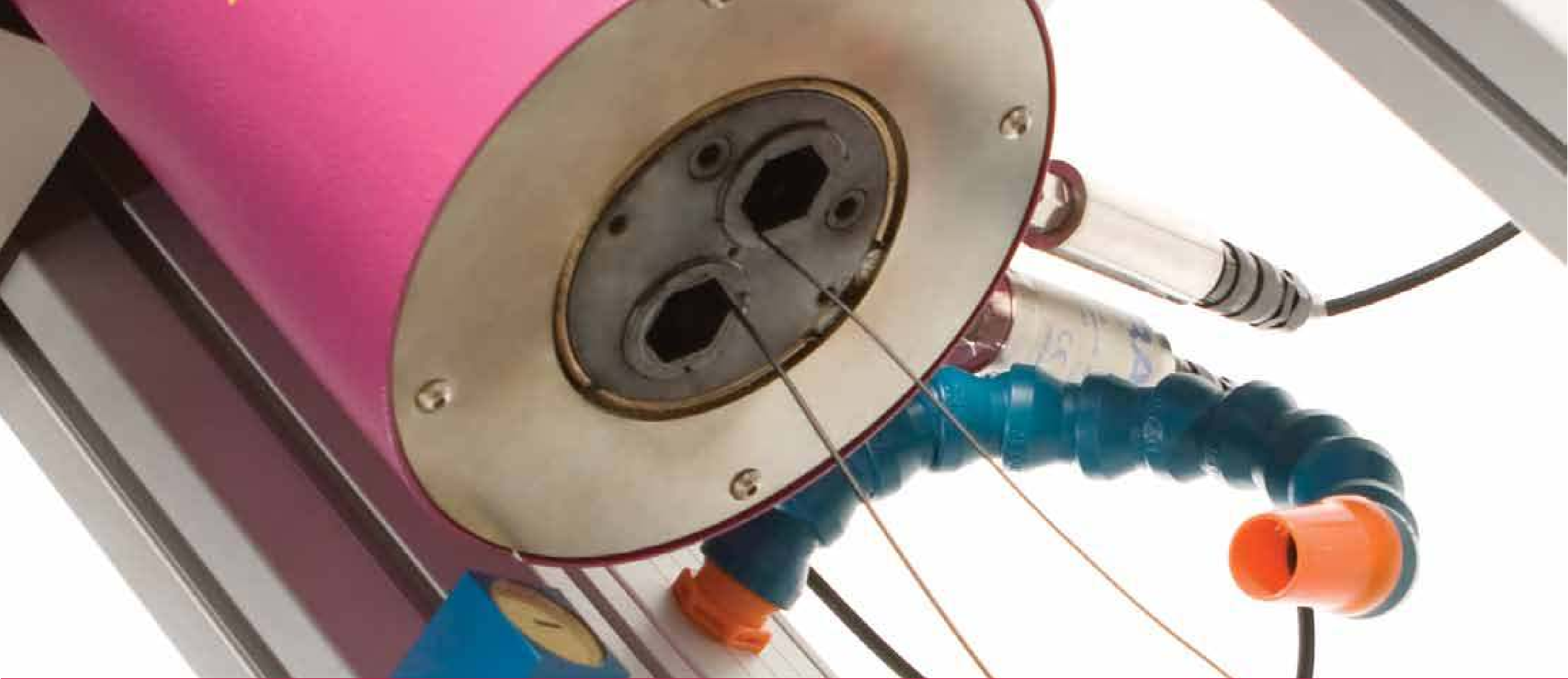


CEAST SmartRHEO Series | Capillary Rheometer Systems

INSTRON®

CEAST SmartRHEO Series

Capillary Rheometer Systems

All Things Flow

Plastics are amazing materials with the unique ability to flow when heated to relatively low temperatures. They can be formed into a wide variety of shapes and tailored for many different applications. However, their flow properties during this process are complex and affected by many parameters. Instron® provides comprehensive and effective testing solutions in plastics applications and industries through the CEAST SmartRHEO Series. This capillary rheometer simulates the process conditions, measuring the plastic materials flow behavior that characterizes the rheology of materials.

Deformation and Flow is a Material Matter

Plastics are found in virtually every facet of human activity and industry. They are used in everything from plastic containers to new textiles and cutting-edge technologies. There would be no innovation or new applications without determining the performance of plastic materials. Typically, plastics contain two or more polymers plus various additives and fillers. This improves the material processability, thermal stability, and mechanical resistance, while strongly affect the flow properties. This complex behavior of molten plastics, the way they deform when forces are applied and their resistance to flow, make their applications critical. Accurate rheological measurements provide better characterization and understanding of the full spectrum of plastic materials properties and performance.

Special Applications

Powder injection molding process is often used to create small and complex metal or ceramics parts. It starts with an injectable mix of powder and a soft plastic. This process is the combination of powder and plastic technology, and it requires a high level of rheological characterization by utilizing capillary rheometers.

Composites

Adding rigid particles or fibers to a raw polymer improves its mechanical properties, ultimately obtaining novel materials with unique properties. An advanced evaluation of flow properties is essential to optimize the rheologic response of composites and their forming techniques.

Compounds

Synthesized polymers are normally compounded with other polymers, inorganic particles, and additives. This improves the physical properties such as thermal stability and transparency during the product's life. Accurate measurements of the flow properties are crucial to prevent processing difficulties and to determine the influence of additives on compounds.

Thermoplastic Elastomers and Rubber Materials

Using thermoplastic elastomers in the manufacturing industry is in high demand due to their ability to recover their original shape after stretching or deformation. Their complex elasticity properties affect the material response; therefore, it is necessary to study the flow behavior to establish the material processing conditions.

Raw Polymers

Raw polymers are formulated based on the applications and forming techniques. It is essential for finished product engineering to investigate its flow properties and stability.

Recycled Materials

Plastic materials are often re-used for further applications and reintroduced into a cycle after a high number of processing stages. Due to the broad variety of material types and their unknown history, it is critical to perform quality control of recycled plastic materials to improve the properties of the end-use material.

It's All About Processability

The CEAST SmartRHEO Series includes the most versatile and technically advanced capillary rheometers. They are used to determine the rheological properties of polymer samples over a wide range of shear rates and testing conditions.

Outstanding Advantages

Key testing factors for polymer melts include consistent time savings, accurate results, uniform temperatures, and extrusion speeds. The Twin Bore barrel configuration allows for two simultaneous and independent rheological tests with direct comparison of the behavior of two different samples or two lots of the same material. Operators can obtain the Bagley correction during a single test by using a different die in each bore. To guarantee maximum repeatability of test results, our capillary rheometer systems are equipped with two independent load cells - one for each bore - as well as two independent barrel-mounted pressure transducers.

CEAST SR10

The entry level SR10 model is ideally suited for basic QC tests. It features a single bore barrel configuration, maximum force range of 10 kN, and a 9.55 mm (0.37 in) diameter bore. The NNI version of the SR10 is equipped with a 10 mm (0.39 in) diameter bore and is designed for Non-Newtonian Index test as defined by the industrial standard methods.

CEAST SR20

The intermediate level SR20 is designed to characterize the most common raw polymers or blends with a medium viscosity range. It is suited for single or twin bore barrel configuration, with a maximum range of 20 kN and a standard 15 mm (0.59 in) diameter bore.

CEAST SR50

The premiere model SR50 features a specially reinforced frame that matches the performance of floor standing systems. This capillary rheometer characterizes newly developed materials with a high viscosity range - including reinforced polymer formulations. It is suited for single or twin bore barrel configuration and can apply a maximum force range of 50 kN.

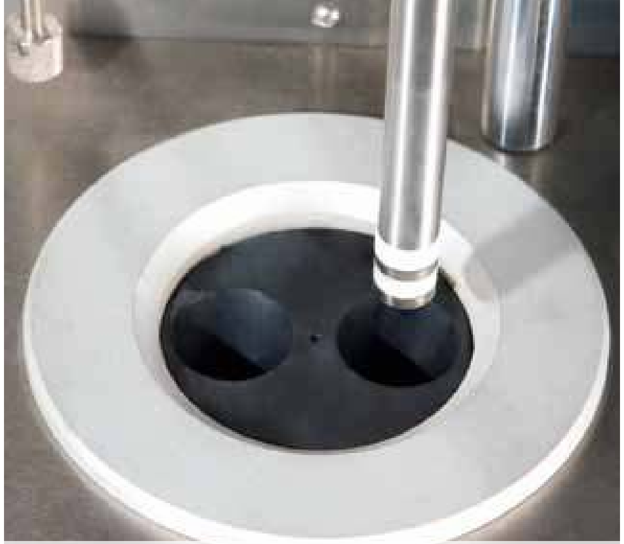
Measurement

The capillary rheometer is a “piston-die” lab extrusion machine. The measuring system is based on a barrel, piston, capillary die fitted inside the barrel, pressure gauge, and force transducer. The sample is loaded into the barrel and heated, and then the piston, attached with a force transducer, pushes the material through the capillary die at a specified rate. Above the die, a sensor measures the melt pressure - the starting point for the calculation of viscosity.

CEAST SmartRHEO systems are built in accordance with ISO 11443, ASTM D3835, and DIN 54811 international standards for Rheology testing.

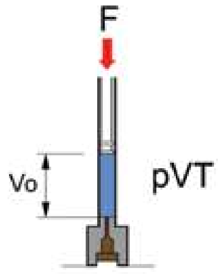
Extended Capabilities

The modular concept is the main feature of the CEAST SmartRHEO Series. Its capabilities can be extended with various accessories and options that fulfill international standards and make the SmartRHEO Series suitable for specific material applications.



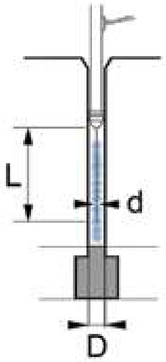
PVT Piston

Thermal Conductivity Piston



PVT | Polymer Cooling Behavior and Compressibility

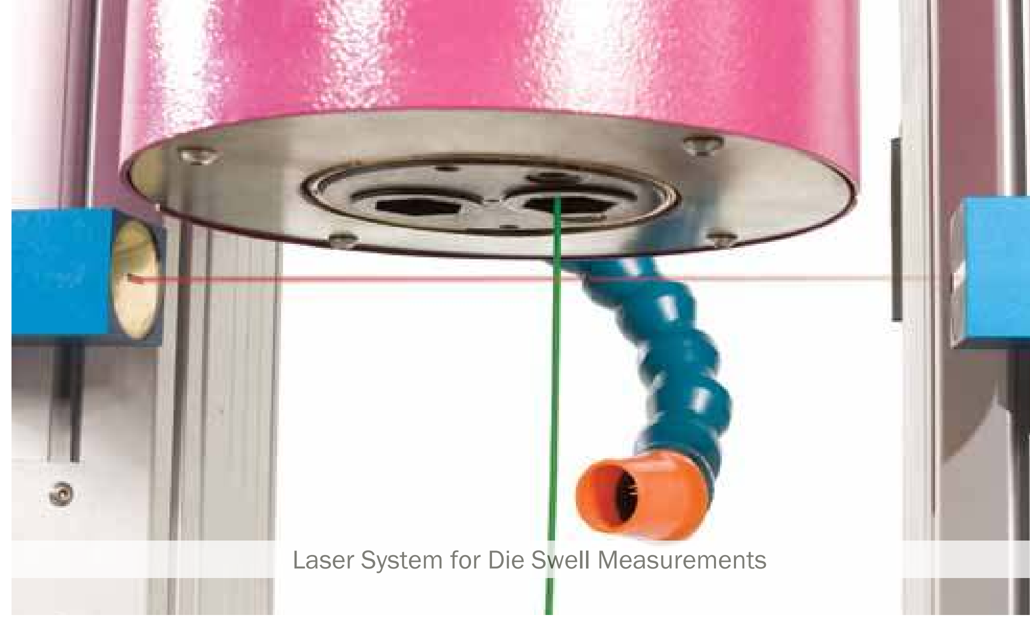
The objective of the injection molding process is to produce finished parts that are free of defects and have a sufficient strength and stiffness for the end use. However, as manufacturers push to decrease cycle times, which improves throughput, they could introduce processing errors. To optimize the mold filling phase, the relationship between a material's pressure, volume, and temperature must be identified. According to the ISO 17744 standard, the PVT device measures the specific volume of plastics directly on the sample by a special piston and a die with a plug.

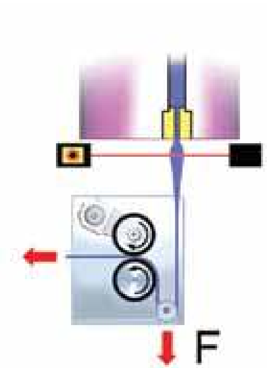


Thermal Conductivity | Polymer Melt Heat Transfer Properties

A material's thermal conductivity describes its ability to conduct and dissipate heat. This property influences the temperature distribution and the cooling behavior of the polymer melt. Thermal conductivity data is vital for high-end process simulation of extrusion and injection molding - as polymer thermal properties affect the process design, optimization, and the quality of finished parts. According to ASTM D5930, the thermal conductivity piston provides data over a vast range of temperatures and pressures.


Stretching Unit in Testing Conditions


Laser System for Die Swell Measurements

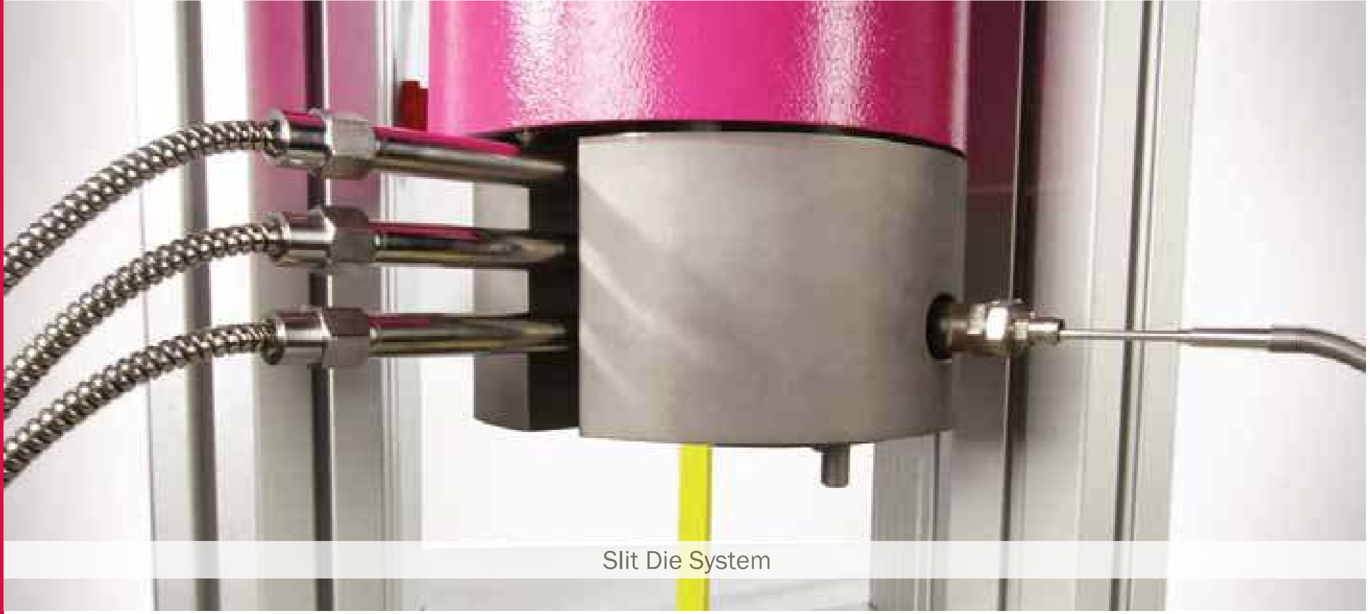


Die Swell | Material Elasticity After Extrusion

The die swell measurement is used for QC purposes as it affects several polymer processes, such as extrusion and blow molding. When a polymer melt is extruded from a die, the cross-section of the extradite is usually bigger than that of the die. This is called die swell and is related to the material’s elasticity. The swelling can be related to processing problems and can generate defects in the finished product. The Die Swell device, equipped with a laser detector below the die exit, measures the diameter of the extrudate at different shear rates.

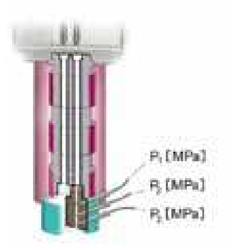
Stretching Unit | Melt Strength and Material Drawing Capability

In processes — like blow molding, film blowing, fiber drawing, and cable coating — the molten polymer is subjected to a tensile stress while cooling; this can cause ruptures and unstable behaviors while trying to increase production speed. Melt stretching techniques are developed to measure the maximum force that the molten material can withstand, and its maximum extensibility. The Stretching Unit — a motorized haul-off device — is equipped with driving pulleys that stretch the extrudate with constant acceleration or constant speed until it breaks. During testing, the load cell records the tensile force. This test can be combined with a Die Swell device to measure the extrudate diameter during stretching.



Slit Die System

Semi-Automated Barrel Cleaning



Slit Die | Viscosity Tests with a Different Extrusion Geometry

Rheological tests are performed to simulate the flow during extrusion through a rectangular duct. This is done using special dies with a rectangular cross section instead of standard cylindrical capillaries. The Slit Die system is designed to fit three additional flush-mounted pressure sensors, which measures the pressure drop inside the die and eliminates the need for entrance pressure corrections (Bagley).

Barrel Cleaning | Sticky Materials

Semi-automated cleaning of all the instrument parts and components is important for instrument maintenance and reliable results. The pneumatic cleaning device is designed to simplify and expedite barrel cleaning at the end of each test. It is fully integrated into the system frame and is suitable for the single and twin bore configurations.

Nitrogen Blanket | Hygroscopic Materials Testing

This optional device blows dry nitrogen gas inside the barrel and protects the tested sample from moisture absorption. It is particularly suited for materials such as PET, PBT, and Nylons.

Dies and Other Accessories

Dies and Other Accessories

A variety of capillary dies is available, with a standard flat inlet or a special conical inlet for materials with high filler content or particular flow behaviors.

Standard capillary diameters range from 0.25 up to 2 mm and cover a range of shear rates (ranging from less than 0.1 to more than 10^6 1/s), and standard capillary lengths range from 0.25 (zero-length dies) to 40 mm. Custom dies are available upon request.

Die reamers for easy and efficient cleaning are available for any capillary diameter, together with Go/No-Go gauges to check the size tolerance. This is critical for accurate results.

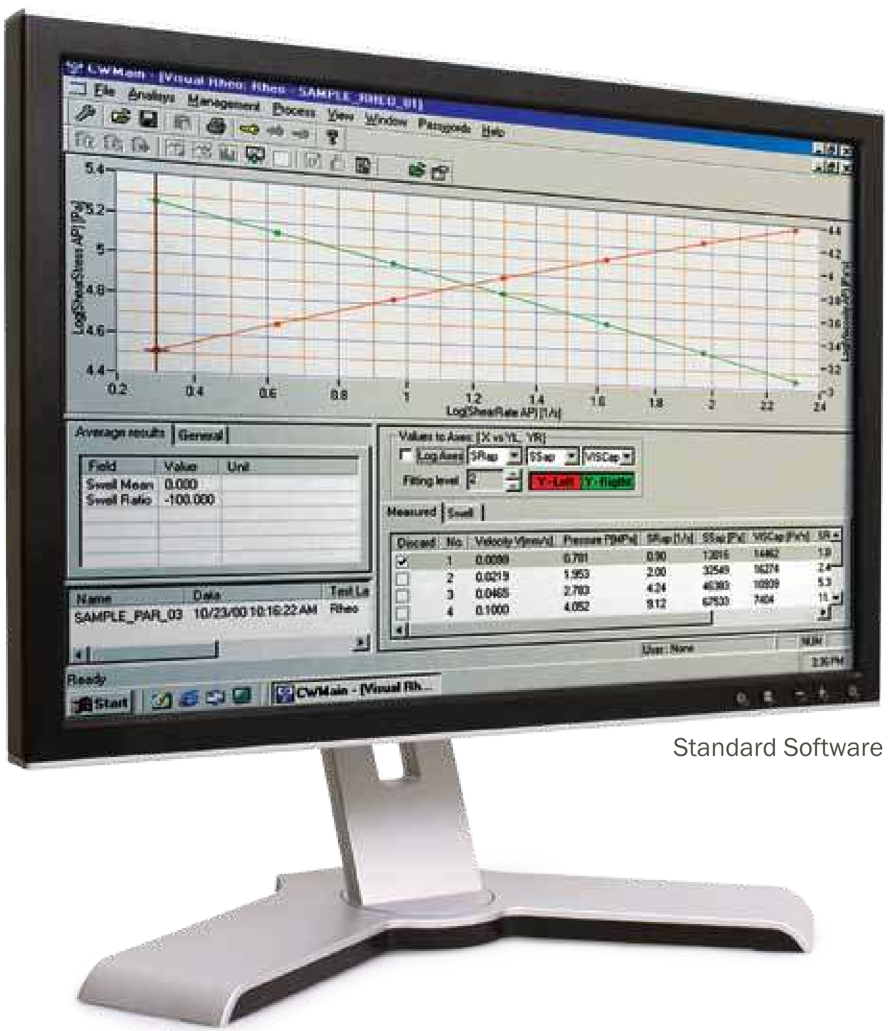
All accessories are suitable for the vast majority of testing applications, including a corrosion resistant stainless steel (Stavax) barrel, pistons, and dies for chemically-aggressive polymer materials.

How to Choose the Right Die

Capillary dies are required to generate different shear rates — the smaller the die diameter the bigger the shear rate. The choice of different capillary die lengths, is required to generate different pressure drops along the capillary length. Moreover, capillary dies with different geometries are used for rheological investigation of materials — especially composites, where fillers within the polymer matrix affect the choice of capillary die dimension.

Repeatability and Reproducibility

The test data is collected, conveniently managed, and analyzed by dedicated software that is designed with a user-friendly interface to control the test instrument. In addition to the standard software capabilities, continuous development produces a wide range of additional modules, providing deeper rheological data analysis and accurate simulation of different test modes for advanced material characterization.



Standard Software

Software Standard Features

The standard software enables users to run the capillary rheometer through a password-based access that is designed for maximum security. It provides the complete flow curve of tested materials and comparison charts for Statistical Quality Control (SQC) and for material curves reference. Customized data export allows easy post-processing analysis and feeding for software simulation programs.

Melt Fracture Module

Flow instabilities are detected using a special test mode with increasing piston speed. This module helps to identify the onset of critical stress for melt distortion and rupture, determining processability limits.

Thermal Degradation Module

This module allows the sequential rheological test procedures to run at different time intervals at a constant temperature. It provides useful information for materials that are sensitive to degradation, as well as for other procedures that have a long time scale, like rotational molding.

Elongational (Extensional) Viscosity Module

Based on the Cogswell calculation method, this module allows the operator to determine the elongational flow properties in terms of viscosity, strain rate, and tensile stress. Ideal for studying the resistance of polymer melts to elongational deformation, it analyzes the data obtained via Bagley correction and provides test results in graphical format for a direct comparison between the elongational and the shear properties.

Viscosity Dependence on Temperature Module

In accordance with different theoretical models — Arrhenius Equation, Approximate Arrhenius Equation, and WLF (William-Landel-Ferry) — this module allows the operator to study how the shear viscosity of the material changes as a function of the temperature. Additionally, the user can determine the temperature at which the material stops flowing (temperature of No-Flow.)

Wall Slip Module

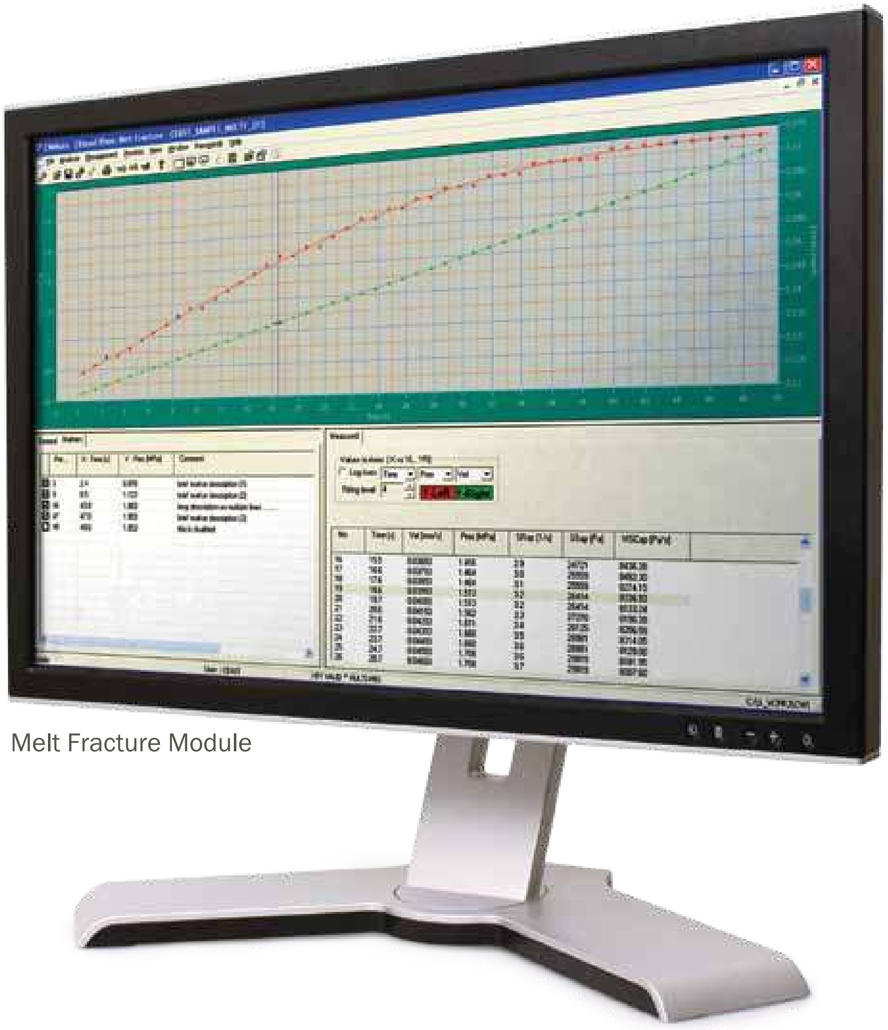
Based on the Mooney method, this module allows the operator to evaluate the wall slip velocity in capillary flow by using tests results performed with different dies having the same L/D ratio. This module is ideal for materials where lubricants or additives (oils, waxes) are added to the polymer to ease the flow.

Advanced Fitting Equations Module

The Viscosity vs. Shear Rate curve of a material can be interpolated by using well-known mathematical rheological models (Power Law, Cross Law, Yasuda Carreau, Polynomial). This module provides additional characteristic constants of the polymer, like the viscosity at zero shear rate (η_0) and the relaxation time λ.

Stress Relaxation Module

Based on a specific test procedure, this module is ideal for studying the melt response in regards to the relaxation of stress after a steady state shear flow.



Melt Fracture Module

Support for the Life of Your Equipment

When You Need Us, We're There

Operating with 25 offices in 18 countries and more than 1,200 employees, Instron® has a global infrastructure that is local to you. When you need service and support for your CEAST SmartRHEO Series, we'll be there. We remain committed to advancing materials and components testing techniques.

Maximize Uptime

The Instron world-class service organization is committed to delivering high-quality installation, calibration, training, maintenance, and technical support throughout the life of your CEAST SmartRHEO Series. We help to ensure that your capillary rheometer is working when you need it.

Quality Standards You Can Trust

Operating under ISO 9001 quality standards and with an extensive list of accreditations, Instron employs a product design philosophy where our customers' data integrity, safety, and protection of investment are paramount. We strive to ensure that our customer satisfaction is second to none.

Specifications

CEAST SR10

CEAST SR20

CEAST SR50

		CEAST SR10	CEAST SR20	CEAST SR50
Maximum Force Range	kN	10	20	50
	kgf	1020	2040	5100
	lbf	2250	4500	11250
Piston Speed	mm/min	0.0024 - 1200 (Speed Ratio: 500,000:1)	0.0024 - 1200 (Speed Ratio: 500,000:1)	0.0024 - 1200 (Speed Ratio: 500,000:1)
	in/min	0.000094 – 47	0.000094 – 47	0.000094 – 47
Barrel Type		Single Bore	Single Bore / Twin Bore	Single Bore/Twin Bore
Barrel Working Length	mm	170	290	290
	in	6.7	11.4	11.4
Temperature Range	°C	50 - 350	50 – 450 (option 500)	50 – 450 (option 500)
	°F	122 - 662	122 – 842 (option 932)	122 – 842 (option 932)
Temperature Accuracy	°C	± 0.2	± 0.2	± 0.2
	°F	± 0.3	± 0.3	± 0.3
Force Transducers	kN	1 - 10	1 - 20	1 - 50
Pressure Transducers	MPa	3.5 - 140	3.5 - 200	3.5 - 200
Dimensions with Shield Lifted (w × d × h)	mm	520 × 600 × 1660	670 × 600 × 1750	670 × 600 × 1750
	in	20.4 × 23.6 × 65.4	26.3 × 23.6 × 68.8	26.3 × 23.6 × 68.8
Dimensions with Auto Clean (w × d × h)	mm	520 × 600 × 1720	670 × 600 × 1800	670 × 600 × 1800
	in	20.4 × 23.6 × 67.7	26.3 × 23.6 × 70.8	26.3 × 23.6 × 70.8
Weight (without options)	kg	110	130	190
	lbs	242.5	286.6	418.8

Americas

Canada +1 905 333 9123
Central America +1 781 575 5000
Mexico +1 781 575 5000
South America +1 781 575 5000
United States +1 800 877 6674, +1 781 575 5000

Europe, Middle East, Africa

Africa +44 1494 456815
France +33 1 39 30 66 30
Germany +49 6157 4029 600
Ireland +44 1494 456815
Italy +39 011 968 5511
Middle East +44 1494 456815
Netherlands +32 3 454 0304
Nordic Region +44 1494 456815
Spain +34 93 594 7560
Portugal +34 93 594 7560
Switzerland +0800 561 550
United Kingdom +44 1494 456815

Asia, Australia

Australia +61 3 9720 3477
China +86 21 6215 8568
India +91 44 2 829 3888
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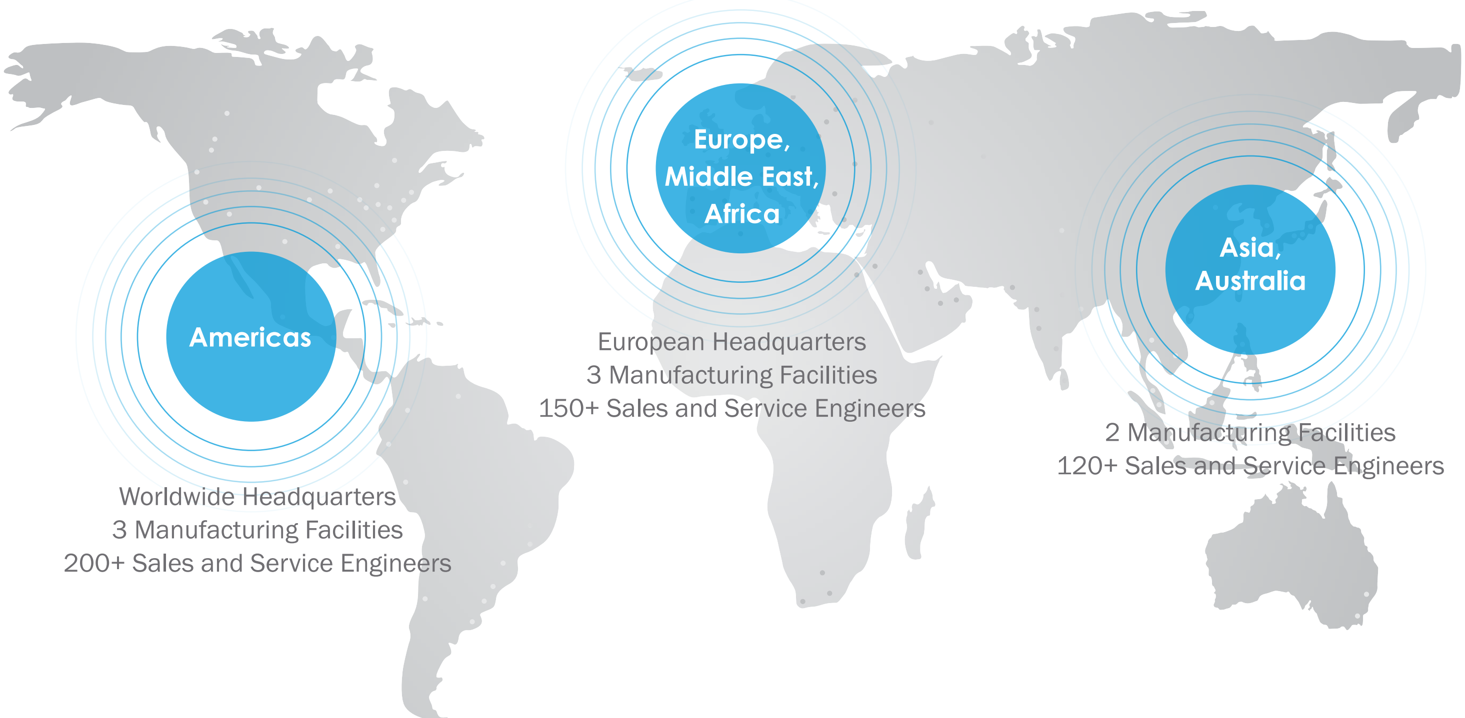

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Worldwide Headquarters
825 University Avenue, Norwood, MA 02062-2643 USA
+1 800 564 8378 • +1 781 575 5000

European Headquarters
Coronation Road, High Wycombe, Bucks, HP12 3SY UK
+44 1494 464646

CEAST Headquarters
Via Airauda 12, 10044 Pianezza TO, Italy
+39 011 968 5511

WB1281B