



 RHEOLOGICAL PROPERTIES

# KINEXUS SERIES

REDEFINING RHEOMETER CAPABILITIES

# KINEXUS SERIES

Redefining rheometer capabilities for characterizing dispersed systems

At Malvern, we haven't just redesigned a rheometer – we've redefined the way it interacts with you. Kinexus is the next generation rotational rheometer platform that's been developed from extensive market feedback, integrating innovative instrument design with a revolutionary software interface, to deliver a solution that will exceed your rheological expectations.

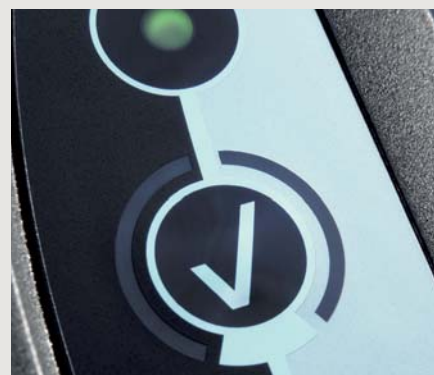
A modular rheometer with true 'plug and play' functionality for all measuring systems and environmental control units, Kinexus enables pioneering Standard Operating Procedure (SOP) driven rheological testing.

Targeted at the characterization of dispersions and other complex fluids and soft solids, the Kinexus rheometer has unprecedented dual-action capabilities for both shear and vertical (or axial) testing.



## Key benefits of the Kinexus rheometer

- All modes of operation – stress control, shear rate control and direct strain controlled oscillation at demand strain amplitude for accurate control of sample strain history
- Exceptional vertical travel and gapping capabilities with ultra-responsive and highly sensitive Normal Force for class-leading performance
- Unique rSpace software interface that offers total flexibility of test set-up - from sequence-driven Standard Operating Procedure (SOP)-type functionality to fully customizable test design for advanced research capabilities
- Wide variety of measurement geometries optimized for rheological characterization of complex fluids and soft solids, including dispersions, emulsions, polymer and surfactant solutions, pastes and gels
- Intelligent geometry recognition with full auto-configuration and user feedback on system status to guarantee robust data for all measurements
- Complete sample history from the point of loading onto the rheometer available in data file as standard – because ensuring reliable rheology data for complex non-Newtonian materials actually starts before a measurement takes place
- Unique 'plug and play' cartridge system for all environmental controllers – all mechanical, power, communication and fluid connections made in one simple action
- Multifunctional accessory design – plate cartridges with interchangeable lower plates for a cost-effective solution addressing the widest application coverage

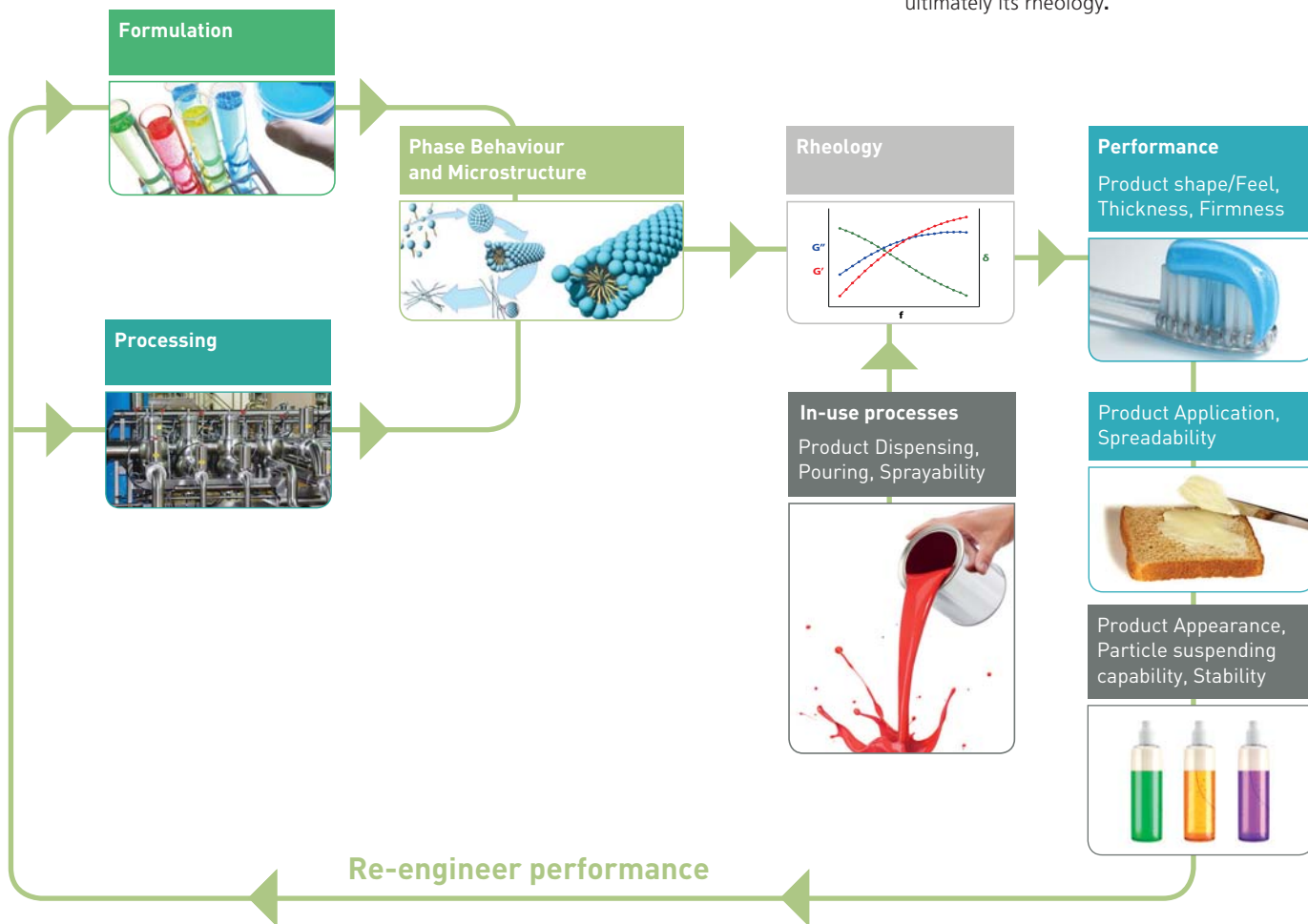


# FROM FORMULATION AND PROCESSING TO END-USE PRODUCT PERFORMANCE

The importance of rheology

Rheology provides an important link between product microstructure and performance.

A formulators' goal is to produce a product which meets the desired performance criteria by controlling its microstructure and ultimately its rheology.



The Kinexus rheometer helps you to define and understand material characteristics - from viscosity to viscoelasticity - and to solve material problems at all stages of the product lifecycle:

- as part of a manufacturing process
- over a particular timescale or a particular temperature range
- with a particular sample batch
- with a change in formulation
- with packaging the material
- with transportation of the material
- with product stability or storage shelf-life
- with aspects of end-use performance
- with consumer acceptance of a product
- with comparison to other products available in the marketplace

# UNPRECEDENTED DUAL-ACTION CAPABILITIES

A revolution in shear and vertical (axial) test control



The unique combination of Kinexus 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

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

- All rotational shear-based testing
- Advanced vertical (axial) testing including squeeze flow and tack testing
- A combination of shear and vertical actions for revolutionary process-relevant measurements

**Significant design effort has been directed at the vertical, or axial capabilities of the Kinexus platform – an area that typically sees compromises on most rheometer systems.**

Kinexus combines high speed and ultra-fine resolution gap control with high sensitivity and ultra-responsive Normal Force control for truly innovative sample loading and measurement capabilities – from sensitive structures to rapid curing systems.

Allied to 'cradle to grave' data collection providing a complete sample history from loading to unloading, every aspect of rheological testing can be optimized and verified for total consistency.

# UNPRECEDENTED DUAL-ACTION CAPABILITIES

Using synchronized torque, displacement, gap and Normal Force data at ultra-high rates



## Gap Control

- Exceptional vertical travel range of 230mm for maximum user access and flexibility of test setup
- Unmatched vertical speed range from 0.1 $\mu$ m/s to a maximum 35mm/s
- Controllable speed and Normal Force profiles over full range of vertical travel - linear, exponential and max/min limited
- Gap measured to 0.1 $\mu$ m over full range
- Optimal sample loading for all material types – from sensitive strain-critical structures to rapid curing systems
- Highly controllable axial test capabilities - squeeze flow and tack tests

## Normal Force

- High sensitivity and rapid response times from a novel strain gauge design
- More controllable and reactive system designed to capture transient material responses
- Ultra-fast, constant streaming data update rate of 5kHz for all instrument variables, including gap and Normal Force – synchronised with rotational and temperature data
- Normal Force data captured and stored during sample loading process – because robust rheology for non-Newtonian materials starts with a consistent and controllable sample loading process



# rSPACE SOFTWARE

Experience the ultimate in test flexibility with sequence-driven rheometer control



One of the key development aims for the Kinexus rheometer was to deliver a system that enabled total flexibility of control – to provide unique test capabilities that went beyond those previously available on rotational rheometer systems.

Market feedback was reporting that Industrial users would like the option to run under Standard Operating Procedure (SOP)-driven protocols, with ‘locked down’ tests that included specific user instructions and inputs to meet their particular requirements.

At the other extreme, University researchers were asking for a completely open ‘programming-type’ test capability that would allow them to link instrument or rheological actions together in ways that ‘thought experiments’ allowed, but not their rheometer interface.

The challenge for rSpace software was to successfully reconcile these needs. Kinexus is unique in that the software user interface is sequence-driven, and it is this concept that meets both of the above requirements.

rSpace software is driven by ‘sequences’ – which consist of fundamental rheological actions (or test building blocks) that can be linked together with other test actions, such as user feedback and choices, calculate values, loops and triggers, in order to build ‘intelligent’ tests.

- Set a sequence to ‘run’ only, and a user operates under SOP-type conditions with defined test instructions and feedback
- Set user access to ‘edit’ sequence functionality, and researchers have the full design capabilities at their fingertips

	Enter temperature properties	<input checked="" type="checkbox"/>
	Enter amplitude table stress properties	<input checked="" type="checkbox"/>
	Enter frequency table strain properties	<input checked="" type="checkbox"/>
	Full temperature equilibrium	<input checked="" type="checkbox"/>
	Oscillation amplitude table	<input checked="" type="checkbox"/>
	Run Analyse_0027-1	<input checked="" type="checkbox"/>
	Run Oscillation_0003-1	<input checked="" type="checkbox"/>

*‘What rheological test progression would you like to run?’*

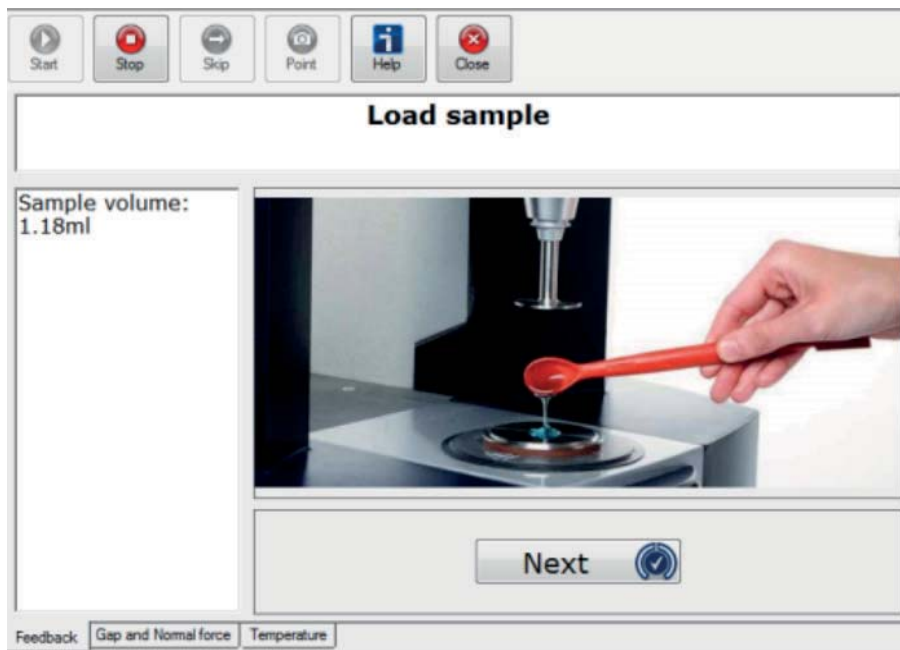
- You think it - Kinexus can run it
- Dedicated and advanced tests exactly to your needs

### Program sequence in Kinexus

- ‘Drag and drop’ actions and ‘Import subsequence’ functionality
- Include user choices, calculate values, loops, triggers
- Include specific user inputs and instructions as required

# rSPACE SOFTWARE

Standard Operating Procedure (SOP) driven tests for robust rheological measurements



**Malvern’s Standard Operating Procedure (SOP) approach to material testing** has been a corner stone to all our technologies, and is now available for the first time on a rheometer system.

- Lock-down tests including geometry and parameter set-up
- Continuous feedback and user guidance
- Produce standard test methods
- Available for use company-wide
- Consistent testing as standard

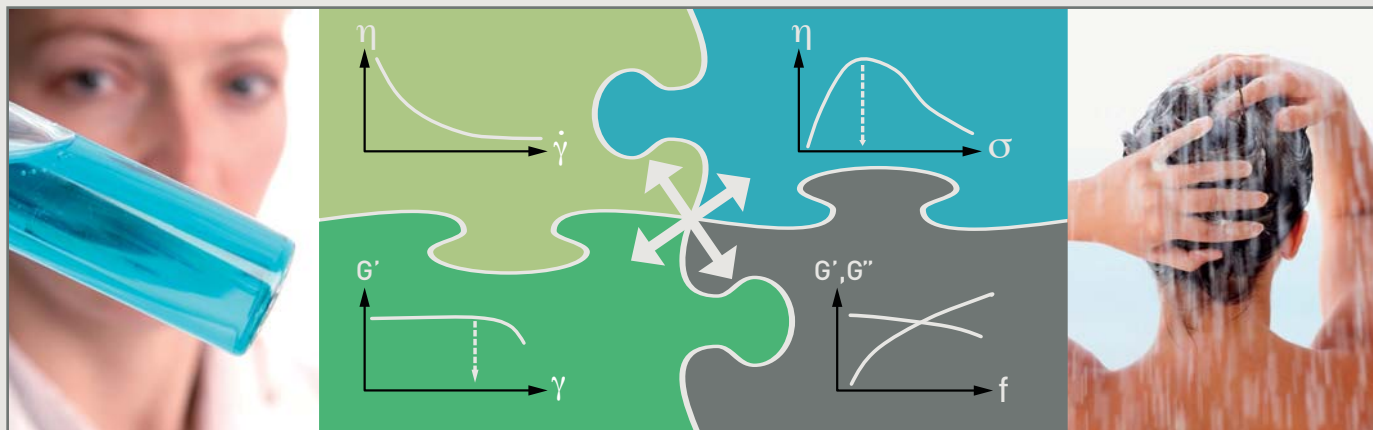
## Rheology Toolkit

- Series of fundamental rheological tests available in rSpace at the click of a mouse
- Get started with robust rheology testing
- Fully configured SOP-driven tests with associated test description

## Use Toolkit tests to solve your material puzzles:

- Build up a ‘picture’ of the overall rheology of a material
- Find an answer to material formulation, application or process problems

- Target optimization of a key material characteristic, or implementation of a critical diagnostic test



# MEASURING SYSTEMS AND ACCESSORIES

Designed for the rheological testing of complex fluids and soft solids



## Measuring Systems

- Quick-connect geometries with intelligent auto-recognition
- Geometry constants and test preferences automatically configured
- Lock-down tests to specific geometry to minimize operator error
- Automated geometry lock via software for ease of trimming
- Various material and surface finish options
- Solvent trap compatible
- Disposable options
- Coaxial cylinders (cup and bob) to DIN standard
- Double gap cell and vane tool options
- Geometry adapter allows use of custom geometries with Kinexus

## Environmental Controllers

- Exclusive 'plug and play' cartridge design
- Quick, easy and robust insertion
- All mechanical, power, communication and fluid connections made 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 sample
- Temperature resolution to 0.01°C
- Easy to clean designs



# KINEXUS AND ACCESSORIES

Designed for the rheological testing of complex fluids and soft solids

## Peltier Plate Cartridge

(-40°C to 200°C)

### Environmental controller for cone-plate and parallel plate measuring systems

- Meets the temperature control requirements for the majority of applications from fluids through to soft solids, such as creams, pastes and gels
- Interchangeable lower plates enable optimal geometry choice e.g. match lower pedestal diameter for self-supporting samples, without compromising thermal performance
- Efficient solvent trap design for accurate measurement of samples with volatile components and to minimize sample drying
- Disposable plate option for curing materials

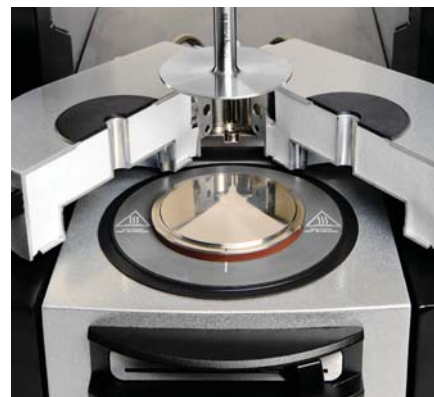


## Active Hood Cartridge

(-40°C to 200°C)

### Environmental controller with minimized thermal gradients for 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
- Proprietary design combines Peltier elements with additional heaters to actively control radial and vertical thermal losses from the local sample environment
- Low thermal mass components for rapid response
- Inlet for inert gas feed into sample environment



## Peltier Cylinder Cartridge

(-30°C to 200°C)

### Environmental controller for concentric cylinder-type measuring systems

- Options to meet temperature control requirements for materials from highly fluid-like samples through to high concentration yield stress dispersions
- Twin Peltier design for rapid temperature changes and sample equilibration, and minimized thermal gradients
- Various cup and bob sizes available - C14 (DIN), C25 (DIN) and wide diameter C34
- Double gap cell and vane tools
- Interchangeable lower cups with removable base for ease of cleaning
- Plate insert provides a 'universal Peltier option'



# KINEXUS SPECIFICATIONS

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 as to specifying an appropriate rheometer model for your application, Malvern recommend contacting us for further advice and/or a sample test and evaluation report.

	ultra+	pro+	lab+
Rheometer platform	Highest specification bearing available for advanced testing	Meeting rheological needs in research and development	Standard Operating Procedure (SOP) testing for Quality Control
Standard operating modes	Direct strain control; Shear rate control; Shear stress control		
Torque range – Viscometry (rate and stress control)	5nNm – 250mNm	10nNm – 200mNm	20nNm – 200mNm
Torque range – Oscillation (strain and stress control)	0.5nNm – 250mNm	2nNm – 200mNm	10nNm – 200mNm
Torque resolution	0.05nNm	0.1nNm	0.1nNm
Position resolution	<10rad	<10rad	<10rad
Angular velocity range	10rads <sup>-1</sup> to 500rads <sup>-1</sup>	10rads <sup>-1</sup> to 500rads <sup>-1</sup>	10rads <sup>-1</sup> to 325rads <sup>-1</sup>
Step change in strain	<10ms	<10ms	<10ms
Frequency range	6.28μrads <sup>-1</sup> to 942rads <sup>-1</sup> (1μHz to 150Hz)	6.28μrads <sup>-1</sup> to 942rads <sup>-1</sup> (1μHz to 150Hz)	6.28μrads <sup>-1</sup> to 628rads <sup>-1</sup> (1μHz to 100Hz)
Motor inertia	13μN.m.s <sup>2</sup>	13μN.m.s <sup>2</sup>	13μN.m.s <sup>2</sup>
Normal Force range	0.001N - 20N (50N optional)	0.001N - 20N (50N optional)	0.001N – 20N (50N optional)
Normal Force resolution	0.5mN	0.5mN	0.5mN
Normal Force response time	<10ms	<10ms	<10ms
Vertical lift speed	0.1μms <sup>-1</sup> to 35mms <sup>-1</sup>	0.1μms <sup>-1</sup> to 35mms <sup>-1</sup>	0.1μms <sup>-1</sup> to 35mms <sup>-1</sup>
Vertical lift range (measurable)	230mm	230mm	230mm
Gap resolution (over full vertical lift range)	0.1μm	0.1μm	0.1μm
Fully configurable vertical profiles	By speed and by Normal Force		
Raw instrument variables	5kHz constant streaming data		
Complete sample history	Data available from loading to unloading as standard		
Instrument interface	USB2 – plug and play		
rSpace software	Sequence-driven user interface enabling Standard Operating Procedure (SOP)-type test functionality and fully customizable test designs		
21 CFR part 11 software	Optional	Optional	Optional
<b>Dimensions</b>			
D x W x H (Weight)	485mm x 490mm x 680mm (47kg)		

# KINEXUS SPECIFICATIONS

	ultra+	pro+	lab+
<b>Accessories</b>	<b>Designed for dispersed systems characterization – including polymer and surfactant solutions, foams, emulsions, suspensions, pastes and gels</b>		
<b>Measuring systems (geometries)</b>			
Quick-connect upper geometries	Plug and play; auto-recognition and configuration in software		
Material	Stainless Steel 316 as standard Other options are available e.g. for chemical compatibility (Titanium)		
Plate and cone diameter	20mm through to 60mm as standard size range - other sizes on request 4mm, 8mm and 25mm plates specifically designed for Asphalt testing		
Cone angle	0.5°, 1°, 2° and 4° variants – 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		
Interechangeable cups	Quick release/engage mechanism		
Surface finish options	Roughened (sand blasted); Serrated; Splined or grooved (cup and bobs)		
Vane tools	C14 and C25 vane tools		
Disposable option	Upper and lower disposable plate options for curing materials		
<b>Environmental controllers</b>			
Quick-connect cartridge system	Plug and play; auto-recognition and configuration in software		
Peltier plate cartridge	Temperature range -40°C to +200°C Maximum heating rate* 30°C/minute Maximum cooling rate* 30°C/minute		
Active Hood Peltier plate cartridge	Temperature range -40°C to +200°C Maximum heating rate* 30°C/minute Maximum cooling rate* 20°C/minute		
Peltier cylinder cartridge	Temperature range -30°C to +200°C Maximum heating rate* 15°C/minute Maximum cooling rate* 15°C/minute		
Temperature resolution	0.01°C		
Temperature stability	Better than ±0.1°C		

\* Temperature range dependent.



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