TA Instruments

DISCOVERY HYBRID RHEOMETER

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Eschborn, Germany
Brussels, Belgium
Etten-Leur, Netherlands
Paris, France
Elstree, United Kingdom
Barcelona, Spain
Milano, Italy
Warsaw, Poland
Prague, Czech Republic
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São Paulo, Brazil
Mexico City, Mexico
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HR1 HR3 HR2

DISCOVER a New Level of Rheometer Performance

DISCOVER
NEW RHEOMETER TECHNOLOGY

The Discovery Hybrid Rheometer (DHR) features powerful new technologies from the world leader in rheological measurements. Our new hybrid technology combines a patented magnetic bearing, drag cup motor, force rebalance transducer (FRT), new patent-pending optical encoder dual-reader, and True Position Sensor (TPS) into a single-head rheometer.

The DHR has improved every performance specification and delivers unrivaled true strain, strain rate, stress control, and normal force accuracy. The DHR also features our most popular TA innovations including patented Smart Swap™ geometries and Smart Swap™ temperature systems.

The New Discovery Hybrid Rheometer - The most powerful and versatile rheometer for your laboratory.

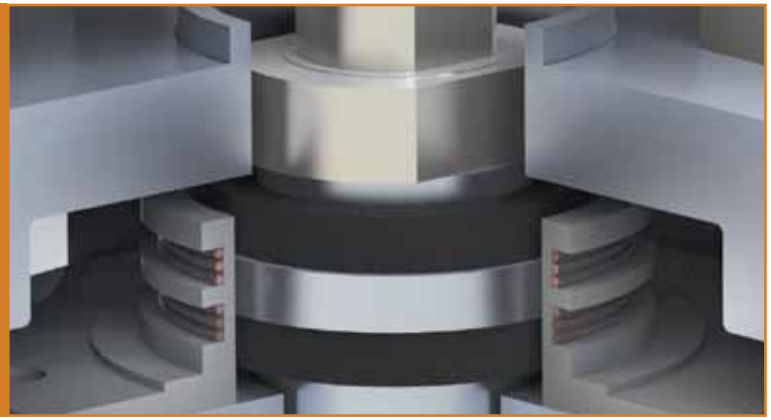
The next generation of strain measurements
Optical Encoder Dual-Reader

All DHR systems feature optical encoders for high resolution displacement measurements. The HR-3 features a patent-pending optical encoder with dual reader. This new technology provides ultra high displacement resolution of two nanoradians, reduces noise, and enhances phase angle measurements. The benefit is better data and higher sensitivity when running challenging materials over a broad range of conditions, or even extreme conditions.

DISCOVER
POWERFUL
NEW INNOVATIONS

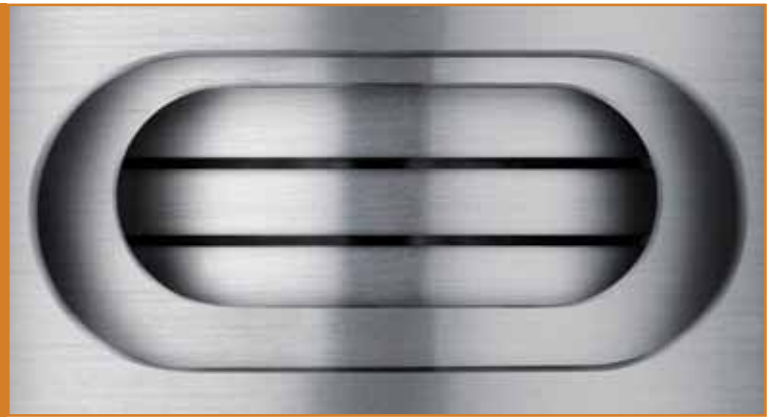
Normal Force Rebalance Transducer (FRT)

The TA Instruments ARES-G2 force rebalance technology has long been the industry standard for normal force measurements. This FRT technology is now part of the Discovery Hybrid Rheometer. Competitive strain gauge and capacitive sensors rely on physical movement of the device to sense a force. This can result in measurement error. An FRT provides the most accurate normal force measurement because the linear motor is driven to maintain zero deflection.



Second Generation Magnetic Thrust Bearing

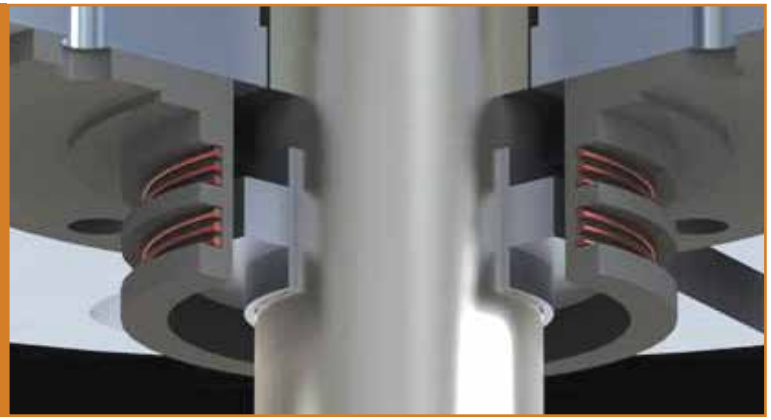
The DHR is the only commercial rheometer with a magnetic thrust bearing and our second generation patented design offers improved low torque performance and mapping stability. The low-end torque performance of any rheometer depends on bearing friction which results in residual torques. The DHR magnetic bearing has a gap 250 times larger than competitive air-bearing designs, and thus no drag from pressurized air flow. The result is 70% less friction enabling the DHR motor to measure 0.5 nN.m of torque. The magnetic bearing design is inherently robust and not susceptible to contamination. (Patent #'s 7,137,290 and 7,017,393)



New True Position Sensor (TPS)

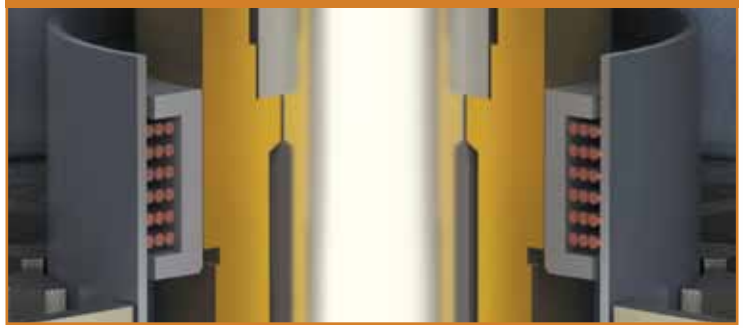
The DHR includes a patent-pending True Position Sensor (TPS) for true gap accuracy. The TPS is a high resolution linear position sensor that ensures the most accurate data, by measuring and compensating for the effects of thermal expansion, in real time. Unlike competitive devices, the TPS eliminates thermal expansion errors without the need for special high inertia iron core geometries and environmental systems.

The TPS works with all Smart Swap™ geometries and Smart Swap™ environmental systems.



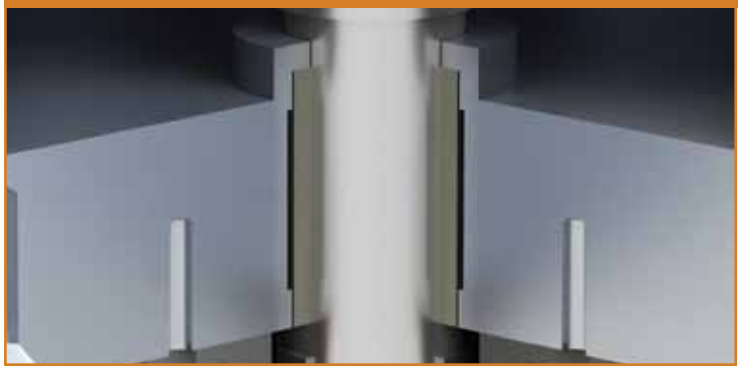
Advanced Drag Cup Motor

The DHR incorporates our redesigned and patented drag cup motor, with digital current control for more stable torque output and minimal drift. The DHR motor provides extremely smooth acceleration, the fastest step strain and step rate response, and keeps inertia, temperature, and friction to an absolute minimum. There are significant performance advantages of TA Instruments' drag cup motor design compared to other drag cup designs and to the synchronous electrically commutated (EC) motors. Scientists will see significant benefits from the TA motor design in the quality and reproducibility of their sample data. (Patent # 6,798,099)



Radial Air Bearings

The DHR is designed with two porous carbon radial air bearings positioned along the length of the shaft providing high stiffness and low friction support in the radial direction. This design is ideal for the testing of high stiffness samples, such as solids in torsion as well as soft solids and low viscosity fluids.



Active Temperature Control (ATC)

Precise control of upper and lower plate temperatures is vital for the most accurate rheological measurements. The DHR features patented ATC technology that enables wireless temperature measurements across an air gap for significant temperature control advantages over traditional non-contact systems. Only with ATC is the actual upper plate temperature known rather than inferred, making real-time control of both plates possible. The benefits are faster temperature response, true temperature ramp capability, and elimination of complex calibration procedures and offset tables. (Patent # 6,931,915)

TA Drag Cup Motor Features	Benefits
Low moment of inertia with less correction before,	• Accurate data to higher frequencies on low viscosity fluids during, or after the measurement • Faster transient response because less mass to overcome • Purer information for LAOS measurements
No permanent magnets	• No interference from external metal such as neighboring instruments on bench, or the rheometer frame itself • Metal geometries can be made shorter for less compliance • Residual torque maps are independent of gap settings
True open loop stress control	• Absolutely TRUE stress control • Best creep and recovery measurements available • Can measure zero rate
Digital current control	• No range switching for completely seamless torque over the entire torque range
Trim Lock	• Electronic bearing lock for sample trimming
Patented non-contact temp sensor and integrated active motor cooling	• Sensor provides temperature corrected torque for the most accurate torque control and measurements • Time at max torque is not limited by motor temperature, as in competitive designs

DISCOVER
INNOVATIONS DESIGNED FOR EASE OF USE AND ACCURACY

Single-Piece Aluminum - Casting and Linear Ball Slide

The DHR is built on a new single-piece aluminum casting with the rheometer head attached to the casting by a rugged linear ball slide. This configuration reduces torsional and axial compliance by 60% over traditional designs. A micro stepper motor and linear optical encoder ensure precision positioning of the geometry with a resolution of 0.02 microns. The open design provides ease of access and ample space for sample loading and trimming.

Capacitive Touch Keypad

The new capacitive touch keypad is constructed from toughened glass to hold up to the most aggressive materials and features a number of useful functions including: gap zero, trim gap, go to gap, raise and lower head, start and stop tests.

Color Display

The color display reports a variety of real-time data to the test station to facilitate sample loading, and provide system information during experiments.

Smart Swap™ Geometries

The DHR features our patented Smart Swap™ geometries with automatic detection. Smart Swap™ geometries include an integrated magnetic cylinder that stores unique geometry information. When attached, the information is automatically read and the software is configured with appropriate parameters (type, dimension, material). (Patent # 6,952,950)

Smart Swap™ Temperature Systems and Accessories

Only TA Instruments offers the convenience and versatility of Smart Swap™ temperature control options and accessories. Smart Swap™ options are attached to the instrument on its unique magnetic base. Once attached, the instrument automatically detects and configures the system for operation.

DHR
TEMPERATURE SYSTEMS

TA Instruments offers the widest variety of temperature control systems and accessories to address a broad range of material applications. For additional details on the capabilities of these systems, please consult the Temperature Systems and Accessories brochure.

Peltier Plate

Our best selling temperature control system is the Peltier Plate. It can handle the widest range of material applications with standard, stepped and disposable models. Temperature range is -40°C to 200°C with controllable heating rates of up to 20°C/min. Peltier Plate accessories include evaporation blocking, thermal covers, purge covers, and immersion capability. It is the highest performing, most versatile, and best accessorized Peltier Plate Temperature System on the market.

Peltier Concentric Cylinder Temperature Systems

The DHR patented Peltier Concentric Cylinder combines the convenience of SmartSwap™ and Peltier Heating technology with a wide variety of cup and rotor geometries. Concentric cylinder geometries are commonly used for testing low viscosity fluids, dispersions or any liquids that are pourable into a cup. (Patent # 6,588,254)

Environmental Test Chamber, ETC

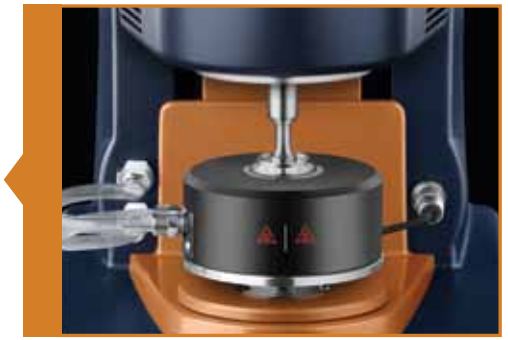
The ETC is a high temperature Smart Swap Option that uses a controlled convection/radiant heating oven. Temperature range is -160 °C to 600 °C with heating rates up to 60 °C/min, providing fast response and temperature stability. The ETC is a very popular option for polymer applications and can be used with parallel plate, cone and plate, disposable plate, and rectangular torsion clamps for solids. Image capture and camera viewing option is available on the ETC and it operates over the entire temperature range.

Electrically Heated Plates, EHP

Provides active heating and cooling of cone and parallel plate geometries to a maximum temperature of 400°C. Optional Gas Cooling Accessory extends the temperature to -70°C. The EHP is ideal for high-throughput polymer sample testing. With patented Active Temperature Control, ATC, it is the only EHP system capable of direct temperature control of the upper and lower plates. Standard and disposable systems are available for polymer melt and thermosetting materials. Camera viewing option available.

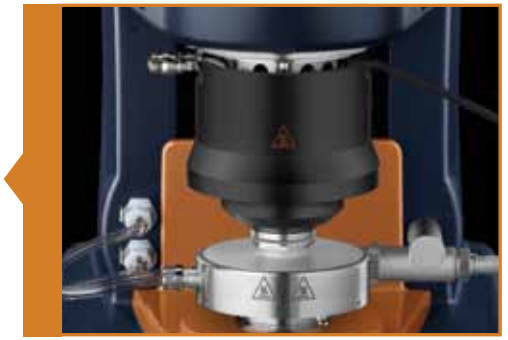
New Dual Stage Peltier Plate

The New Dual Stage Peltier Plate is another first from the innovator of Peltier Plate technology. The unique design uses a stacked Peltier element approach. The benefit is unprecedented low temperature performance providing a continuous temperature range of -45°C to 200°C with water circulating at a single heat sink temperature. The Dual Stage Peltier is the perfect choice for applications requiring sub-ambient temperature control.



Upper Heated Plate, UHP

The UHP is a temperature option designed for use with Peltier plates to help minimize vertical temperature gradients. The UHP is compatible with all Peltier plate models and provides both upper plate temperature control and purge gas environment. The UHP has a maximum temperature of 150°C and the lower temperature can be extended using liquid or gas cooling options. The UHP is the only non-contact temperature system to feature patented active temperature control for direct measurement and control of the upper plate technology.



Dry Asphalt and Asphalt Submersion Systems

TA asphalt systems meet or exceed SHRP, ASTM, and AASHTO requirements and include 8 and 25 mm parallel plates and sample molds. The Dry Asphalt System combines our superior Upper Heated Plate with a unique lower stepped Peltier Plate. Flexible cooling options include Peltier, Vortex, and water circulator cooling. The Asphalt Submersion Cell employs the classic approach of temperature control fully submersing the sample in circulating water.

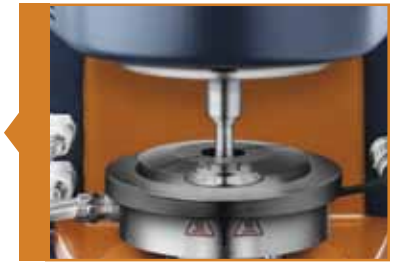
DHR
ACCESSORIES

Double Wall Ring Interfacial, DWR

Patented technology for the most advanced rheological characterization of viscous and viscoelastic interfacial properties, in all standard oscillatory and steady shear testing modes. (Patent # 7,926,326)

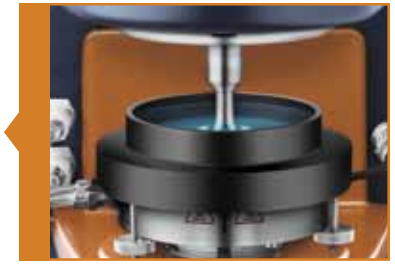
Solvent Trap/Evaporation Blocking System

Solvent Trap cover and Solvent Trap geometries together create a thermally stable vapor barrier, virtually eliminating any solvent loss during rheological experiments.



Peltier Plate and Torsion Immersion Testing

Options allow samples to be measured while fully immersed in a fluid on the Peltier Plate or for testing of solid rectangular bar-shaped samples while immersed in a temperature controlled fluid in the Peltier Concentric Cylinder temperature system.



Pressure Cell

An optional sealed vessel for studying the effect of pressure on rheological properties or materials that volatilize under atmospheric pressure. Can be used to a pressure up to 138 bar (2,000 PSI) and to a maximum temperature of 150°C.

Electrorheology

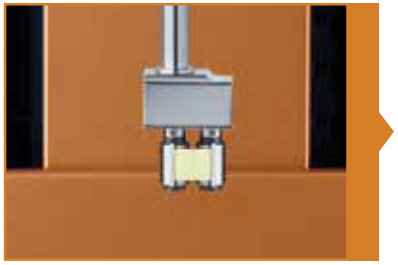
Allows characterization of electrorheological fluids with a voltage up to 4000 V in both DC and AC modes. Features parallel plate and concentric cylinder geometries and a maximum temperature of 200°C. Flexible programmable voltage profiles such as step, ramp, sine, and triangle wave functions as well as functions with DC offsets

Small Angle Light Scattering, SALS

Option provides simultaneous rheological and structural information, such as particle size, shape, orientation and spatial distribution. Features patented Peltier Plate temperature control, scattering angle (θ) range of 6° to 26.8°, scattering vector range (q) of 1.38 μm^{-1} to 6.11μm^{-1}. Length scale range is 1.0 µm to about 4.6 µm. (Patent # 7,500,385)

UV Curing

Both mercury lamp light guide and LED light accessories are available for rheological characterization of UV-curable materials. LED systems feature primary peaks of 365 nm and 455 nm. Optional disposable plates and temperature control to 150°C

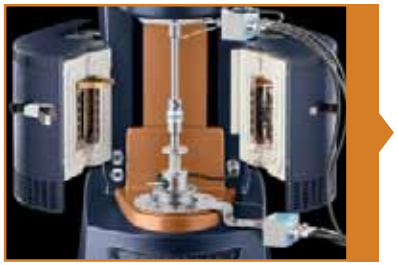


SER2 Universal Testing Platform

The SER2 is a universal testing platform to perform extensional rheology measurements and a range of physical material property measurements such as tensile, peel, tear and friction on small solid sample

Starch Pasting Cell

The Starch Pasting Cell (SPC) is a powerful and accurate tool for rheological characterization of the gelatinization process and final properties of starch products or basic characterization of many other highly unstable materials.



Dielectric

Dielectric analysis is powerful technique for characterizing polar materials such as PVC, PVDF, PMMA, and PVA, for phase separating systems, and for monitoring curing kinetics of materials such as epoxy and urethane systems. The technique involves applying oscillating electrical field (AC Field) as opposed to mechanical force to measure the degree to which the sample is storing (capacitance) or passing a charge (conductance) through its bulk. Provides a frequency range of 20 Hz to 2 MHz and temperature range of -160°C to 350°C. Can be used in stand-alone or simultaneous mechanical and dielectric techniques.

DHR
specifications

Technical Specifications

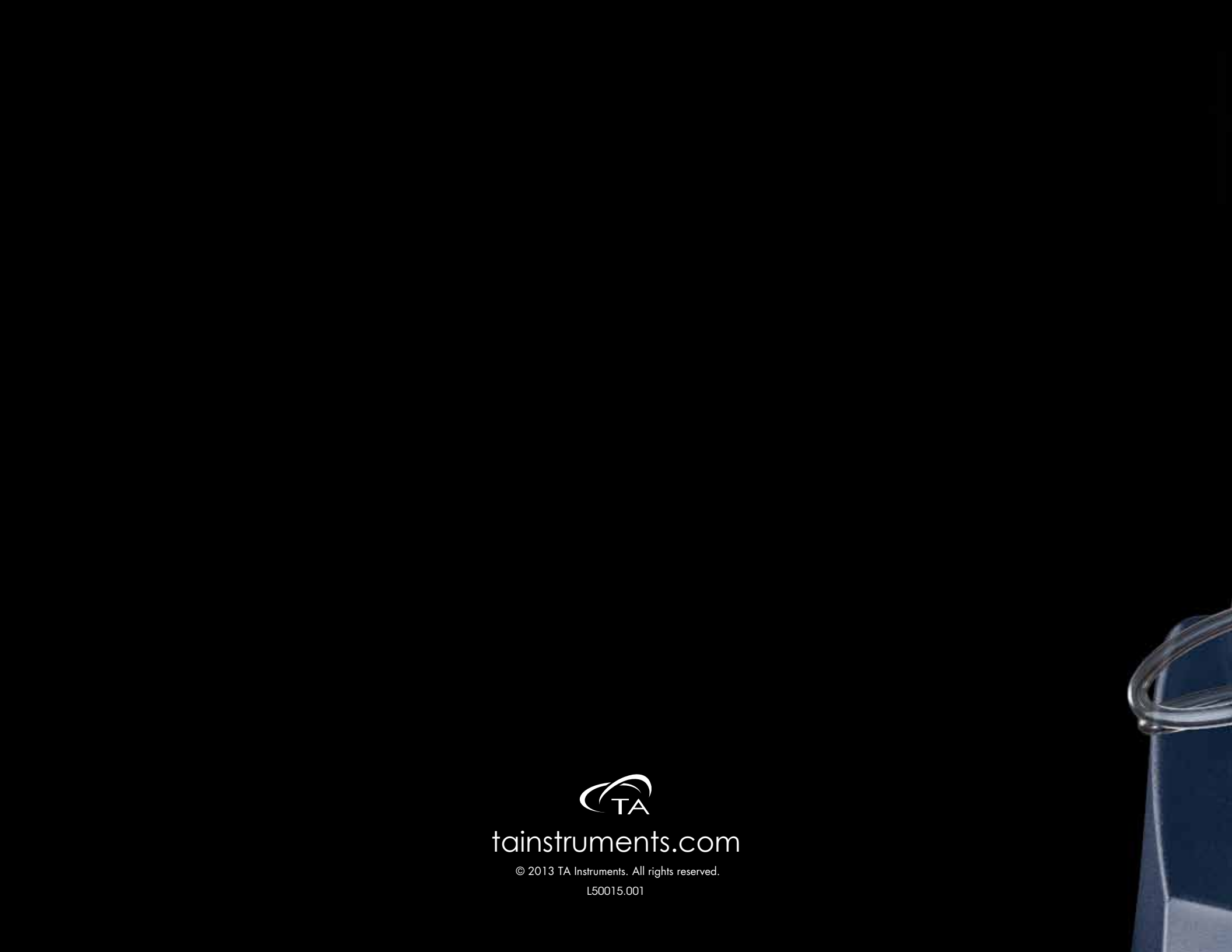
Specification	HR-3	HR-2	HR-1
Bearing Type, Thrust	Magnetic	Magnetic	Magnetic
Bearing Type, Radial	Porous Carbon	Porous Carbon	Porous Carbon
Motor Design	Drag Cup	Drag Cup	Drag Cup
Minimum Torque (nN.m) Oscillation	0.5	2	10
Minimum Torque (nN.m) Steady Shear	5	10	20
Maximum Torque (mN.m)	200	200	150
Torque Resolution (nN.m)	0.05	0.1	0.1
Minimum Frequency (Hz)	1.0E-07	1.0E-07	1.0E-07
Maximum Frequency (Hz)	100	100	100
Minimum Angular Velocity[1] (rad/s)	0	0	0
Maximum Angular Velocity (rad/s)	300	300	300
Displacement Transducer	Optical Encoder	Optical Encoder	Optical Encoder
Optical Encoder Dual Reader	Standard	N/A	N/A
Displacement Resolution (nrad)	2	10	10
Step Time, Strain [2] (ms)	15	15	15
Step Time, Rate [2] (ms)	5	5	5
Normal/Axial Force Transducer	FRT	FRT	FRT
Maximum Normal Force (N)	50	50	50
Normal Force Sensitivity (N)	0.005	0.005	0.01
Normal Force Resolution (mN)	0.5	0.5	1

Instrument Features

Discovery Series Hybrid Rheometer Features
Patented Ultra-low Inertia Drag Cup Motor
Patented Second Generation Magnetic Bearing
High-Resolution Optical Encoder
Optical Encoder Dual Reader (Patent Pending)[3]
Normal Force Rebalance Transducer (FRT)
True Position Sensor (Patent Pending)
Nano-Torque Motor Control
Superior True Stress, Strain, and Strain Rate Control
Direct Strain Oscillation[4]
Thrust & Dual-Radial Bearing Design
Ultra-low Compliance Single-Piece Frame
Heat and Vibration Isolated Electronics Design
Patented Smart Swap™ Geometries
Original Smart Swap™ Temperature Systems
Superior Peltier Technology
Patented Heat Spreader Technology
Patented Active Temperature Control
Color Display
Capacitive Touch Keypad
Patented Traceable Torque Calibration

[1] Zero in controlled stress mode. Controlled rate mode depends on duration of point being measured and sampling time.
[2] Results at 99% of commanded value
[3] Discovery HR-3 model only
[4] Discovery HR-2 and HR-3 models only

NOTES



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