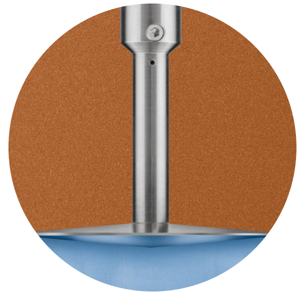
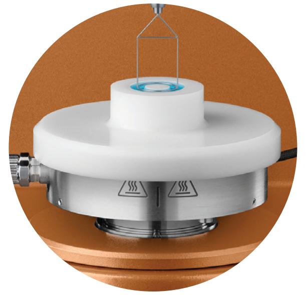
INTERFACIAL RHEOLOGY | ACCESSORIES



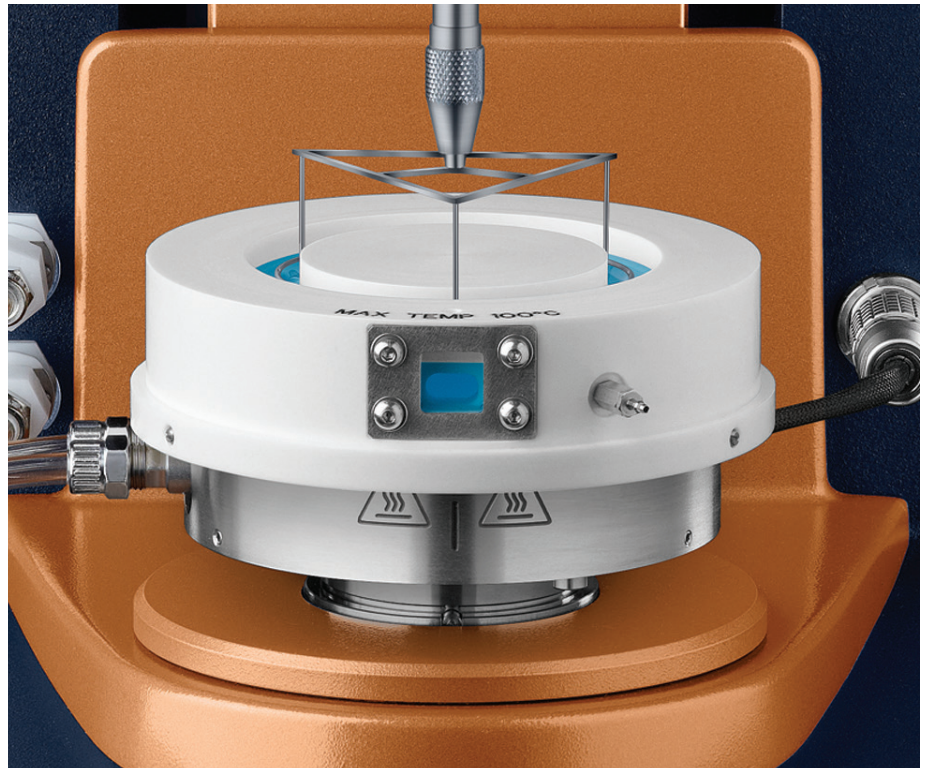
Bicone



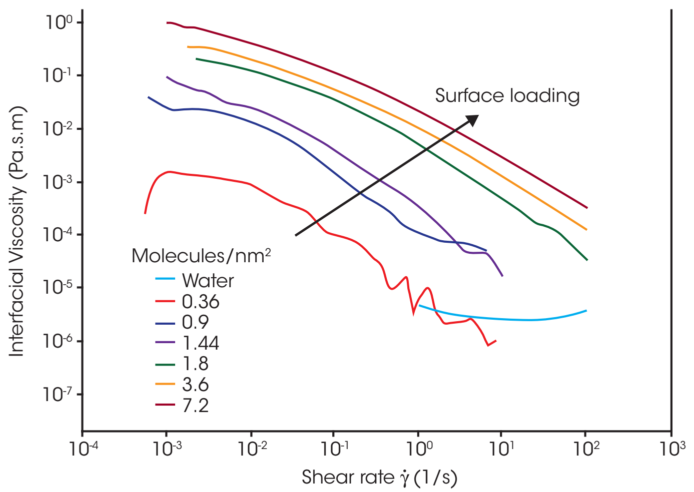
Double Wall Du Noüy Ring (DDR)

Interfacial Accessories

Rheometers are typically used for measuring bulk or three-dimensional properties of materials. In many materials, such as pharmaceuticals, foods, personal care products and coatings, there is a two-dimensional liquid/liquid or gas/liquid interface with distinct rheological properties. Only TA Instruments offers three separate devices for the most flexibility and widest range of quantitative measurements for the study of interfacial rheology. The options include a patented Double Wall Ring (DWR) system for quantitative viscosity and viscoelastic information over the widest measurement ranges, a Double Wall Du Noüy Ring (DDR) for samples available in limited volumes, and a traditional Bicone for interfacial viscosity measurements.



Surfactant Concentration & Interfacial Viscosity

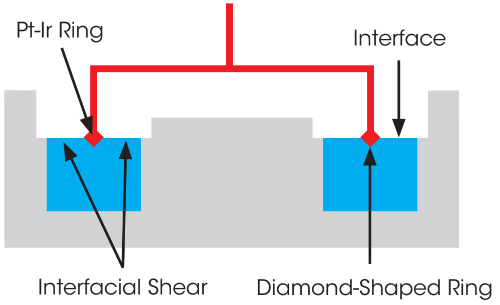


Shear Thinning Behavior in Interfacial Rheology

In this series of tests, the surfactant SPAN65 was spread evenly at the water-air interface using a solution of SPAN 65 in chloroform. After the evaporation of the chloroform, the SPAN65 film deposited on the water was measured using the Double Wall Ring Interfacial accessory. Different loadings of surfactant were tested from 0 (just water, no surfactant layer) to 7.2 molecules per nm². Continuous shear experiments were conducted and the interfacial viscosity was measured as a function of shear rate and interfacial concentration. As expected, the surfactant layer shows significant shear thinning. At high rates, sub-phase contributions dominate for loadings less than 1.8 molecules/nm². Sub-phase correction becomes important below an interfacial viscosity of 10^{-5} Pa.s.m and the well-defined geometry of the DWR makes these quantitative sub-phase corrections possible. At higher interfacial viscosities, sub-phase contributions are negligible and the correction is unnecessary.

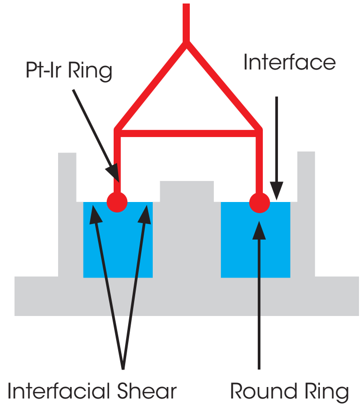
Interfacial Geometries

TA Instruments offers patented double wall interfacial rheology geometries that provide well-defined shear planes on both sides of the geometry for quantitative flow fields and high sensitivity to surface rheology. In TA Instruments interfacial rheology systems, the sample is contained in a Delrin® trough with measuring geometries made of Platinum-Iridium for the Double Wall Ring (DWR) and Double Wall Du Noüy Ring (DDR) geometries. These materials are selected for their inert chemistry and ease of cleaning. The choice of different interfacial rheology options gives you the greatest flexibility in choosing the appropriate geometry for your application.



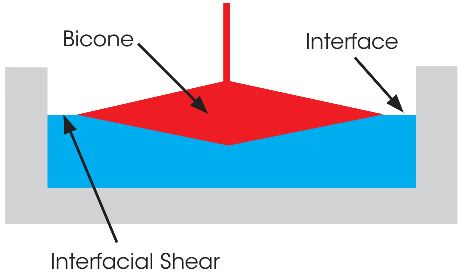
Double Wall Ring

The Double Wall Ring (DWR) is the most sensitive interfacial rheology geometry and is capable of truly measuring quantitative viscoelastic parameters. This patented ultra-low inertia ring(1) features a diamond shaped cross-section to "pin" the interface to the ring. Together, the large diameter and narrow cross-section minimize subphase drag. The low inertia design assures the best oscillation measurements over the widest frequency range of any interfacial system. As a result, surface viscosity measurements as low as 10^{-6} Pa.s.m are possible without complicated corrections. Unlike competitive offerings, the DWR does not require additional experiments or mathematical manipulation to account for the torque contributions from the individual phases of the interfacial system.
(1) U.S. Patent # 7,926,326



Du Noüy Ring

The Du Noüy ring geometry of the Double Wall Du Noüy Ring (DDR) is an industry standard device used for surface tension measurements. The round cross-section allows for meniscus formation between the interface and geometry, creating a slight error in the absolute data. With a much smaller diameter of 20 mm, this system is ideal for testing interfacial properties of samples that are available in very limited quantities, such as biological or pharmaceutical materials. The patented double wall trough (1) provides well-defined interfacial shear planes on both sides of the geometry surface, permitting the characterization of viscoelastic interfaces in both steady shear and oscillatory tests.
(1) U.S. Patent # 7,926,326



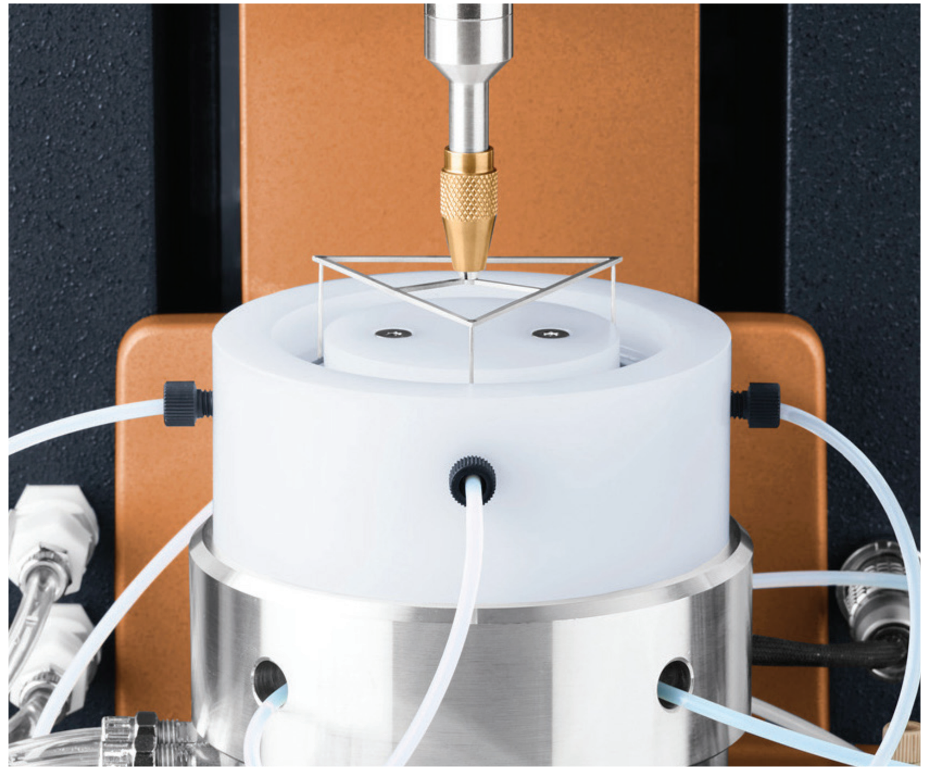
Bicone

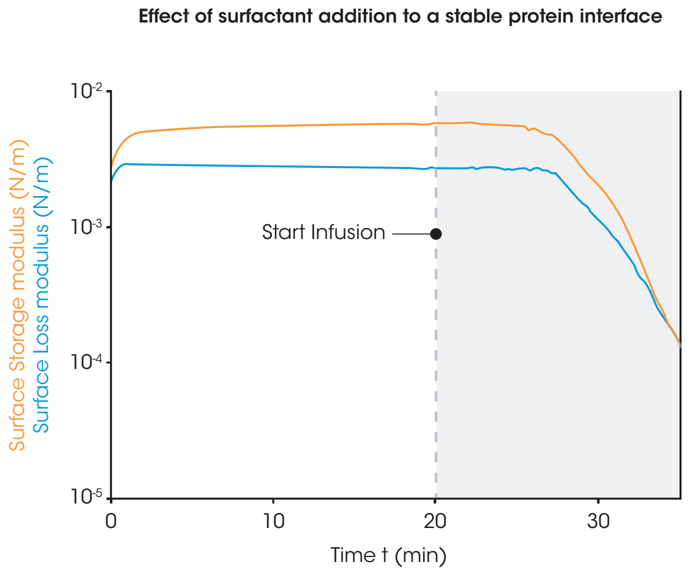
The Bicone is a double conical stainless steel geometry with a sharp edge that reproducibly pins the interface. Rheological tests with the bicone require mathematical corrections to account for the drag contributions from the cone surface submerged in the subphase. The geometry's large moment of inertia limits measurement capability to interfacial viscosity in steady shear mode, precluding valuable measurements of quiescent structure and elasticity. Well-established in scientific literature, the bicone is appropriate for studying stiff interfaces in steady shear

INTERFACIAL EXCHANGE CELL | ACCESSORIES

Interfacial Exchange Cell

The Interfacial Exchange Cell expands TA Instruments' patented offerings for interfacial rheology by providing the ability to directly manipulate the composition of the lower liquid layer (subphase) during rheological measurements. This unique capability enables the characterization of the interfacial response to a modified subphase composition, opening possibilities for quantifying the effects of changes in pH, salt, or drug concentration, or the introduction of new proteins, surfactants, or other active ingredients.





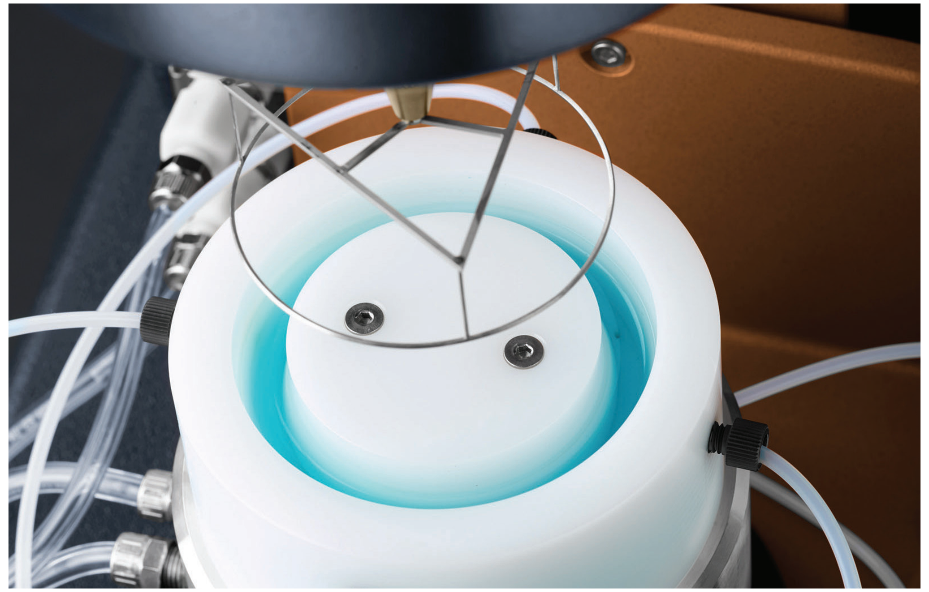
Controlled Infusion of Soap Solution

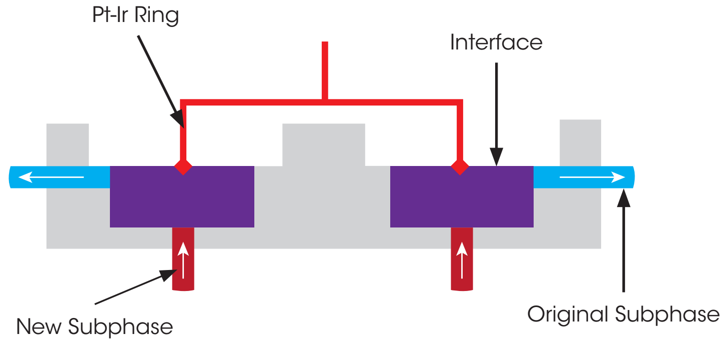
The interfacial strength of a protein network adsorbed at an oil/water interface can be affected by factors such as the pH, salt concentration, and presence of surfactants. In this example, a strong and stable network of bovine serum albumin was formed at the interface between a phosphate-buffered saline solution and dodecane.

Next, the buffer solution in the subphase was exchanged with a very dilute soap solution. Within minutes after the infusion of the soap solution, the interfacial moduli drop several orders of magnitude, reflecting a dramatic destruction of the protein interface. The introduction of the surfactant lowers the surface tension and displaces protein molecules from the interface. Over time, the continued accumulation of surfactant at the interface brings about the catastrophic destruction of the original protein interface through an orogenic displacement or phase separation processes.

Technology

The Interfacial Exchange Cell consists of three key components – the Double Wall Ring geometry, an exchange cell trough with inlet and outlet ports, and a computer-controlled syringe pump. The cell design, based on computational fluid dynamic simulations by Schroyren *et. al.* (1), is optimized to maximize compositional uniformity while maintaining a constant interfacial height and minimize the stress at the interface from pumping fluid into the cell.





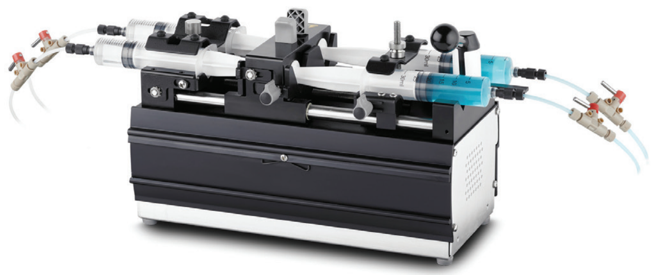
Double Wall Ring

The Interfacial Exchange Cell uses the ultra-low inertia Double Wall Ring (DWR) as the measuring geometry. Featuring a large diameter and a diamond shaped cross-section to "pin" the interface to the ring, the DWR is the preferred platform for sensitive, quantitative interfacial rheology data.

Exchange Cell Trough

The specially-designed double wall interfacial trough (2) features strategically placed fluid inlet and outlet ports to exchange the subphase during a rheological measurement. During the experiment, the new subphase is introduced through four ports located at the bottom of the cell while the same volume is simultaneously removed through four ports located just below the fluid/fluid interface. This concurrent exchange and the balanced trough design ensures uniform infusion and withdrawal guaranteeing a constant subphase volume and interface location throughout the test.

(1) Schroyren *et. al.*, Rheologica Acta, Volume 56, Issue 1, pp1-10
(2) U.S. Patent # 7,926,326



Syringe Pump

The subphase exchange is precisely executed by a simultaneous infuse/withdraw syringe pump that is directly controlled and programmed through TRIOS software. A pair of syringes at each side allow for a complete and uniform exchange of the subphase volume while maintaining a constant interfacial height. At a representative 6 mL/min flow rate, the subphase volume inside the cell can be completely exchanged within 8 minutes.