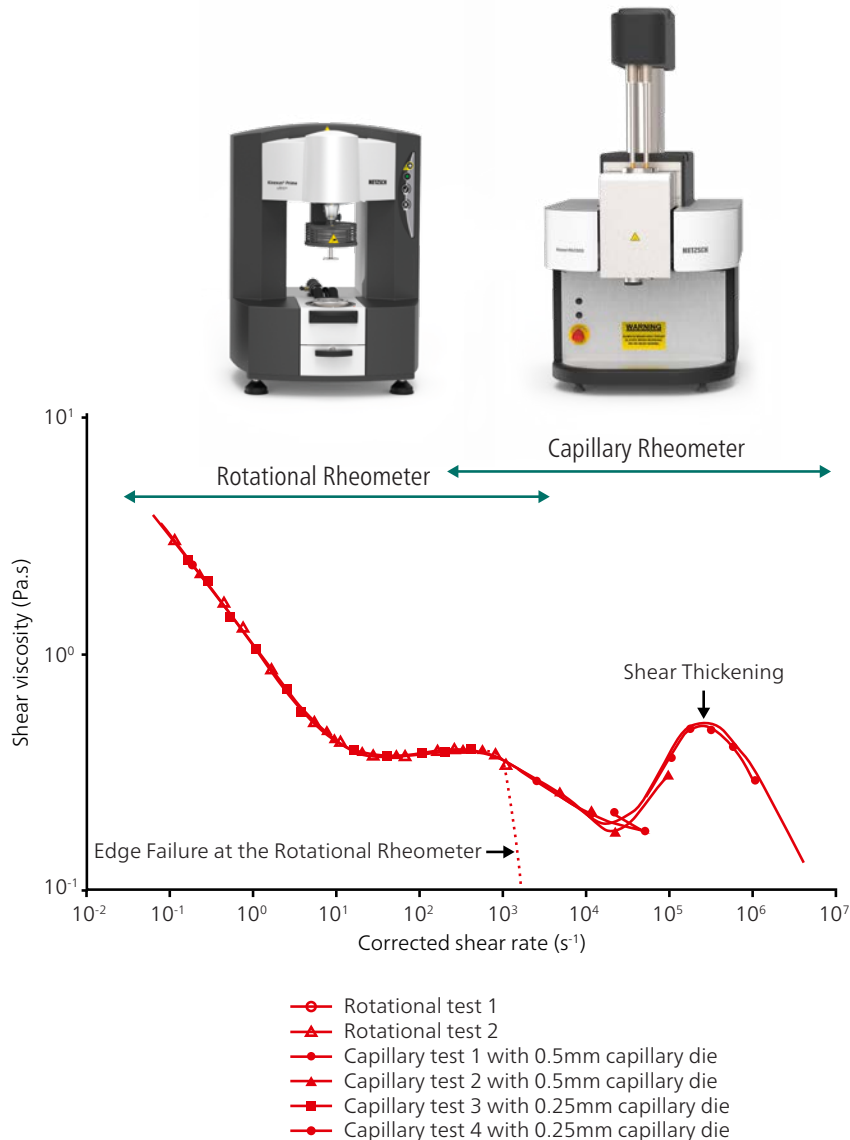
NOTE: Specifications have been obtained under conditions as stated in the Installation and Site Requirements for Kinexus Prime rheometers

Unmatched Shear Rate Range with Decades of Experience

With over 60 years experience in thermal analysis, NETZSCH uniquely offers solutions in both rotational and capillary rheometry.

In a rotational rheometer, the maximum shear rate is reached if the sample is ejected from the measurement gap. Therefore, how can you obtain information regarding the flow behavior at higher shear rates, for processes such as spraying? The solution is a Rosand high pressure capillary rheometer, capable of achieving shear rates up to 10^8 s^{-1} .

Here, a spray coating substance was measured with both Kinexus and Rosand RH2000. At low shear rates, the material is shear-thinning. The faster the product is poured or mixed, it becomes less viscous. At the typical shear rates used for spraying ($\sim 10^6 \text{ s}^{-1}$), it shows a shear-thickening transition indicating this product is not suitable for spraying applications!



Expertise in Service

CLOSE TO OUR WORLDWIDE CUSTOMERS



Our Expertise – Service

All over the world, the name NETZSCH stands for comprehensive support and reliable service, before and after sale. Our qualified personnel from the technical service and application departments are always available for consultation.

In special training programs tailored for you and your employees, you will learn to tap into the full potential of your instrument.

To maintain and protect your investment, you will be accompanied by our experienced service team over the entire life span of your instrument.

Our Expertise – Application Laboratories

The NETZSCH Thermal Analysis applications laboratories are a proficient partner for extensive thermal analysis and rheological issues. Our involvement in your projects begins with proper sample preparation and continues through meticulous examination and interpretation of the measurement results. Our diverse methods and over 30 different state-of-the-art measuring stations will provide ready-made solutions for all your thermal analysis needs.

Within the realm of thermal and rheological analyses, including the measurement of thermophysical properties, we offer you a comprehensive line of the most diverse analysis techniques for materials characterization.

Measurements can be carried out on samples using a diverse selection of geometries, accessories and test options.. You will receive high-precision measurement results with valuable interpretations in the shortest possible time scales. This will enable you to fully characterize new materials and components prior to product launch, minimizing risks of failure, saving time, costs and company resources.

TECHNICAL SERVICE



Maintenance and Repair



Software Updates



Exchange Service



IQ/OQ Documents



Calibration Service



Spare Part Service



Moving Service

TRAINING



Online Training Services



Comprehensive Instrument and Method Training

LABORATORY



Application Service and Contract Testing

The NETZSCH Group is an owner-managed, international technology company with headquarters in Germany. The Business Units Analyzing & Testing, Grinding & Dispersing and Pumps & Systems represent customized solutions at the highest level. A worldwide sales and service network ensure customer proximity and competent service.

Our performance standards are high. We promise our customers Proven Excellence – exceptional performance in everything we do, proven time and again since 1873.

When it comes to Thermal Analysis, Calorimetry (adiabatic & reaction), the determination of Thermophysical Properties, Rheology and Fire Testing, NETZSCH has it covered. Our 60 years of applications experience, broad state-of-the-art product line and comprehensive service offerings ensure that our solutions will not only meet your every requirement but also exceed your every expectation.

Proven Excellence. ■

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