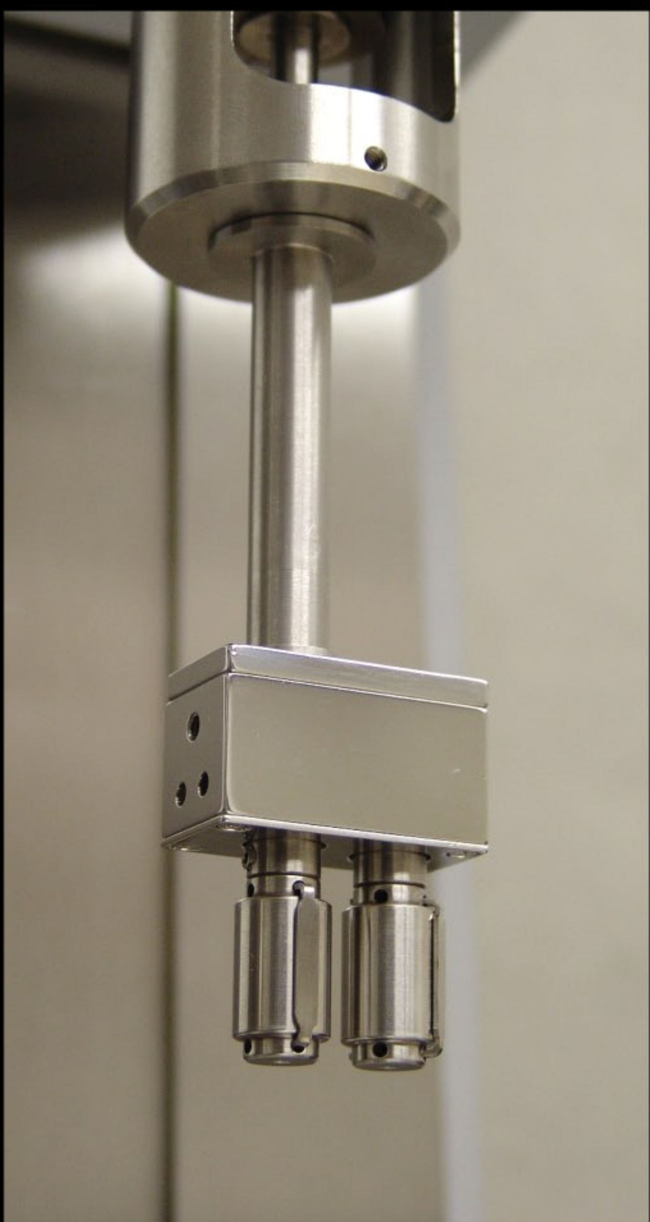
Xpansion Instruments
Xpand Your Capabilities

SER Universal Testing Platform

The Power of Extensional Rheology and Broad-Range Physical Material Testing in the Palm of Your Hand



Extensional Rheology

Peel/Adhesion Testing

Friction Testing

Tensile Testing

Tear Testing

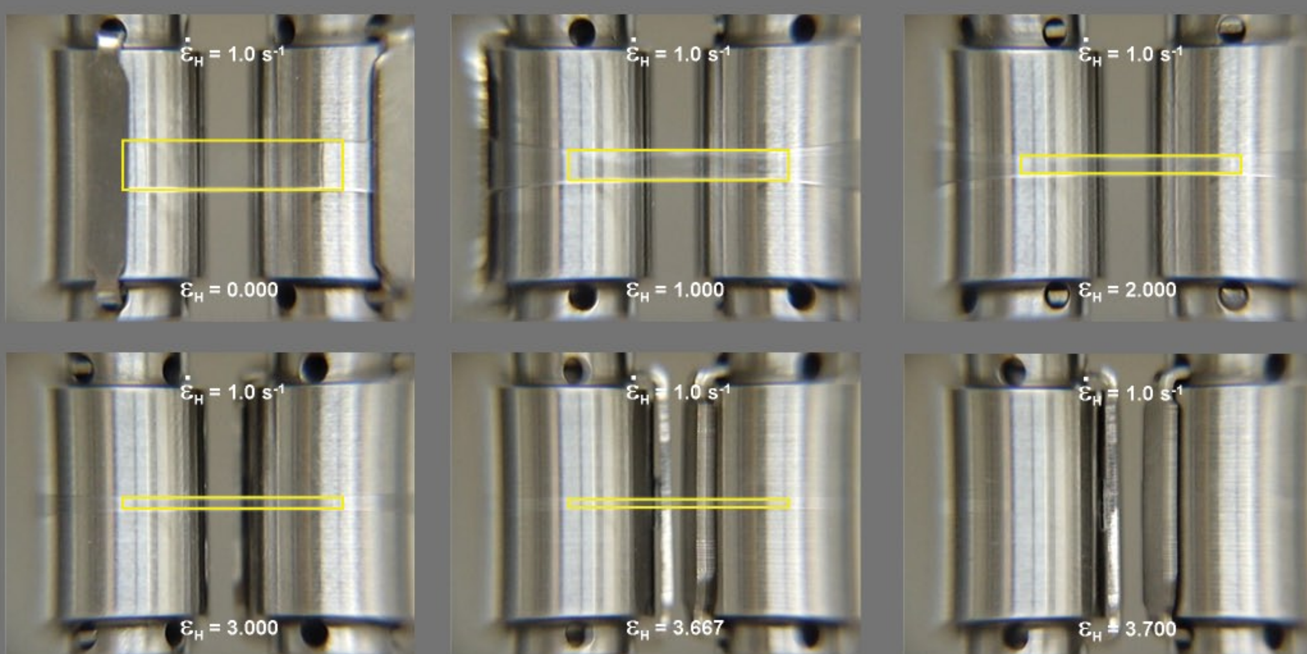
High-Rate Fracture

SER Universal Testing Platform...
The New Paradigm in Extensional Rheology

The SER (Sentmanat Extensional Rheometer) Universal Testing Platform manufactured exclusively by Xpansion Instruments represents the new paradigm in extensional melt rheology and a breakthrough in the field of physical material characterization technology. The unique patented technology (US Pat. No. 6,578,413 & 6,691,569) first developed by Dr. Martin Sentmanat in his pioneering work at The Goodyear Tire & Rubber Company incorporates dual wind-up drums that allow for a truly uniform extensional deformation during material testing. Although first developed for use in characterizing the physical behavior of polymeric materials in uniaxial extension, the SER is not just an extensional rheometer. From extensional melt rheology to solids tensile, tear, fracture, peel, and friction testing, this miniature unit's unparalleled performance and capabilities can help you cover the broad spectrum of your physical material characterization needs.

Unique Patented Technology

The unique dual windup drum design of the SER allows for a truly uniform and controlled extensional deformation in a fixed plane of testing, which allows for easy strain validation and continuous visual access to the sample during the material deformation process. Because the deformation remains in a fixed plane at all times, other experimental visualization techniques such as flow birefringence and x-ray/neutron beam scattering can be incorporated with the SER regardless of the mode and kinematics of material deformation.

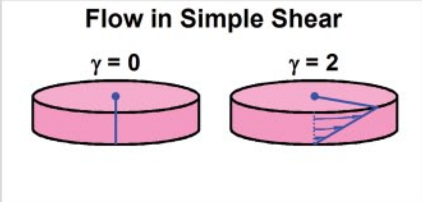


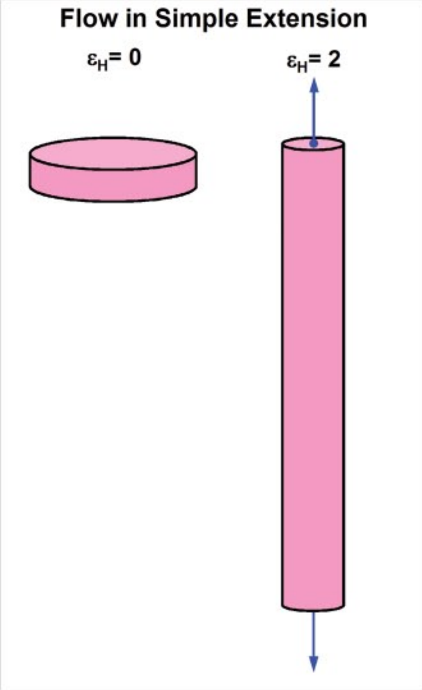
The superposition of the theoretical width evolution (shown as a yellow box) over the actual sample width evolution illustrates the true control of extensional deformation with the SER. The ease of sample deformation visualization and strain validation with the SER is also clearly demonstrated because the extensional deformation remains in a fixed plane.

Deformation Visualization AT ALL TIMES.

The Power of Extensional Rheology

Flows in simple extension are said to be “strong” in the sense that they can generate a much higher degree of molecular orientation and stretching than flows in simple shear. Shown here are relative depictions of a strain deformation of 2 in simple shear and extension for samples of identical initial dimensions. As a consequence, extensional flows are very sensitive to crystallinity and macrostructural effects such as polymer long-chain branching. High-rate, transient extensional flow is also the dominant type of deformation in converging, squeezing, and stretching flows that occur in typical polymer processing operations. Although these types of transient extensional flow measurements have historically been difficult to perform on polymer melts, the revolutionary technology embodied in the SER Universal Testing Platform marks a true breakthrough in the field of polymer melt extensional rheology. Most notably, recent studies with the SER [*Rheol Acta* (2004) 43: 624–633; *Rheol Acta* (2005) 44: 1–15] have revealed the important role of high-rate extensional flow behavior in polymer melt processability, fracture, and flow instabilities.

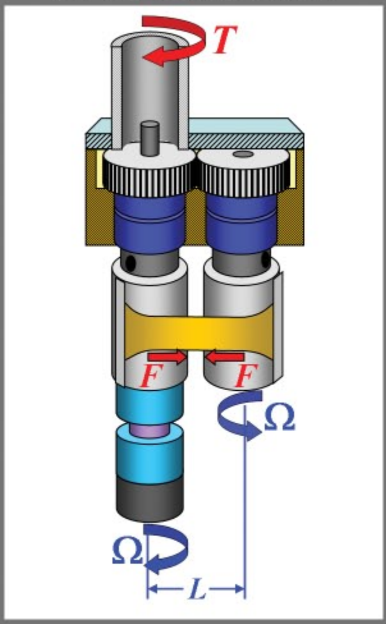




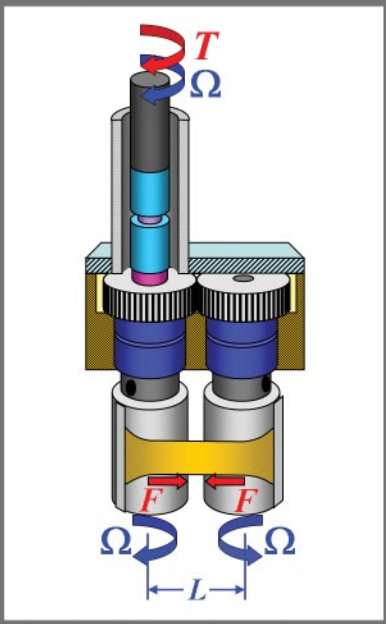
The SER Principle

The ends of a specimen are secured to the surfaces of two windup drums, such that for a constant drum rotation, Ω, a constant Hencky strain rate is achieved. As the specimen is stretched across the drum surfaces, it offers a resistant force, *F*, on the windup drums that translates into a torque, *T*, about the primary axis of rotation. Hence, for a given rate of extensional deformation, the measured torque signal is directly related to the extensional viscosity of the specimen being stretched in the isolated ‘stretch zone’ of length *L* defined by the tangent plane between the drums.

Controlled Rate Rheometer (CRR) Configuration



Controlled Stress Rheometer (CSR) Configuration



By virtue of its unique design and the fact that the specimen deformation zone remains in a fixed plane regardless of the kinematics of deformation, the SER can be used on rheometers comprised of a separate motor and transducer (CRR) or a single motor/transducer (CSR) module.

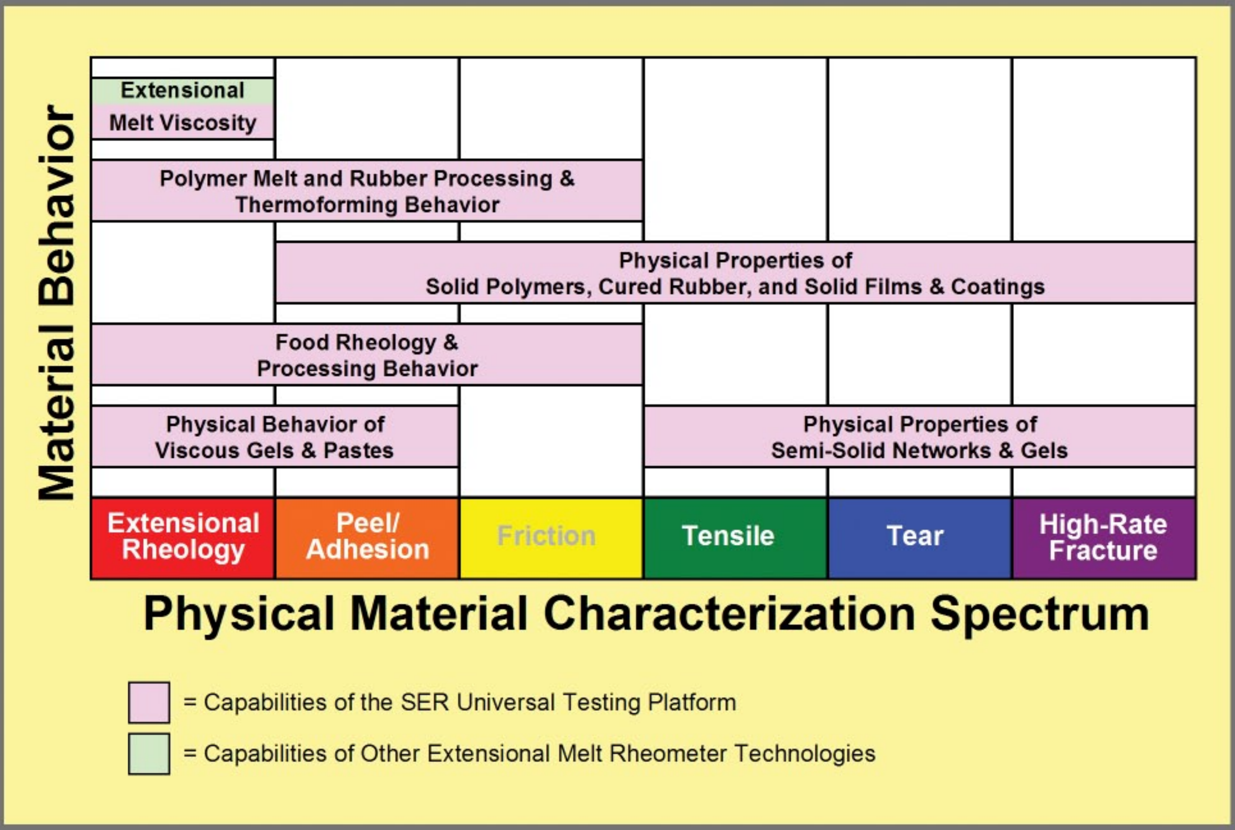
The SER Universal Testing Platform ... Unrivaled Performance.

Unleash The Full Potential of Your Rotational Rheometer System

Far more than just an extensional viscosity fixture, the SER Universal Testing Platform can transform your conventional rotational rheometer system into a multi-tasking test station capable of covering an unprecedented breadth of the physical material characterization spectrum. Whether its extensional melt rheology, peel/adhesion, friction, solids tensile, tear, or high-rate fracture testing, the SER can characterize the physical properties of complex polymeric materials and compounds from the molten state to the solid state.

SER Multi-Tasking Performance

Although extensional rheology can provide valuable insight into polymer macrostructure and melt behavior, the characterization of extensional melt viscosity alone does not provide a comprehensive glimpse into a material's overall processing and physical behaviors. Because the SER can characterize such a broad range of physical behaviors of a material from the melt to the solid state, this miniature platform is capable of providing a comprehensive assessment of both melt processing and finished product material properties.

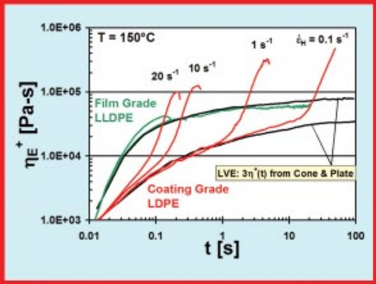


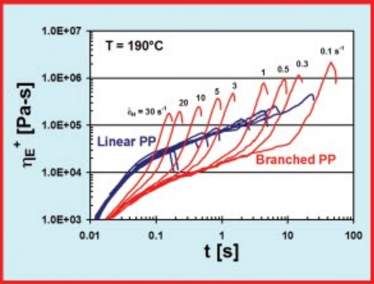
More Than Just An Extensional Viscosity Fixture...

A Multitude of Applications

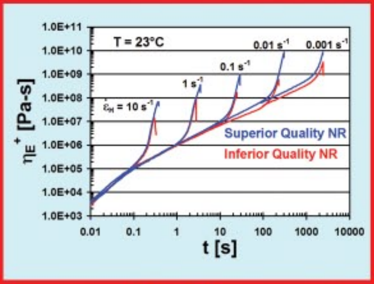
Extensional Rheology

The miniature SER fixture can be easily attached to the host rotational rheometer system, accommodated within the oven chamber of the host rheometer, and operated with the existing control software of the host rheometer. By controlling the motor rotation and operating temperature of the host rheometer system, the SER can be used to characterize extensional melt flow behavior of a large variety of polymeric materials over a very broad range of rates and temperatures, from low viscosity polymer melts to ultra high viscosity elastomers and compounds.

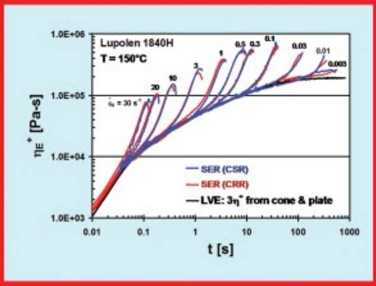




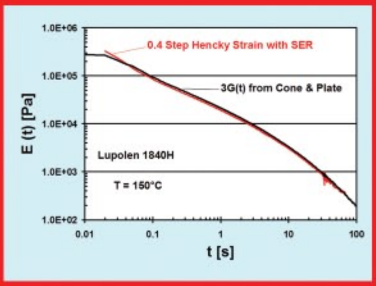
Differences between linear and branched polymer architectures are clearly evident from the melt tensile stress growth data. Note the broad span of rates and how the low strain portions of the tensile stress growth curves superpose with the linear viscoelastic envelope defined by the plot of 3 times the shear stress growth curves taken from cone & plate measurements.



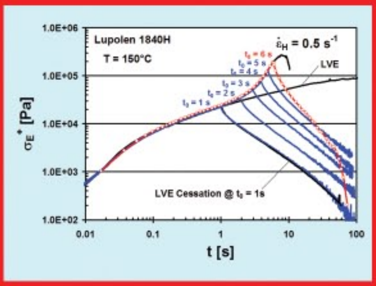
Even subtle differences in polymer architecture that are often difficult to detect from shear rheology data are clearly evident from extensional data.



Regardless of the host platform being used, the SER provides accurate and consistent results over a very broad range of rates and melt viscosities.



Although historically difficult to perform, the tensile stress relaxation modulus of polymer melts can be easily and directly determined from step extension experiments.

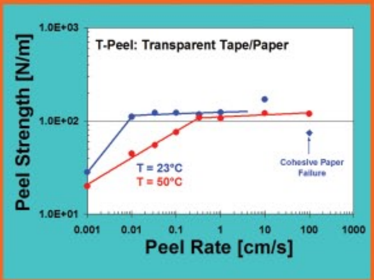


Cessation of extension experimnets are useful in determining the strain dependence of relaxation behavior and in studying the onset of elastic melt instabilities.

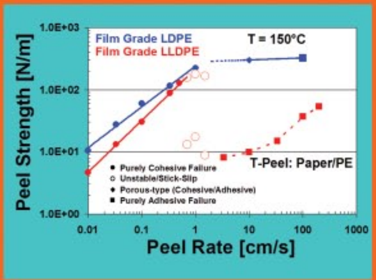
Peel/Adhesion Testing

The peel separation front is confined to the region between the drums ensuring full visual accessibility during controlled rate and/or force peel testing.

The SER can also be used to measure the adhesive properties of pressure sensitive adhesives, gels, and pastes against a variety of substrates over a very broad range of rates and temperatures. Using this same 180° peel geometry the SER can be used to measure the work of adhesion and the onset of cohesive/adhesive instabilities of polymer melts against various surface energy interfaces.



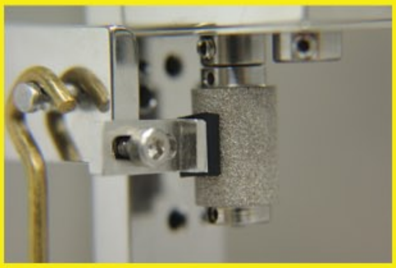
The peel properties of pressure sensitive adhesives can be characterized as a function of substrate, temperature, and rates unachievable with conventional testing.



The peel properties of polymer melts can be used to fingerprint polymer melt processing behavior and to elucidate the role of adhesive failure in melt processing instabilities.

A Broad Range Multi-Tasking Test Platform.

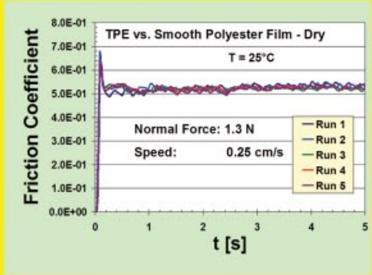
Miniature Scale Solids Testing



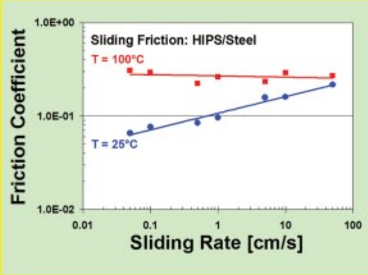
Friction Testing

Normal force is controlled with the use of weight on the friction armature. The texture/surface properties of the drum can be controlled for friction and/or abrasion measurements.

With the use of the friction armature attachment that comes with the SER, the dynamic friction/abrasion properties of solid and semi-solid media can be easily evaluated as functions of interfacial contact surface, rate, normal force, environment and temperature. Because of its miniature size, very small-scale friction/abrasion testing at rates relevant to processing and product application is now achievable.



The friction properties of solid materials used in dynamic sealing/gripping applications can be characterized against substrates and/or coated surfaces at conditions relevant to end use.

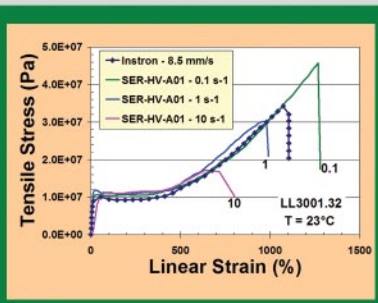


Friction coefficients of solid/polymer interfaces can be characterized over a very broad range of rates and temperatures relevant to polymer processing operations such as thermoforming.

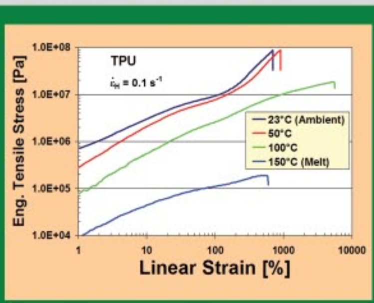
Tensile Testing

Sample necking and fracture are confined to the stretch zone thereby facilitating deformation visualization as well as other in-situ optical and radiation techniques during stretch.

The SER can also be used to perform tensile testing on elastic solids and semi-solids over a very broad range of true strain rates unachievable with conventional testing methods. The tensile properties of complex polymeric materials may also be characterized over a wide range of temperatures from the solid state to the melt state on miniature samples weighing just a few milligrams.



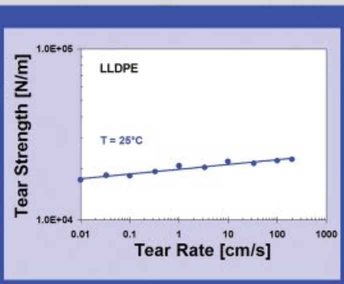
The broad range and high speed tensile rates achievable with the SER clearly reveal the rate dependent tensile behavior of crystalline polymers not observable with conventional testing.



The tensile behavior of rheologically complex materials can be characterized from molten, to softened, to solid state in order to evaluate the strain dependence of crystallization.

Tear Testing

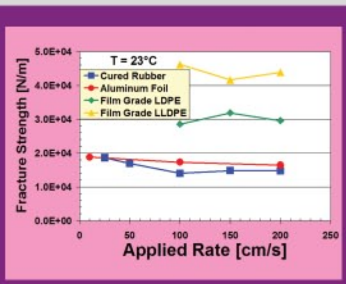
Sample tear of the trouser specimen is confined to the region between the drums thereby allowing full visual access to the tear propagation site during controlled rate and/or controlled force tear testing.



The tear behavior of solid materials can be characterized in pure shear (trouser tear) as a function of temperature at rates unachievable with conventional testing.

Fracture Testing

Sample fracture and crack propagation is isolated to the region between the drums allowing full visual access to the crack propagation tip during controlled rate and/or controlled force fracture testing.



The fracture behavior of thin gage solid polymers, cured rubber, composites, and metals can be characterized at rates unachievable with conventional testing.

Coming Full Circle in Material Characterization ... Bridging the Gap From Molten to Solid State.

The SER2 Advantage

SER2 Features

Detachable Drums

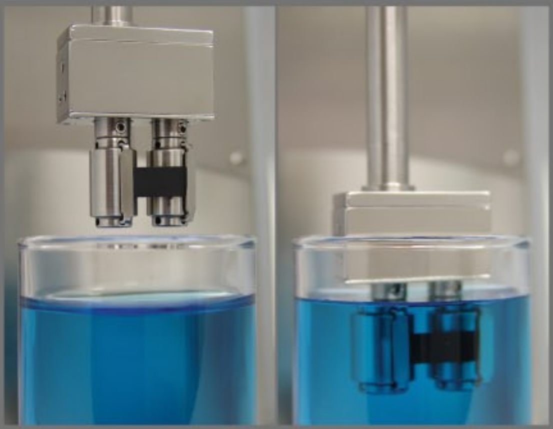
All SER2 models have removable drums that can be configured of any size, material of construction, or surface properties thereby greatly enhancing material characterization capabilities and greatly facilitating sample cleaning and residue removal.

Available SER2 Drum Options:

- SER2-DS (Std. Smooth Drums)
- SER2-DK (Knurled Drums)
- SER2-DR (Textured Drums; 180-grit)

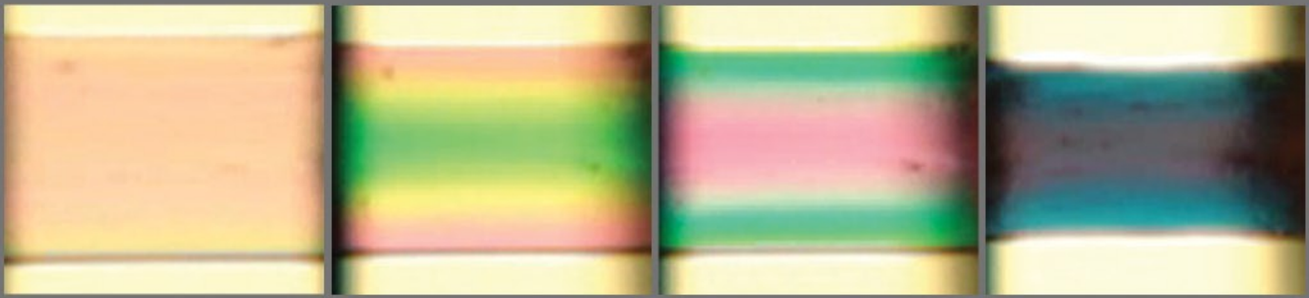
Fluid Immersion Testing

Because both of the detachable drums are cantilevered and suspended from the SER2 base chassis, the SER2 models that are configured for use on CSR host systems are capable of fluid immersion testing. The drums of said SER2 models can be raised from and lowered into a controlled temperature fluid environment contained within a jacketed beaker or other such fluid containment vessel. Applications include biomaterials testing as well as high-temperature silicon oil bath testing to eliminate any effects associated with molten sample sag at low melt viscosities.



Rheo-Optics

Because the deformation field occurs in a fixed plane with the SER, in-situ rheo-optics and birefringence measurements can be made on materials exhibiting birefringent behavior during the deformation process. Although operation of the SER can be coupled with any number of sophisticated laser, or electromagnetic radiation techniques, a simple white light source, a pair of linear polarizer optical filters, and a camera with video capturing capability is all that is needed in order to characterize the rheo-optical behavior of materials undergoing deformation on the SER. Below is an illustration of the evolution (from left to right) of the rheo-optical behavior of a butyl elastomer relaxing from a uniform uniaxial extension deformation.



An Even Broader Range of Versatility

The SER2 Model Line:
An Even Broader Range of Adaptability

SER2-A

Building on the success of the original SER-HV model line, the SER2 model line can be accommodated on an even broader range of commercially available host rotational rheometer systems, defining a new standard in physical material characterization.

SER2 Model Line:

SER2-P - for the Anton Paar MCR 300/301/500/501

SER2-A - for the TA/Rheometrics ARES/RDA3/RDA2

SER2-G - for the TA Instruments AR-G2/2000EX

SER2-T - for the Thermo Fisher Scientific HAAKE MARS

SER2-M - for the Malvern Kinexus

SER2-R - for the Reologica NOVA

SER2-P

INSTRUMENT PARAMETER	***SPECIFICATION***
Maximum Operating Torque	**2500 g-cm**
Minimum Torque Threshold	**< 0.1 g-cm**
Maximum Recommended Hencky Strain Rate	**20+ s^{-1}**
Hencky Strain Per Drum Revolution	**5**
Maximum Tear/Peel Rate	**100+ cm/s**
Operating Temperature Range	**0°C to 315°C**
Windup Drum Diameter	**1.031 cm (0.406 in)**
Stretch Zone Gage Length	**1.272 cm (0.501 in)**
SAMPLE PARAMETER	***SPECIFICATION***
Min. Zero-Shear Viscosity (without fluid immersion)	**~ 10,000 Pa-s**
Sample Mass Range	**5 – 200 mg**
Recommended Sample Width Range	**0.1 – 1.27 cm**
Recommended Sample Thickness Range	**0.005 – 0.1 cm**

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