
NOVAE

The New Star of Rheometers



Pure.....

Rheology

The Novel Rheometer from ACCURATE

The **NOVAE** is a new rheometer with a unique “**Net – Zero**” bias bearing system with InNovaetive Drag-cup Motor Design for nano measurement control and analysis. Designed for research and quality control, the instrument couples nano-radian position resolution and a wide torque range, from 3 nNm up to 200 mNm, with Quantitative Normal Force capability and a user interface working in a true Windows environment. The software utilizes mouse control and features multitasking help screens, well known Windows menu and data files transferable to other applications like Excel. Transient (Creep & Relaxation), Periodic (Dynamic oscillation) and Steady testing modes are available. Samples can range from low viscosity fluids to high modulus solid materials.



Quantitative normal force capability using the **Integrated NF** sensor patented by ACCURATE is used for normal force controlled sample loading on all systems. The Normal Force Sensor is non interactive, and does not cross talk with the torque signal. The Normal Force Sensor has a wide dynamic range and can be used for both user selectable constant force loading and quantitative Normal Force measurements. Neither the Normal Force nor the torque signals interferes with the motion, or applies any external forces on the air bearing. This technology is unequalled in the industry. We employ automatic, real time, inertia compensation (not a software correction after the data is collected) and automatic temperature compensation of the gap during temperature sweep experiments. **NOVAE** employs a true Windows based user interface and the software is fully functional running under Windows 2000/ XP. NOVAE can be operated by either serial or Ethernet communication. This enables integration into a network or direct connection with a computer with an *Ethernet interface*. Remote operation and maintenance of the instrument via the internet can also be performed.

Key Features

- Quantitative Normal Force Capability (Patented)
- Unique **Feed-forward Direct Strain Oscillation** over the entire specification range.
- True Windows Environment user interface with multitasking capability, mouse control, data exportation and on line help functions
- Operation by any Windows based computer or notebook
- Automatic gap setting for controlled reproducible sample loading.
- Actua-Gap - Optional Online Gap Measuring Transducer to measure actual gap at all times.
- Automatic compensation for thermal expansion of measuring systems.
- Built in communication port for remote control operation, remote service diagnostics and software updates.
- LAN / Ethernet communication feature for remote control is included.
- Automatic Real-time Inertia Compensation.
- ISO 9001 approved.

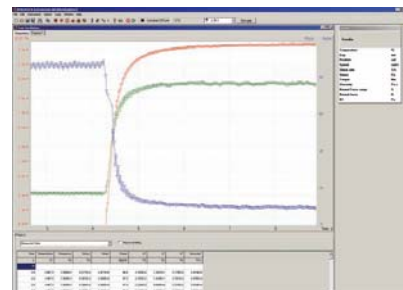
Every detail of the NOVAE is carefully designed for optimum user-friendliness. Using the fast fitting **Plug & play Tool** coupling system, you can switch different measuring systems easily in a matter of seconds. The large working area gives optimal access for sample loading, cleaning and trimming. With improvements in nearly all rheometer specifications, the performance of the NOVAE stands alone. It is the most advanced rheometer available in the market, and the preferred choice for the serious rheologist.

RheoApollo Software

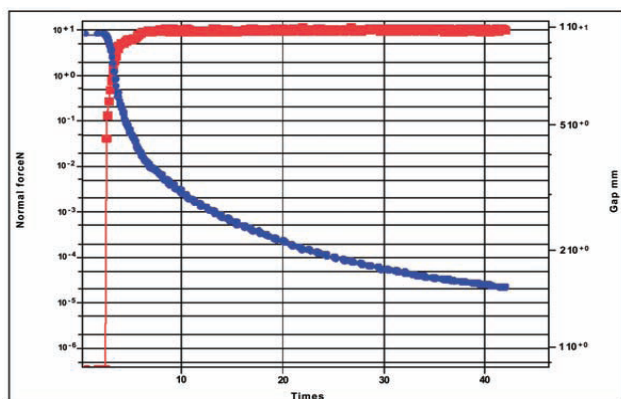
RheoApollo runs under Windows 2000/XP, and utilize a new flexible open – source operating software. It is designed to provide flexibility for configuring and using your ACCURATE Instruments rheology system. The software enables a normal PC to be used as the interface to allow the user to control the instrument, collect and analyse the resulting data. Viscometry, Oscillation under *True stress and Direct strain control*, Creep and Recovery, Constant Rate, Yield Stress, Stress Relaxation, Fast Oscillation, Process Control, Parallel Superposition, Squeeze Flow, Multiwave and Project (multi-experiment linking) packages are available allowing the sample to be analysed via different rheological procedures. Powerful data analysis capability allows model fitting, graph and table customisation and cut/paste operation to all other Windows based software. Analytical Rheology options such as Time – temperature superposition (TTS), Molecular weight distribution (MWD), etc are also available.

Fields of Application

UV Cell Application: The **NOVAE** Ultraviolet cell has been designed to precisely irradiate UV light onto the sample. There is the ability to measure the viscoelasticity of the sample curing at very high speed. Temperature sweep measurement is done at the same time without the need to exchange the test sample. Measurement of curing transition temperature is possible with the automatic control of compression and tension, corresponding to the expansion/contraction of the sample during curing. Furthermore, ON/OFF control of the UV light source shutter is controlled by a relay which is linked to the Fast Oscillation software of the rheometer itself.

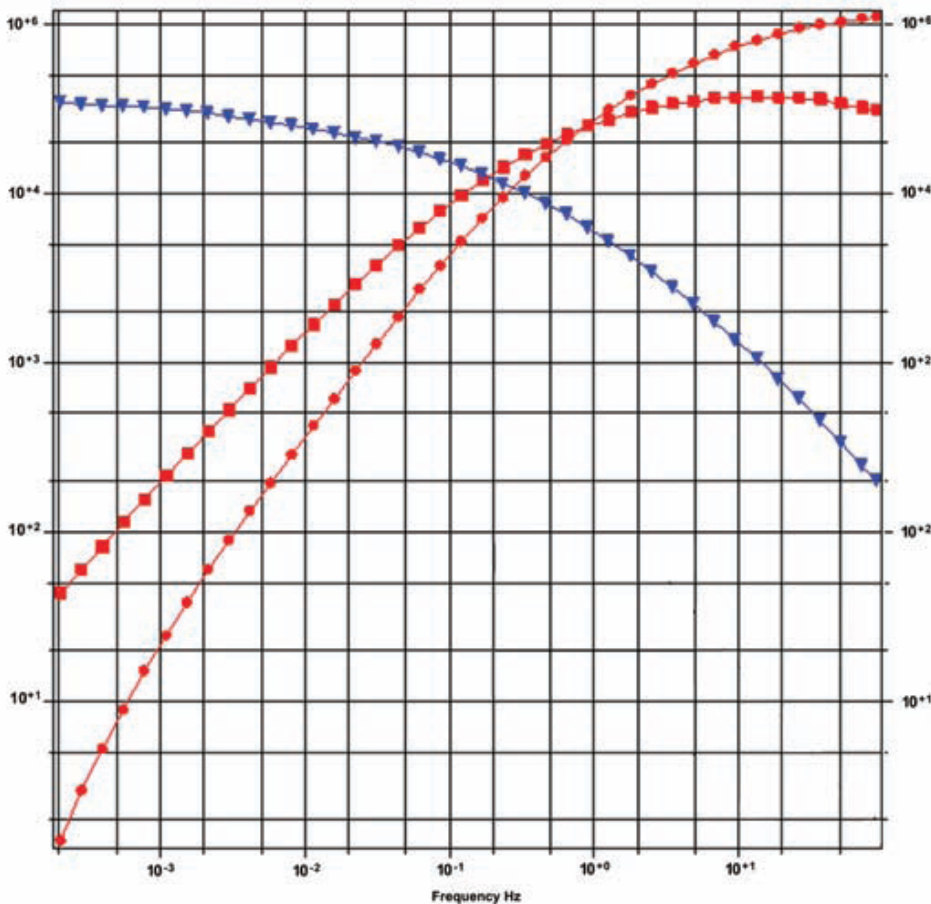


Squeeze Flow: The behaviour of polymers in extension is useful to study for many different polymer processes such as blown film extrusion and blow moulding. The **NOVAE**



rheometer can both be used to measure the rheological behaviour of polymers in squeezing flow or biaxial extension. In the RheoApollo, the operating software of the instrument, you can preset a target stress or force that is maintained by the rheometer as the gap is approached. This data can be recorded and used to measure the behaviour of polymer samples under constant axial force. The figure below illustrates the behaviour of PDMS under constant normal force using a 25mm plate and an initial gap of 10 mm. A ball of material was placed between the plates.

The initial behaviour that is observed is a result of the sample first being squeezed to fill the void between the plates. After about 5 seconds, the polymer fills the plate gap. The target normal force is 10N, which is maintained with good accuracy until the target test gap is reached. In order to maintain a constant normal force on the sample, the vertical speed must decrease exponentially. The change in gap is shown in blue in figure.



Frequency Sweep

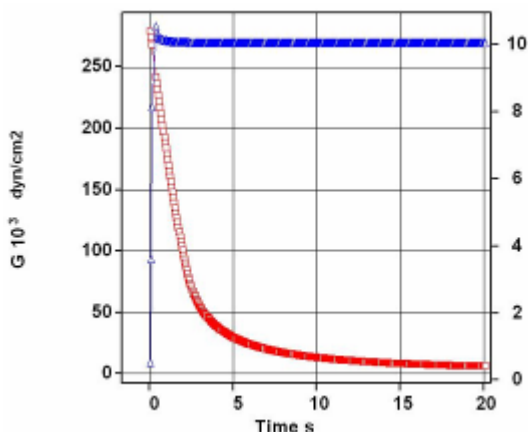
PDMS: Dynamic

oscillation is one of the most popular means to determine the viscoelastic response of materials. One of the features of the **NOVAE** is its ability to make measurements across a wide range in frequency. Measurements at high frequencies for devices with separate active torque transducers such as force rebalance transducers have difficulties making measurements above 16 Hz due to limited system bandwidth. The results shown below were obtained in a single sweep in frequency from 10^{-4} to 100 Hz, five times higher than comparable active compensation (FRT)

The results below clearly demonstrate that the **NOVAE** is able to perform accurate measurements on complex fluids at high frequencies. RheoApollo software in conjunction with the **NOVAE** provides some of the most versatile oscillatory analysis capability available. The user can program independently the delay period, integration period and the FFT size for each data point, either by specifying an initial and terminal value or by manually programming the data in a spreadsheet format. The user can also select to save the raw waveform as well as the Fourier spectrum for each data point. The results can be viewed in sine form (position or torque versus time) or as Lissajous shapes (position versus torque). Ex post examination of the data enables the user to analyze the harmonic content of each wave to verify linearity. RheoApollo also provides automatic signal averaging, ensuring that the user is obtaining the best signal to noise ratio possible.

Application Measurements

Below are shown a few typical measurements from foods, polymer melts, polymer solutions and Elastomers in rectangular torsion



Sample1- NIST 2490 Standard Fluid using QNF (Quantitative Normal Force) measurements:

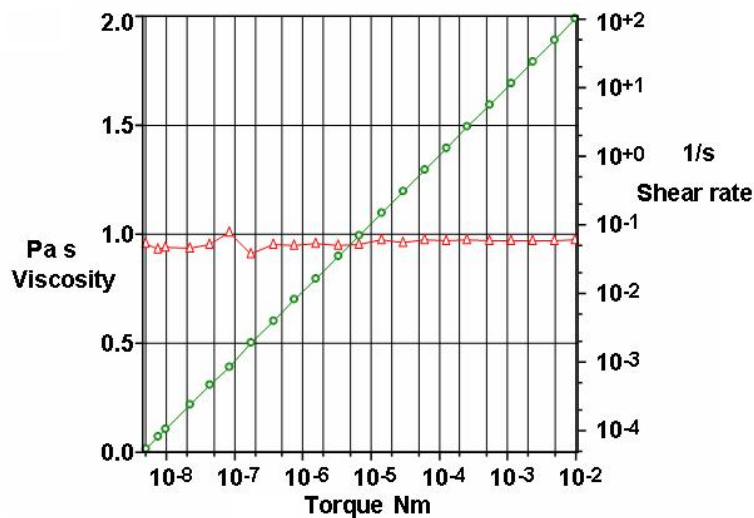
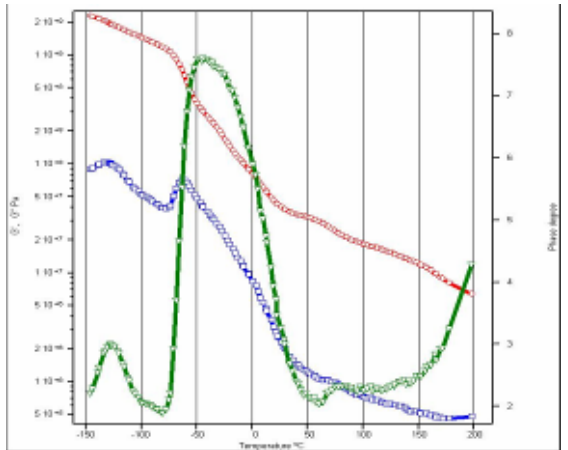
The quality of any normal force sensor is best demonstrated by measuring a standard fluid for which first normal stress difference values, N_1 , are well known. The figure shows a plot of actual N_1 data published by NIST on the 2490 standard fluid and values measured using a Nova Rheometer with **NF**. Also shown for comparison purposes are data from a competitive Rheometers. **NOVAE** have the same **NF** detector but the improved signal handling increases sensitivity and accuracy.

Sample2- PDMS Step-Strain measurement:

The 10% Step Strain, Stress Relaxation test, on PDMS exhibits the Direct Strain Capability of the **NOVAE**. PDMS Subjected to a Step-strain of 10% using a 20mm parallel Plate with 1 mm Gap depicts a Strain step in 11 ms with a strain overshoot of under 0.52% settling in under 3ms.

Sample3 - Elastomer in temperature gradient measurement: An Elastomer in a temperature gradient from -150 to 200°C using rectangular torsion or solid fixture measuring geometry in DMA ((Dynamical Mechanical Analysis) oven operating according to the Forced Air Convection Oven.

Sample4- 1.0 Pa.s Silicone Oil: A nominal 1.0 Pa.s Newtonian standard was run on the Novae Rheometer and Competitive Model. The results are plotted in the above figure as viscosity (Pa.s) versus torque (Nm). As can be



seen, the Novae Rheometer can routinely produce accurate results below 1E-08 Nm of torque while the Competitive Rheometer loses its ability to measure meaningful data below 1E-07 Nm.

The NOVAE Rheometer with its improved technology, based on the knowledge from the high performance Drag-cup rheometer

technique, is capable of measuring torques as low as 2 nNm in rotational tests with a maximum deviation of 5 %.

Easy-To-Interchange Accessories

For the NOVAE rheometer an extensive range of Accessories and Auto detect measurement systems are available to meet the requirements encountered in the rheological characterisation of your samples. From solvents to solids virtually every type of material can be measured.

High and low temperatures, High pressures and fast UV curing

The different accessories cover a temperature range from -180°C to +1700°C, pressures up to 1200 bar and very rapid curing of developing network systems.

Extended Temperature Plate Cell (ETPC)

The ETPC accessory allows measurements in cone, plate, parallel plate and disposal plates over the temperature range -160° to 600°C.. Thermal expansion of the cell, measuring system and sample is compensated for automatically. For environmentally sensitive samples, the ETPC is equipped with an inert gas inlet.

Heated Co-axial Cell (CCE)

The CCE accessory extends the temperature range for concentric cylinders to -100° to 1700°C. A wide range of couette sizes are available, as well as custom made tooling for special applications and disposal cups for quick sample exchange. To extend the measuring range of the CCE further, cone and plate and parallel plates geometric are available.

Closed Cell

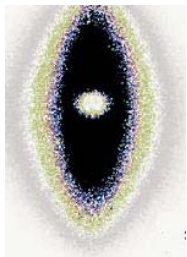
The Closed Cell allows full oscillatory and Viscometry measurements on volatile samples in a controlled environment. The cell is pressurized by a non-contacting air bearing, with cell pressures to 7 bars. Temperature range for the Closed Cell is -10° to 350° C, the upper limit depends on the vapour pressure of the sample of interest. The Sealed Cell can also be used with parallel plate measuring systems viscous samples.

Forced Convection Cell (FCC) for Dynamic Mechanical Analysis Measurements.

The Forced Convection Oven can be equipped with a large variety of cone and plate measurement system and is suitable for almost any type of sample from medium to high viscosity. Typical applications with regard to the temperature range are polymer melts that are measured at very high or very low temperatures, transition points, curing or hardening of resins and adhesives.

For Solids the Torsion Fixture measurement principle is based on the deformation of a known geometric size element subject to a torque. **NOVAE** imparts a user selected torque (stress) or deformation (strain) on the sample and monitors the response. The instrument has a temperature range of -160 to 600° C, with programmability allowing constant, step and gradient temperature profiles. Utilizing quantitative Normal Force Sensing, a constant tension or compressive force can be maintained on the sample, and in addition, thermal expansion coefficient can be determined.

SALS Cell



The SALS Cell allows measurements with microscopic structural information. It is equipped with the option of Polarized and Non-Polarized Scattering. The Cell is Temperature controlled in a range of Ambient to 350° C. The Standard Geometry available is Plate or Cone. However a Concentric Cylinder system can be used with a Lower Temperature range.

High Pressure Cell

The High Pressure Cell for NOVAE rheometer is used for studying rheological properties for samples under pressurized and/ or increased temperature conditions. The Cell offers full Viscometry and limited oscillatory capabilities. The cell is used in the oil industry for studying processes under high pressures, like drilling mud performance, polymer solution addition and gel formation. Further interest is the crude oil transport at low temperatures and wax precipitation under different solids content, temperature and pressure. The Cell can also be as a miniature polymerization reactor. Pressure interval: 0 to 150 bar.

UV Cell

The UV cell is used to monitor rapid changes in material properties as a result of exposure to ultraviolet or other frequency light. The cell has a temperature range from -150° to 400° C. The inNovaetive design allows the plates to be easily removed to facilitate working with vitrified samples. Measurement is done by a Faster Oscillation Software algorithm.

Electro-rheological Cell (ER)

The ER Cell allows measurements where an electric field is applied across the sample. The ER Cell is available for parallel plate, cone and plate, and concentric cylinders, double gap measuring systems. The field strength can be varied up to 3KV/mm. Temperature range is -20° to 90°C.

Fibre/Film Tension Cell

The Tension Cell allows for measurements on thin films and fibres in the temperature range -160° to 600°C. Measurement of Young's modulus, glass transition (T_g), secondary transitions, creep/recovery and shortening can be performed over the temperature range specified.

Peltier Temperature Cell

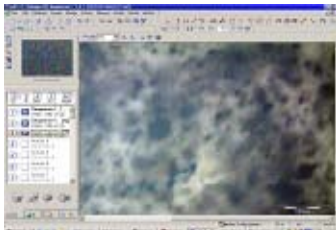
The Peltier Cell accessory allows measurement in parallel plate and concentric cylinder system over a wide temperature range. Heating and cooling rates of 60°C/min are possible. Peltier Cells are available for both Plate/Cone and Co-axial Cylinder System. Optional Hood with Convection elements for Dual temperature Control from Top & bottom with a Peltier Plate Cell. Special Solvent Trap system to ensure almost zero evaporation loss during measurements.

Water Absorption Cell

This cell allows the measurement of the swelling rate and of rheological properties of water absorption polymers.

Liquid is dosed into the sample from the bottom of the cell. Before coming into the cell, the liquid is passed through a porous filter, in order to get an even distribution of the liquid inside the cell.

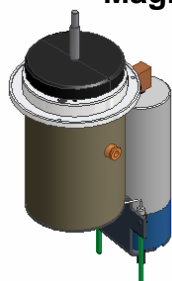
Optical Microscopy Cell (OMC)



The optical microscope and the digital video camera allow you to observe the structural variations under shear and oscillation.

Data, video sequences and images can be visualized on-line or stored in various formats for later evaluation and analysis.

Magneto-Rheology Cell (MRC)



Magneto-rheological fluids consist of suspensions of colloidal particles. Each particle contains many tiny, randomly oriented magnetic grains that can be oriented into chains by an externally applied magnetic field. These chains may further coalesce into larger-scale structures in the suspension, thereby dramatically increasing the viscosity of the suspension. This increase, however, is totally reversed when the magnetic field is turned off. Magneto-rheological fluids can be found in clutches, sealing, dampers, pumps etc.

An extensive range of easy-to-interchange measuring systems ensure the versatility of all our rheometers, and allow measurements on every material. Measuring systems available include:

Cone plates	Vane	cylinders
Parallel plates	Bi-cone	cone system
Concentric cylinders	Surface	roughened systems
Disposable plate		Small sample cell concentric system
Disposable cylinders	Double	gap concentric system

ACCURATE' mission is to meet the specialized needs and individual requirements of rheological instrumentation users. It is inevitable that companies will face increased competitive challenges and pressures in the next decade. As a comprehensive technical support, service, analytical instrumentation and training company specializing in material characterization instrumentation, ACCURATE Instruments focus exclusively on rheometers, rheology and rheological instrumentation.



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