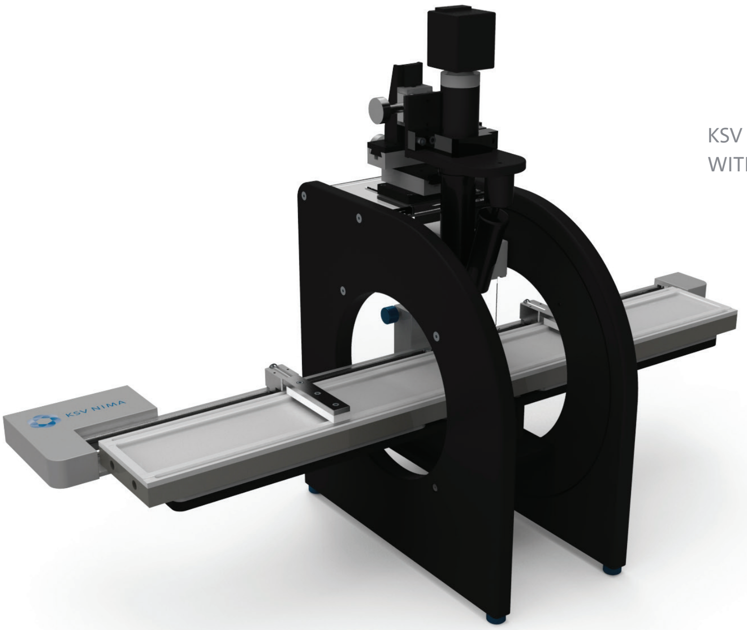
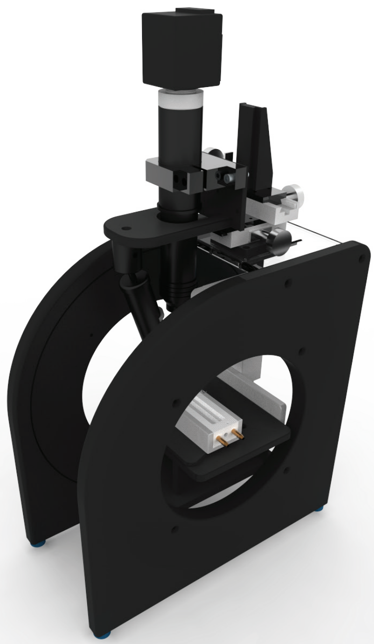
KSV NIMA
Interfacial Shear Rheometer



KSV NIMA ISR
WITH KSV NIMA LANGMUIR TROUGH



KSV NIMA ISR
WITH LOW VOLUME MEASUREMENT CELL

KSV NIMA Interfacial Shear Rheometer

The KSV NIMA Interfacial Shear Rheometer provides an extremely sensitive method to measure the shear properties of films at fluid interfaces (gas/liquid and liquid/liquid). Viscoelastic properties and surface pressure can be measured simultaneously. The film packing density can also be controlled while measuring.

Applications

The relationship between stress and deformation defines the rheological properties of a film. Most thin films encountered *in vivo* and in industrial applications are viscoelastic, where this relationship is intermediate between purely viscous and purely elastic.

The rheological properties are extremely important for defining product stability. Applications can be found in many industries. For example proteins, polymers, pigments, fluoroalkanes and other emulsifiers are strong stabilizers in dispersions and used in the pharmaceutical, cosmetic and food industries.

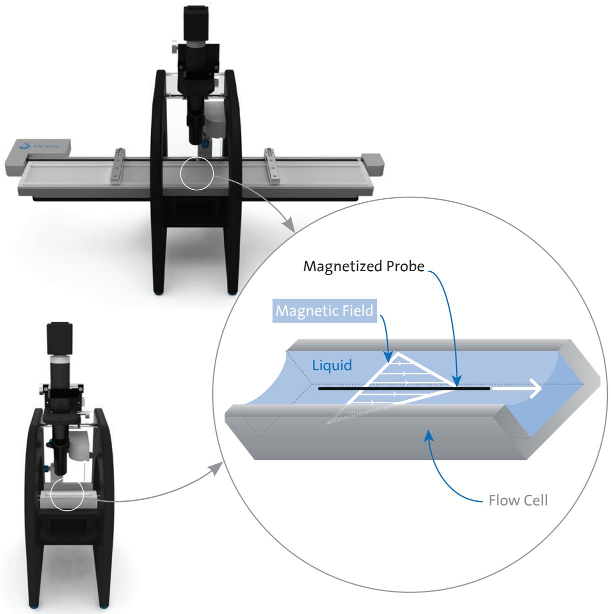
The KSV NIMA Interfacial Shear Rheometer (ISR) can be used for:

- **Prediction of emulsion, froth and foam stability**
  Viscoelasticity of an interface can predict the stability of a complex fluid. Micelle/droplet fusion and fission are largely dependent on the interfacial viscoelasticity.
- **Determination of thin film structure**
  The presence of networking, hydrogen bonding and other interactions can be detected from the viscoelastic behaviour of films.
- **Examination of phase transitions**
  Thin film phase transitions can lead to a change in rheological properties (not always shown in a Langmuir isotherm compression).
- **Real-time monitoring of surface reactions**
  Surface gelation, network formation and protein denaturation at interfaces are detected from the changes in the viscoelastic properties.
- **Continuous monitoring of molecule adsorption into interfaces**
  Especially in biological systems the adsorption and desorption at interfaces and surfaces can change viscoelasticity. Many processes in cells such as mitosis are highly dependent on membrane rheology.

Working principle

The method marks a quantum leap in technology from the traditional rotational rheometers that lack the sensitivity to probe many of the phenomena occurring within a thickness range of a few nanometers.

A magnetized probe, positioned at the air-liquid or liquid-liquid interface, is moved using a magnetic field. The movement of the probe is recorded with a digital camera from above. By measuring any changes in the movement of the probe the surface modulus can be calculated and divided into the elastic and viscous properties of the film.



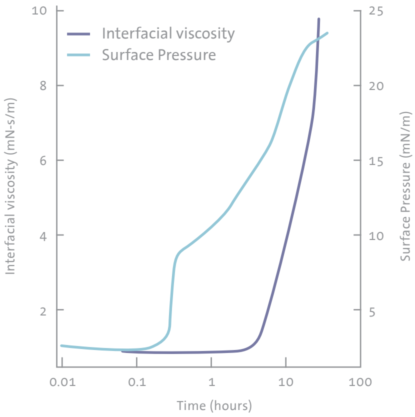
Measuring options

Dynamic measurement
In a dynamic test, the instrument provides both the elastic (storage) and viscous (loss) moduli, G'(ω) and G"(ω) respectively. The relative magnitudes of these two properties immediately provide information whether the film behaves more like an elastic membrane or a viscous fluid film. These quantities can be converted to the dynamic, interfacial viscosity, μ_s^*. The measurements can be performed as a function of frequency, time, strain, temperature or surface pressure.

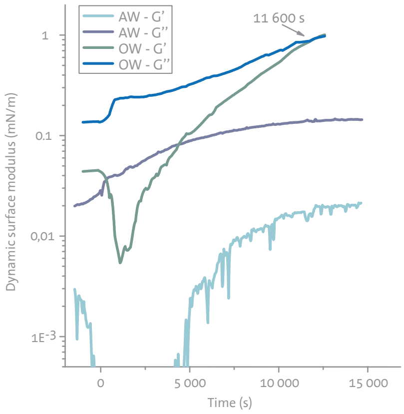
Allows measurements of:

- Elastic (storage) modulus, G'
- Viscous (loss) modulus, G''
- Dynamic interfacial viscosity, μ_s^*

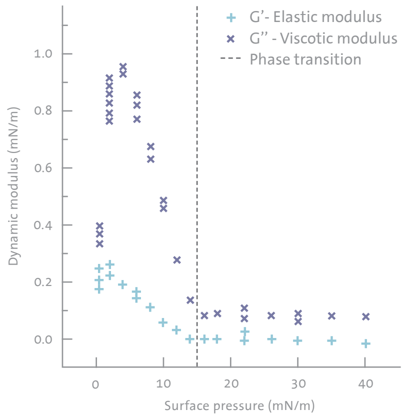
GRAPH 1



GRAPH 2



GRAPH 3



Static measurement

In creep compliance test mode, the instrument provides information on whether the system behaves more like an ideal Newtonian liquid (dashpot model) or ideal elastic (spring model). Viscoelastic systems are more complex as they combine both elements. These can be modelled with Maxwell and Kelvin-Voigt models. From the models the film interfacial surface viscosity, η_s, storage modulus, G, and relaxation time, τ, can be calculated.

Allows measurements of:

- Surface / interfacial viscosity, η_s
- Elastic moduli, G
- Relaxation times, τ

Product range

The KSV NIMA ISR can be equipped with either a KSV NIMA Langmuir Trough (or Liquid-Liquid Trough) for simultaneous control of the film packing density or a Low Volume Measurement cell to work with small interfacial areas and reduced suphase volumes.

Both systems enable surface pressure measurement thanks to the integrated highly sensitive Wilhelmy balance. The Langmuir Trough and the Low Volume Measurement Cell are divided into an upper and lower compartment which can be used to study film viscoelasticity at the liquid-air or liquid-liquid interface.

KSV NIMA ISR with KSV NIMA Langmuir Trough

Combining the KSV NIMA ISR with a Langmuir Trough or Liquid-Liquid Trough allows controlling the compression of both soluble and insoluble films during the measurements. Like with any KSV NIMA Langmuir Trough, measurements of Isotherms, Isobars and interfacial dilational rheology are possible. Please ask for the KSV NIMA Langmuir and Langmuir-Blodgett brochure for additional information on Langmuir Troughs.

KSV NIMA ISR with Low Volume Measurement Cell

When working with valuable compounds and subphases, the KSV NIMA ISR can be used with the Low Volume Measurement Cell which require as little as a 4.7 ml of subphase. It is ideal to study material adsorption and reaction at interfaces. A quartz glass cover minimises liquid evaporation and reduces the influence of airflows. An integrated water circulator enables temperature control from 10 to 60°C. Two injection ports on each end of the Cell enable easy injection of materials (e.g. proteins, enzymes) in the subphase and allow gradual subphase exchange while measuring.

Measurement examples

Graph 1

Graph 1 illustrates the evolution of the interfacial viscosity of a protein monolayer (lysozyme) residing between water and decane plotted as a function of time. The surface pressure of the layer is also plotted. The change in surface pressure shows the evolution of the adsorption, interfacial viscosity and the crosslinking of the protein as a viscoelastic "skin" develops at the interface as a function of time. The surface pressure data complements the interfacial rheology data.

Graph 2

In a KSV NIMA ISR Low Volume Measurement Cell, a 20 mg/ml solution of Lysozyme was injected in the subphase and interfacial viscolelastic properties were monitored (single frequency mode, 0.1 Hz) at an air-water interface (AW) and at an oil-water interface (OW). Graph 2 gives the storage and loss moduli obtained during both experiments. The lyzozyme injection was done at time 0s. The adsorption to the AW interface had only a slight effect on the viscoelastic properties. There was no network formation, the adsorption ended to a plateau and the viscosity dominated during the whole experiment. In the OW experiment the interfacial elasticity clearly developed faster than the interfacial viscosity and a gel point was reached after approximately 11 600 s (3.2 hours).

LOW VOLUME MEASUREMENT CELL

Graph 3

Graph 3 demonstrates the capability to observe a phase transition in eicosanol by measuring changes in the viscoelastic behaviuor as a function of surface pressure. The purple crosses show the viscous modulus (surface loss, G'') that reaches a maximum value at a surface pressure of 5mN/m while nothing is visible on the surface pressure isotherm.The blue crosses show the elastic modulus (surface storage, G'). Both G' and G'' reach a constant value when the surface pressure reaches approximately 15 mN/m. The value corresponds to a phase transition in the packing of the eicosanol monolayer from tilted liquid to a non-tilted liquid phase. After the phase transition value is reached the film retains some viscous properties while the elasticity is practically zero.

Product benefits

- KSV NIMA ISR is the most sensitive rheometer able to measure very weak elastic and viscous moduli of surfaces and interfaces.
  - *Innovative non-contact technology between the probe and the instrument for increased sensitivity: the magnetic field eliminates the need for mechanical connection. This is especially useful for liquid-liquid interfaces as no probe comes through the upper liquid phase.*
  - *Low inertia hydrophobic probe for sensitivity and optimal floating at the interface.*
- Static and dynamic rheological measurement options in equilibrium conditions.
- Measurements in constant surface area compared to dilational (area changing) methods.
- Easily integrated with KSV NIMA Langmuir Trough allowing precise control of monolayer packing density.
  - *The only rheometer enabling surface pressure measurements and monolayer compression/expansion.*
- Possibility to work with volumes as low as 4.7 ml when using the Low Volume Measurement Cell. It enables time and cost savings when working with valuable compounds and subphases.
- Built in data plotting option with capability of viewing multiple measurement results in one graph. Measured data can easily be exported to a data file which is readable from common plotting Software.
- Wide range of experimental parameters that can be controlled and measured in real-time:
  - *Frequency*
  - *Strain*
  - *Stress*
  - *Temperature*
  - *Surface pressure*
  - *Packing density (with the KSV NIMA Langmuir Trough)*

Technical specifications

Measurement

Dynamic moduli resolution: 0.001 mN/m
Frequency range: 0.06 to 25 rad/s (0.01 to 4Hz)
Strain range: 3×10^{-4} to 1

Instrument dimensions (L x W x H)

With KSV NIMA Langmuir Trough: 908 mm x 370 mm x 700 mm
With Low Volume Measurement Cell: 190 mm x 370 mm x 700 mm
(dimensions exclude the pressure sensor Interface Unit: 158 x 209 x 273 mm)

Low Volume Measurement Cell inner dimensions (L x W x H)

Lower compartment (heavy phase): 120 x 11 x 6.5 mm (4.7 ml)
Upper compartment (light phase): 120 x 19.6 x 6 mm (13.9 ml)

Instrument weight

With KSV NIMA Langmuir Trough: 35 Kg
With Low Volume Measurement Cell: 25 Kg

KSV NIMA

KSV NIMA – *at the creative interface of people and technology*

We create value for our customers by providing advanced, innovative instruments for thin film fabrication and characterisation, by constantly exchanging knowledge with our customers and through building open, trusting relationships with customers and partners.

Availability

KSV NIMA products and services are provided to customers all over the world through Biolin Scientific in co-operation with a highly competent network of Distribution Partners. For a list of relevant contact details, visit *www.ksvnima.com*

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