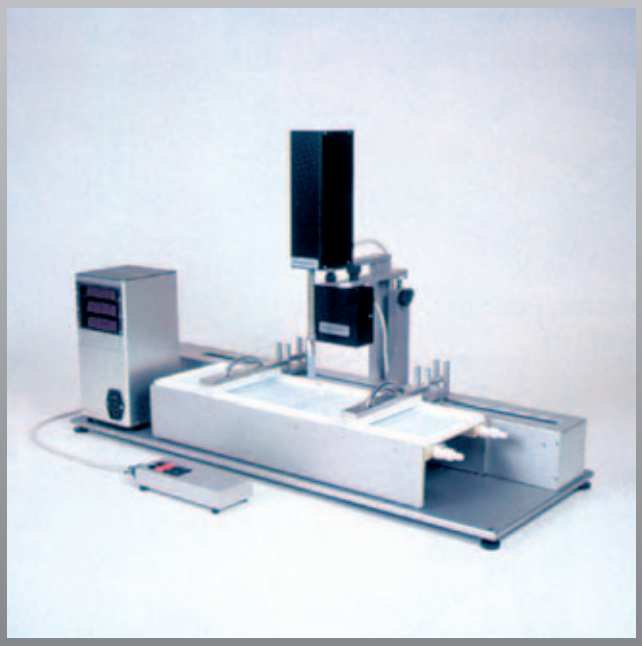
Excellence in Surface Chemistry

KSV 2000 System



The Ultimate Langmuir/ Langmuir-Blodgett System

KSV Instruments Ltd

Langmuir troughs for every application

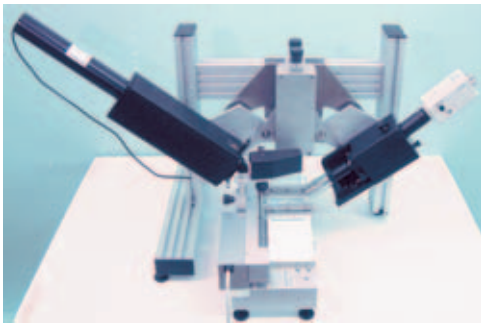
LB-films and their exciting applications are in the focus of many different fields of today's scientific research. The applications range from, the study of kinetic reactions in biological membranes to molecular electronics and optical data storage. To meet the needs of such a wide variety of applications one must be able to offer a complete range of Langmuir troughs, accessories and customized systems. KSV supplies the widest selection of precision Langmuir instruments for today's Langmuir film researchers.

KSV Instruments Ltd is a Finnish company specializing in the development and manufacture of high performance instruments for advanced Langmuir-Blodgett Film and surface chemistry research. Established in 1981, KSV defined its business idea to be the best in the world in chosen niches – this niche was the LB-technology. Today KSV is the leading supplier of Langmuir film and surface chemistry intruments and our dedication to customer satisfaction has earned us the trust of hundreds of researchers around the world.

Jorma Vuorinen, M. Sc.
Research Director, Partner
KSV Instruments Ltd

KSV Minitrough

BAM – Brewster Angle Microscope



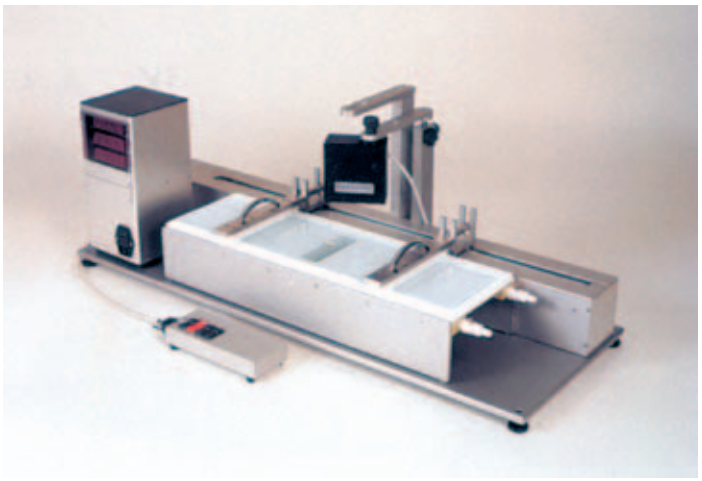
KSV 5000 LB System

KSV 2000 System

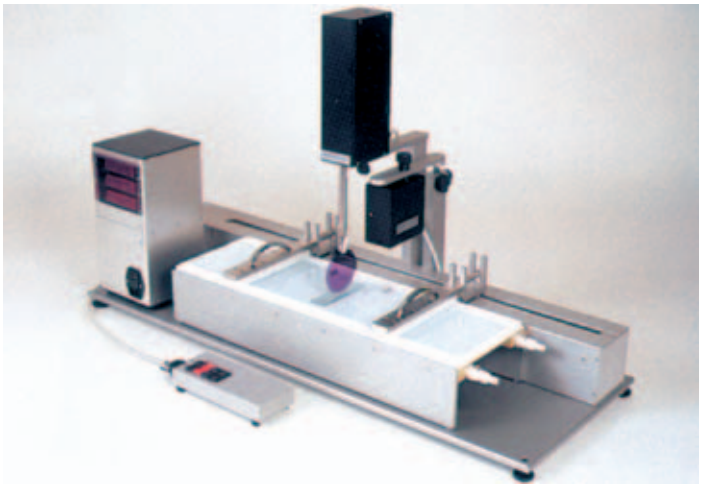
The KSV 2000 System combines the best features of all the Langmuir troughs KSV has ever made. The beauty of this computer controlled modular instrument is in its straight forward and open design. By changing the combination of the modules the KSV 2000 System can expand from a conventional Langmuir film balance to a high performance Langmuir film deposition system or to a fully equipped alternating multilayer Langmuir-Blodgett instrument.

The KSV 2000 System is available in three basic modular set-ups. The heart of the system is the mainframe module and the system is built around it by using the modules and accessories. All the modules are easily plugged into the mainframe without any special tools or mechanical skills. Each system is factory installed and ready to use before shipping and only a minimum amount of work is needed before use. Upgrading the performance of the system with additional modules or accessories is equally easy and can be done by the customers themselves. However; KSV's world wide distributors are available for on-site training and installation.

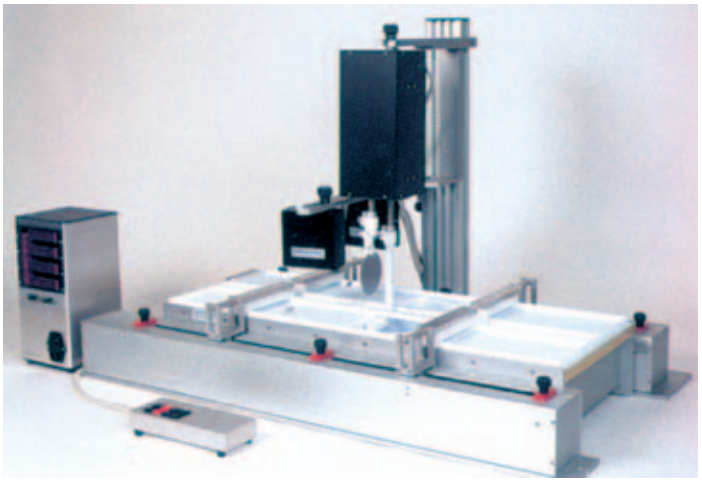
System 1
Langmuir Film Balance



System 2
Langmuir-Blodgett instrument

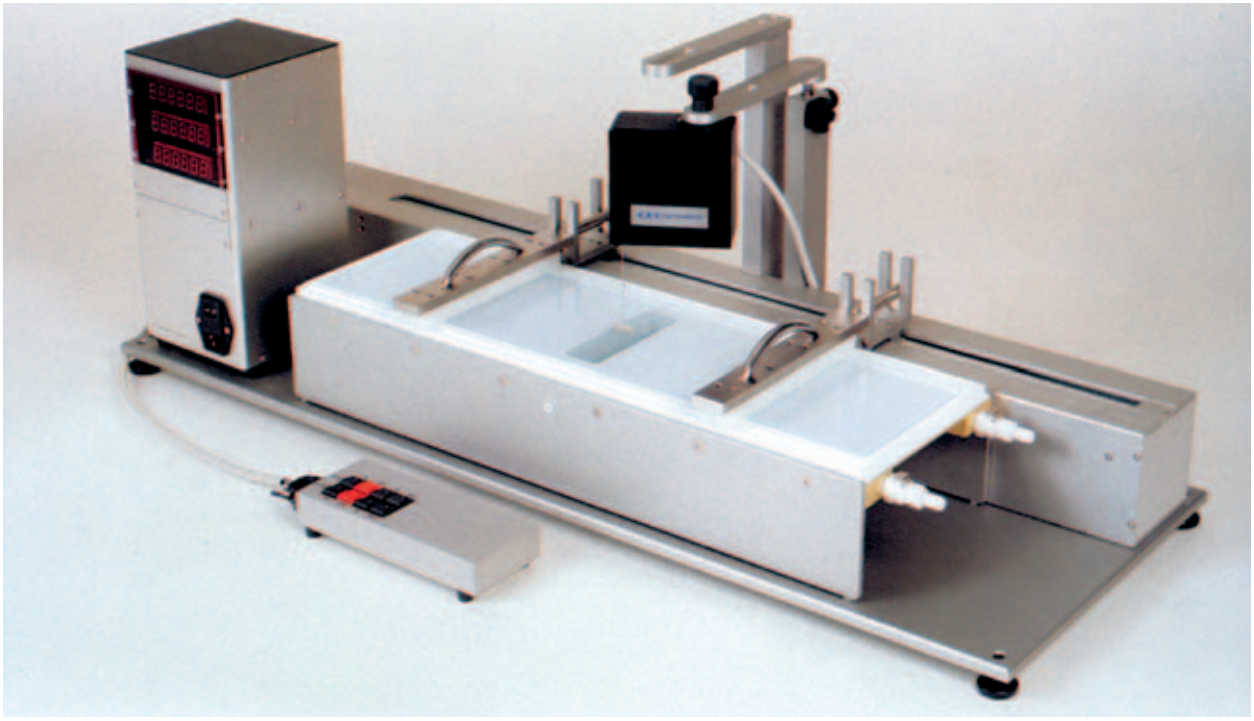


System 3
Alternating Multilayer Trough



System I

Langmuir Film Balance



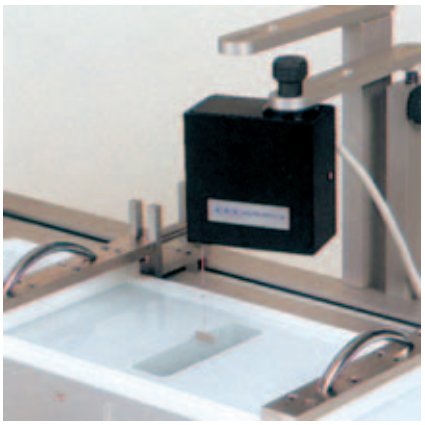
Performance: for conventional monolayer analysis and Langmuir film experiments. Brewster angle microscopy (BAM), biomembrane and enzyme kinetic reaction studies. Upgradable to Systems 2 and 3.

Module configuration

- mainframe
- interface unit
- film balance
- symmetric compression trough
- software

Symmetric compression of the monolayer is used in all KSV troughs. Symmetric compression, achieved by enclosing the monolayer in between two moving barriers, produces uniform shear throughout the whole film area, minimising possible film flow effects and maximising the accuracy and reproducibility of the film pressure measurement. The Wilhelmy plate is evenly compressed from both sides and no shifting of the plate occurs, even with the stiffest of films.

With simple arrangements the barriers can be modified to move in the same direction, for example to go over various subphases in biological applications. System 1 can also be operated with a single barrier only. Extra-large troughs up to 350x1000mm^2 are available by special order.



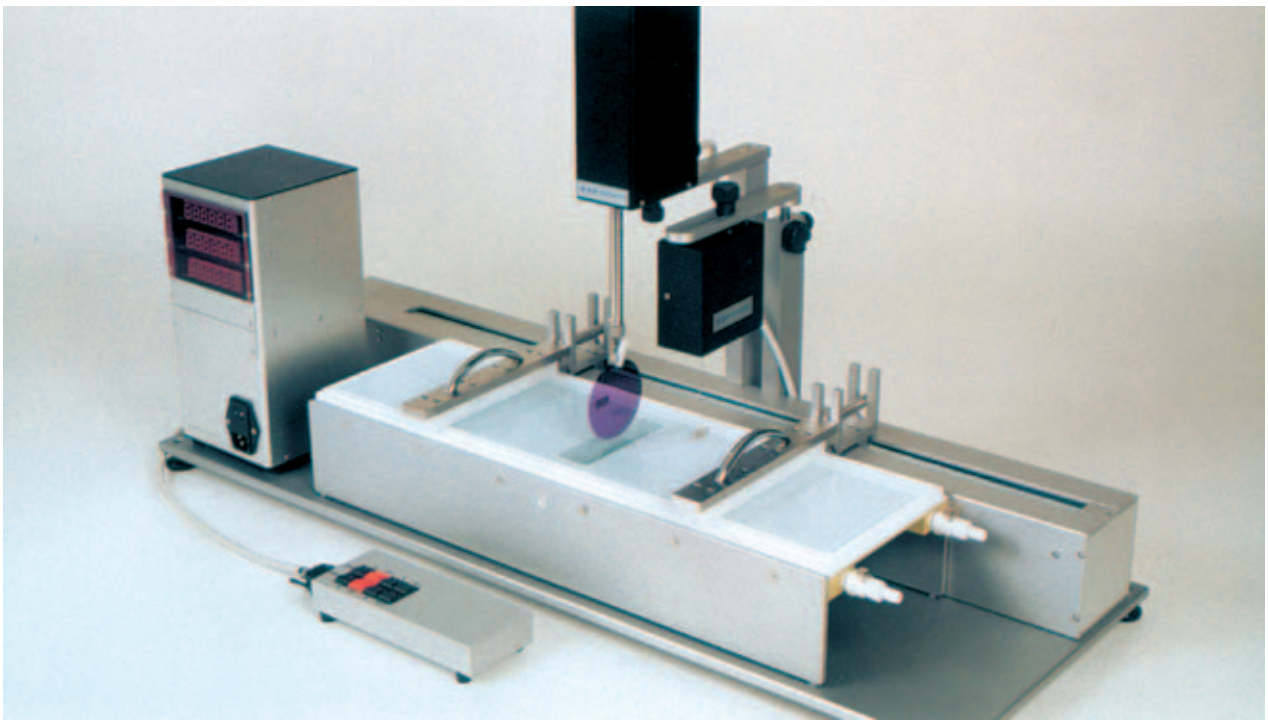
Symmetric compression – no film flow problems and no shifting of the Wilhelmy plate –ideal compression method for highly viscous and condensed films.

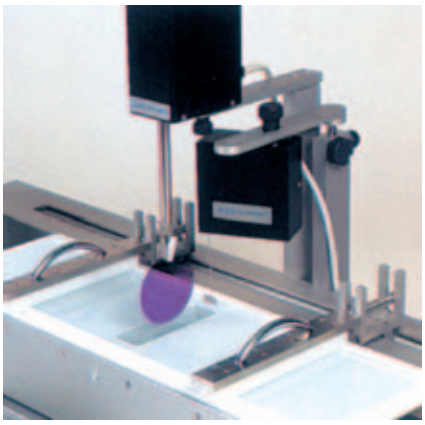
General Specifications

film balance measuring range:	0 to 250 mN/m
film balance resolution:	4 μN/m
effective trough surface area:	530x150 mm^2
subphase volume:	0.75 l
subphase thermostation:	by external bath 0-60°C
compression speeds:	0.01 to 800 mm/min. Programmable
options:	stirrers, BAM, zero-order and microscopy troughs

System 2

Langmuir-Blodgett Instrument





Symmetric compression – no orientation changes during deposition – uniform shear throughout whole film area.

Performance; for unsupervised deposition of ordered multilayer Langmuir-Blodgett films and for System 1 applications. Upgradable to System 3.

Module configuration

- mainframe
- interface unit
- film balance system
- film deposition system
- symmetric compression trough with dipping well
- software

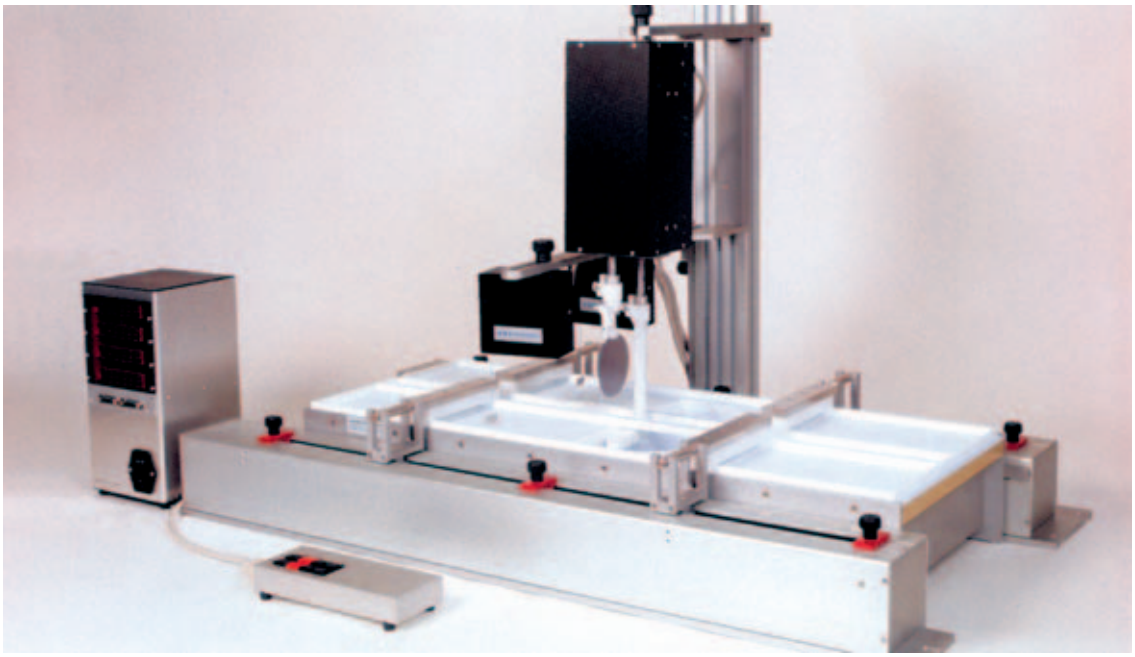
The key issue in successful film deposition is to maintain monolayer molecular orientation unchanged during the transfer from air/water interface onto a solid substrates. The parabolic film flow effect, with the centre moving faster than the sides, caused by the friction between the side walls and the film, is the major source for orientation changes. This problem becomes evident especially with single barrier systems where monolayer flows in one direction. These systems also produce another problem in connection with film deposition. The substrate when deposited perpendicular to the film flow will cause localised instabilities, "back drag", at the back side of the substrate. Therefore the surface pressure measurement if performed near or at the back of the substrate (floating barriers) becomes unreliable.

The symmetric compression avoids the back drag phenomena and pressure measurement problems during the deposition process. The film deposition is performed right at the film compression centre where the film reaches its highest degree of orientation. Both sides of substrate will be deposited identically due to symmetric compression.

General Specifications

balance and compression speed specification	as in System 1
dipping well dimensions	37(w) x 116(l) x 93(d) mm^3
max. substrate size	100x100 mm
deposition speed	0.1 to 85 mm/min or 0.2 to 170 mm/min
speed adjustment	0.1 mm/min increments
deposition cycles	1 to unlimited cycles
max. stroke of arm	145 mm
delay times	adjustable from 0 to 9999s
dipper motor	servo controlled DC motor
effective trough surface area:	530x150 mm^2 with well
trough volume	0.95 l
subphase thermostation:	by external bath 0-60°C

Alternate Multilayer Trough



Performance: unsupervised deposition of ordered layers of two different monolayer molecules and System 1 and System 2 applications.

Module configuration

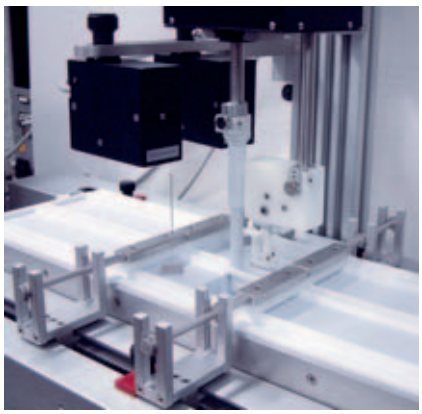
- mainframe
- interface unit
- alternate layer trough
- alternate dipper
- 2xfilm balance system
- barrier drive
- software

The unique substrate transport system with a clean subphase in the middle of the two trough compartments makes it possible to deposit the alternating LB layers in any desired stacking order.

The Film Deposition System, the dipper, is capable of depositing alternating LB films of x, z, y or any other type fully automatically, continuously and without cross contamination. The stacking order of the layers is dependent only on the chemistry of the molecules, not on the instrument hardware.

The trough, made of one piece form-sintered solid PTFE, consists of two rectangular shape compartments each having its own symmetric compression system and film balance. Both compartments function independently of the other. Access to the clean subphase in the middle of the compartments makes any stacking order possible.

Film compression, pressure monitoring and deposition processes for each compartment are controlled by KSV multitasking software.

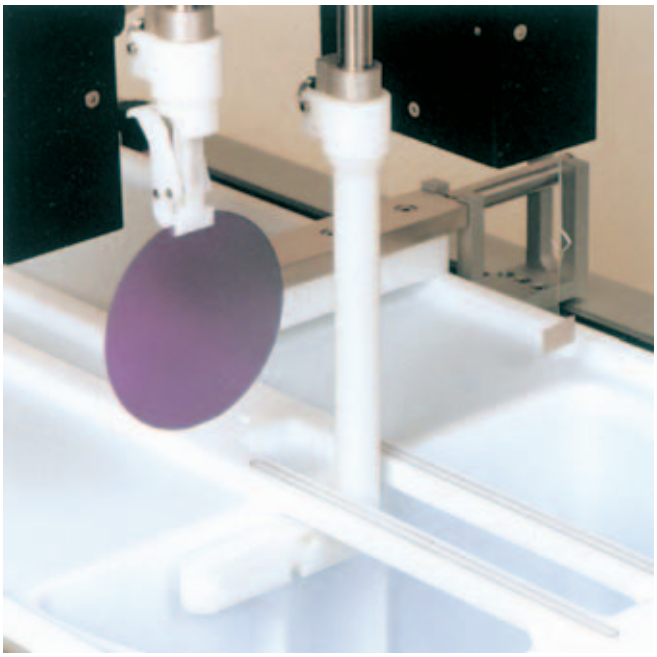


The system 3 LB instrument can alternatively be equipped with a smaller trough i.e. Minialternate, for applications where the amount of subphase volume play a crucial role.

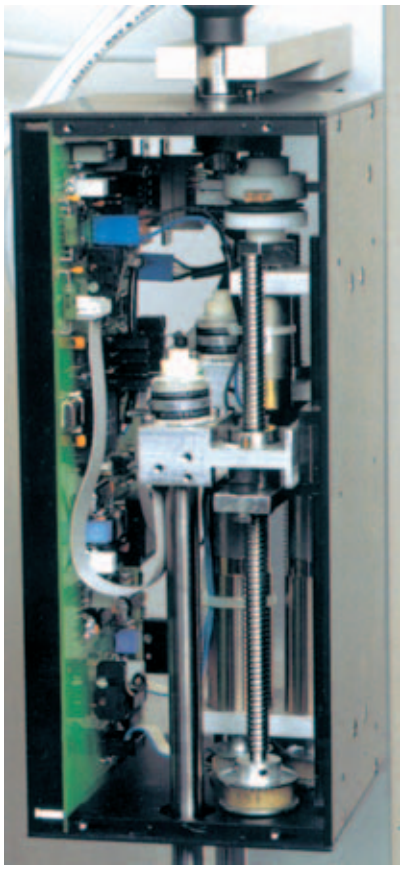
General Specifications

max. substrate size	100x100 mm (45x45 mm Minialt.)
deposition speed	0.1 to 85 mm/min or 0.2 to 170 mm/min
speed adjustment	0.1 mm/min increments
deposition cycles	1 to unlimited cycles
dwell times	adjustable from 0 to 9999s
dipper motor	4 servo-controlled DC motors
film balance measuring range:	0 to 250 mN/m
film balance resolution:	4 µN/m
trough surface area:	2x(775x120 mm) 2x(540x55 mm) Minialt.
subphase volume:	5.5 l (0.95 l Minialt.)
subphase thermostation:	by external bath 0-60°C
compression speeds:	0.01 to 800 mm/min.

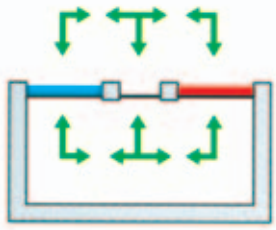
Deposition Cycle



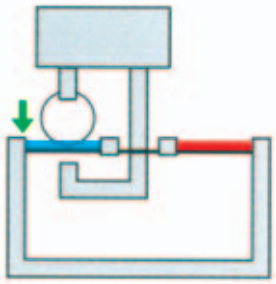
KSV 2000 System 3 builds up any desired alternating layer film structure in any stacking order without cross contamination. The dipper consists of two independent arms equipped with automatic clamps to hold the substrate. Rotation of the dipper, vertical movement of its arms and opening and closing of the clamps are all software controlled. The upper arm is for airborne travel and the lower arm for under subphase travel of the substrate. There is no cross contamination as only the substrate penetrates the film and not the mechanics moving it.



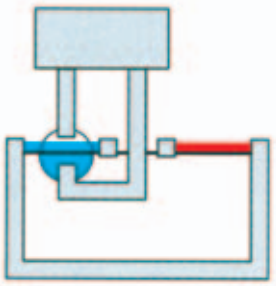
The dipper of the System 3 is a masterpiece of KSV's precision craftsmanship. Four separate DC motors moving the dipping arms and opening and closing the clamps are all controlled by separate microprocessors.



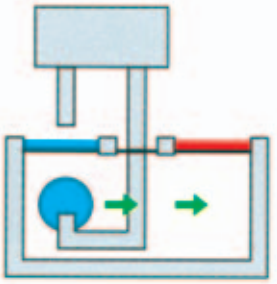
The substrate can be programmed to take any desired path to produce any film structure.



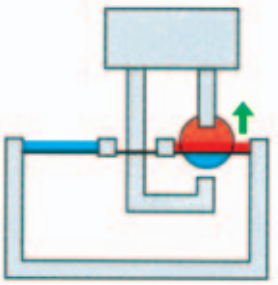
The upper arm brings the substrate down through either of the films or the clean phase in the middle of the trough. The deposition cycle can also start from the subphase.



The upper arm stops before touching the film. Its clamp opens while the clamp of the lower arm takes hold of the substrate.



The lower arm brings the substrate to the bottom of the well. The dipper can now rotate to the other side or to the centre position.



The lower arm takes the substrate up and gives it to the upper arm.

Troughs

Trough geometry

The wide variety of LB film applications requires flexibility in the geometrical design of the trough. Very often special shapes and sizes are needed. The use of original rectangular Langmuir troughs with moving barriers offers greatest flexibility in geometrical design of the troughs. In band and moving wall types of system, the band defines the trough shape while acting as a barrier. In such a system the trough geometry is fixed and cannot be changed to fit special applications.

Customised and standard troughs

The size of the bottom PTFE block of KSV troughs is standardised making it possible to manufacture nearly all shape or size troughs. No matter whether deep or shallow, long and narrow or short and wide, all shapes can be easily made by request.

Cleaning and dismantling

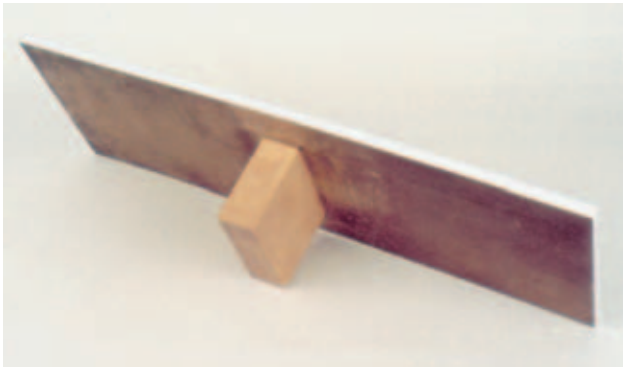
Easy access to troughs and barriers, their quick dismantling and cleaning play a vital role in everyday use of LB troughs. KSV's troughs are modules independent of the main instrument body and they can be dismantled simply by lifting by hand. The instrument body has a guide rail for snap-in mounting of the trough. The barriers are conveniently and accurately placed in their original positions in their riders. All sharp angles are rounded for thorough cleaning.

Subphase temperature control

Temperature regulation and maintenance of accurate, constant subphase temperature are fundamental preconditions for successful film fabrication.
The smaller the subphase volume, the more accurate and fast its temperature regulation. The KSV PTFE trough with bottom thickness of about 1,0 mm is cemented on an aluminum heating plate. Aluminum, being a good conductor, distributes heat evenly throughout the whole bottom area while responding fast and accurately to the temperature changes. Subphase water temperature is regulated by running thermostatically heated water from an external circulator through the heating plate. The temperature sensor probe, situated in the subphase, constantly monitors subphase temperature while controlling the external circulator. The walls of the dipping well are also thermoregulated to minimise the temperature difference between the well and the rest of the trough bottom area.

Trough material

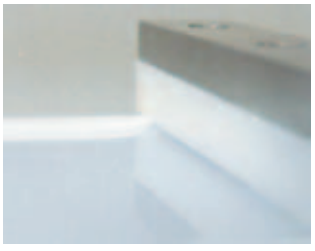
A pure one piece solid PTFE (polytetrafluoroethylene) is used in all KSV's troughs mainly because it is inert and highly hydrophobic and easy to clean. All troughs are made of a solid block of form-sintered PTFE. Since the dipping well is an integral part of the solid PTFE bottom block, no glue is used, so there is no risk of contamination. Sprayed PTFE coatings are not used in any of KSV's LB products because of their porosity and impurities caused by the spraying process, and because they cannot be repaired in case of scratches.



Leakproof barriers

Often it is thought that to make a good seal between the PTFE trough and barrier it is necessary to overfill the trough. This is partially true when using conventional hydrophobic PTFE barriers. Overfilling may cause the subphase to spill over trough edges. The film can escape over the trough edges at high surface pressures.

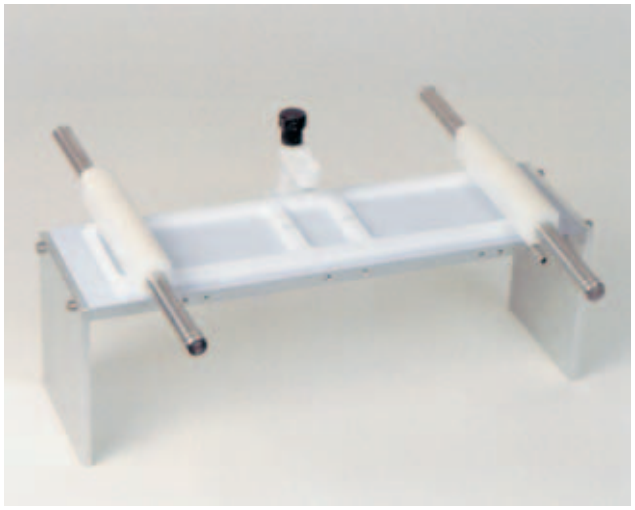
To avoid these problems, KSV uses hydrohilic barrier material, Delrin. The hydrophilic barrier draws the water molecules against the bottom and front wall of the barrier, making film leakage under the barrier impossible. Because of the hydrophilic properties of the barrier, the subphase water level can even be kept below the trough edges to make absolutely sure there will be no film leakage over the trough edges.



Special Troughs

Enzyme kinetics trough

A zero-order trough was originally developed for studying enzyme reactions in monomolecular films. It offers the advantage of linear (zero-order) enzyme kinetics, and the possibility of using mixed lipid monolayers of constant composition as substrates for lipolytic enzymes or other biomolecules.

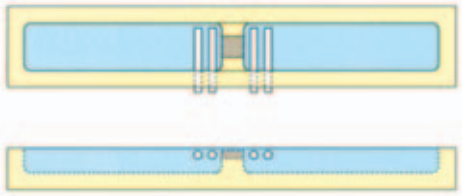


The zero-order trough consists of a reaction compartment and a reservoir compartment separated by a glass bridge just underneath the water surface. The bridge prevents mixing of the subphases of the two compartments.

The enzymes or molecules are injected into the subphase of the reaction compartment.

Conductivity trough

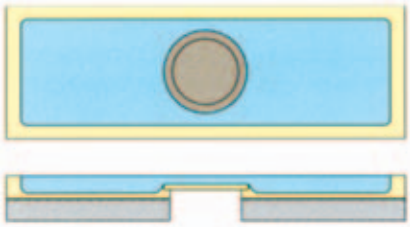
The conductivity trough facilitates the measurement of the lateral conductivities of monolayer films on water. The glass bridge increases the electrical resistance between the electrodes to the extent that one can easily measure films with sensitivities better than one S/cm. Conductivity measurements are performed under CO_2-free atmospheres, and highly purified water is used.



Microscopy trough

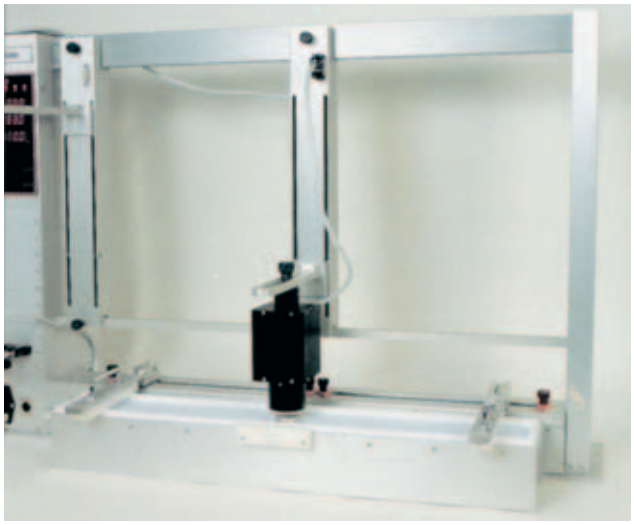
Using mixed monolayers with fluorescent dyes, one can observe any phase separation of different substances through the quartz window at the bottom of the trough.

The trough is a standard KSV trough without a dipping well. A quartz optical window is fixed into the bottom of the trough. The optics of the microscope are arranged below the trough and the monolayer is observed vertically beneath the trough.



Surface potential / Brewster angle microscopy trough

The surface potential of a floating monolayer is measured with a KSV SPOT1 module and KSV surface potential measurement trough. The trough is long and narrow in order to maximise compression area. It is important to have as much space as possible to compress the monolayer because the surface potential of a water/monolayer/air interface usually begins to change when the area per molecule in the film is still quite large. Maximising the compression area is also important during BAM measurements as changes in the monolayer can often be detected with the BAM at very early stages of compression.



Software

KSV 2000 System is run by a powerful 32-bit software written in C++ for Windows™ 2000 and XP. Using the software is easy to learn due to the familiar point and click format of drop down menus, buttons and icons. The software allows the user to perform a variety of pre-programmed experiments covering of the most known Langmuir-film experiments. The programs can be further modified to particular needs. A wide range of datapoints and measuring parameters are stored in a database and can be retrieved, analyzed or exported to another data reduction software.

Standard Program include

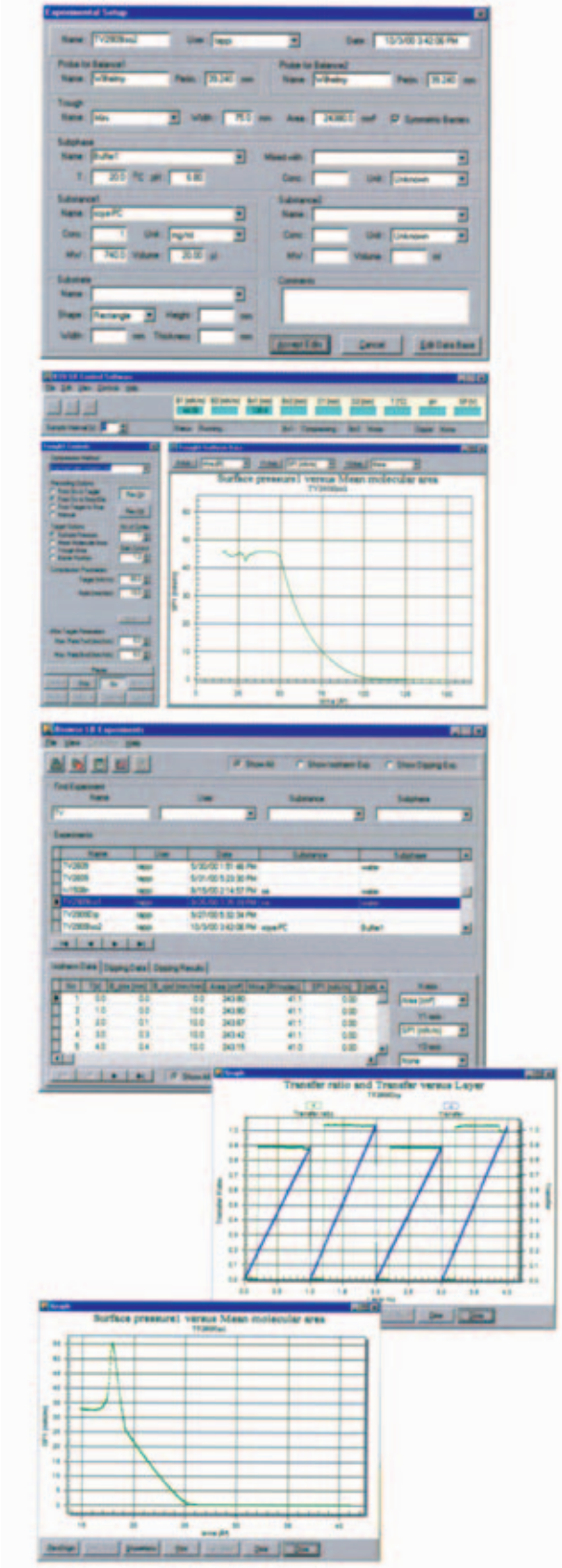
- Compression/relaxation isotherms: surface pressure/mma, surface pressure/time, or surface pressure/any desired measurable parameter
- Transfer ratio and deposition profiles
- Analysis of monolayer kinetics (enzyme kinetics, monolayer hydrolysis, polymerization etc.)
- Analysis of monolayer penetration, solubility and binding of biomolecules (enzymes, proteins, peptides etc.)
- Isochores and isobars: constant increase/decrease of surface pressure/mma, surface pressure/time, or surface pressure/any desired measurable parameter

The program is divided into four main sections – **Main Menu**, **Experimental Setup**, **Measurements**, **Data Reduction** and **Analysis**. The core of the software is the **Main Menu** from which all other sections and programs can be accessed.

The Experimental setup includes information which is specific for every measurement. Once an experiment has been chosen various information and parameters are entered into the **Experimental Setup** window. This helps to keep the data organized and makes it easier to search for a specific measurement afterwards.

To begin a measurement materials and instrument are set ready, Experimental setup window is filled out and Trough Controls are defined. Once the experiment has been started the PC will take full control of the measurement until completion.

The measurement data is stored in a database and can be retrieved and analyzed – even during a measurement – in the Data Reduction and Analysis section. Since each measurement sequence is named it is easy to retrieve the data and have it displayed by your monitor. A variety of graphs for your data can be displayed and printed. There is an option for viewing and editing the Experimental setup information. This is a helpful feature if the data produced should be recalculated based on a new information about the materials involved. Calculation of additional results are easily done as well as exporting of data to other softwares. Because of Windows™ format of the KSV LB software the data files can also be transferred to other locations within a network or by Internet as digital images.



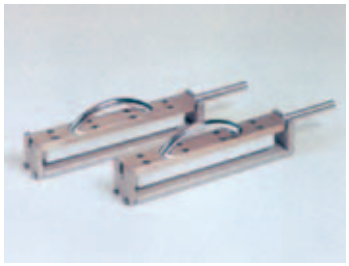
Technical Highlights

Interface Unit

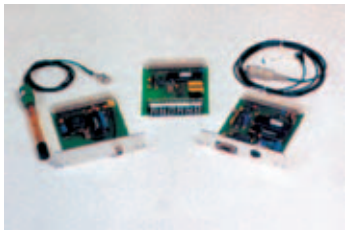
The interface unit acts as a power supply for the system electronics and interfaces the instrument and the PC. It houses optional on-line digital displays to show the status of film pressure, barrier speed, deposition speed, subphase temperature, pH, barrier position etc. 1 display is provided as a standard delivery and up to four displays can be fitted into the unit.

The optional remote control key pad connected to the Interface unit is used to drive the barriers and dipper without PC control during the preparative procedures. The use of the remote control key pad reduces the human activity around and above the film area, therefore minimizing the risk of contamination.

The slide in slots in the Interface Unit make it easy to add new digital display cards.



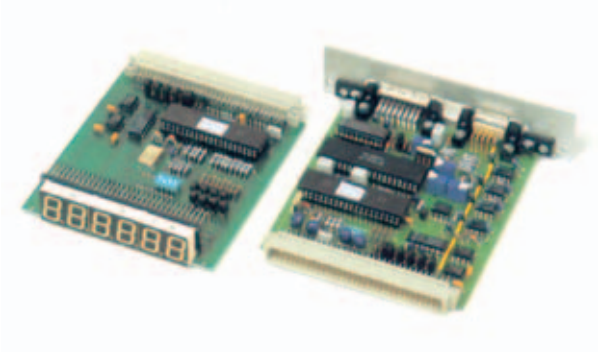
Barrier holders are provided to protect the sensitive edges of the barriers during storage.



Display cards and Interface cards for temperature and pH measurement of the subphase are easily fitted into the slide in slots of the Interface Unit.

AD/DA converter cards

AD/DA converter cards are provided to measure signals from devices designed by the user. Data is collected by the software.



Dipper

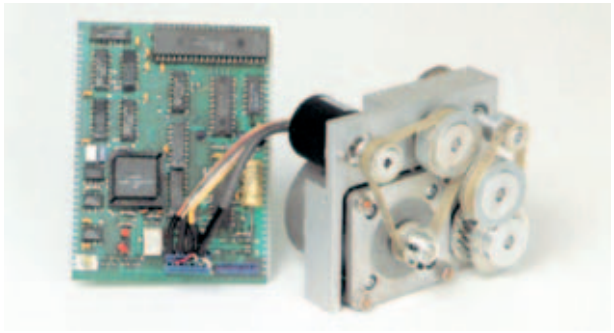
The Film Deposition System, the Dipper, is equipped with high precision DC motor to ensure smoothest possible movement of the dipper shaft. The speed of the shaft, the number of deposition cycles, dwell times, partial depositions etc. all are user-programmable with operation controlled by the software. The substrates can be dipped perpendicular or parallel to the barrier movement.

Surface area control

The method of film compression is important in the fabrication of reproducible high quality films. Several designs have been developed in the search for ideal film compression. In these designs (bands, circular troughs and moving wall) the attempts to eliminate one specific problem have often led to limitation of instrument versatility and reliability.*)

KSV uses original well-proven Langmuir trough design, improved with symmetrical compression of the monolayer. This straightforward method has proven itself to be most practical, without compromising the high standard of research work.

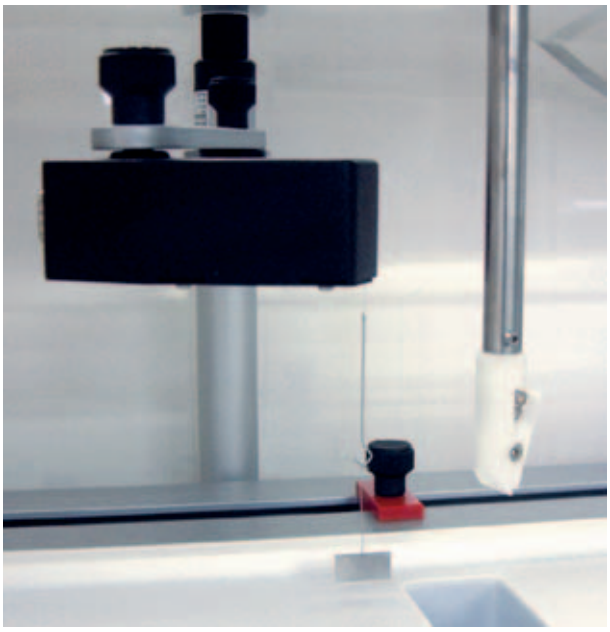
The compression method is only as good as the mechanics moving it. The power of the micro-stepping motor is transmitted through a reduction gearbox into a precision tooth belt driving the barrier holders. The barrier holders ride on precision linear motion rails, giving the barriers smooth and friction-free movement. The barriers are attached to their holders by hand for easy removal.



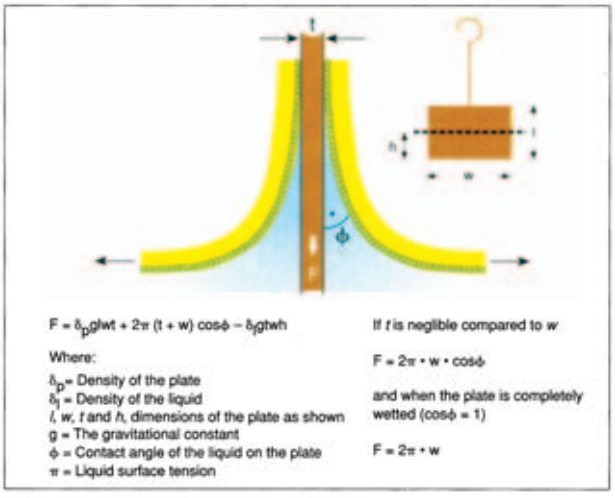
*) ***Moving wall compression***, *usable film area determined by width of substrate, moving wall scratches sides of substrate, no dipping of circular substrates.*
band compression, *band pushed outwards by film pressure, film collapse near corner post with condensed films, complex vibration causing mechanics.*
circular trough, *unstable pressure measurement due to uneven pressure distribution caused by the difference of film speed at inner and outer trough perimeter.*

Film balance

Accurate measurement of the surface pressure and precise surface area control system are crucial in the fabrication of defect-free films. The film balance is interfaced to a barrier driving system with a feedback circuit for compression, expansion or for constant surface pressure operation modes. The film balance



uses the Wilhelmy plate method to measure the surface pressure. This method incorporates an electronic micro balance and Wilhelmy plate made of platinum. Platinum is used because of its inertness and good hydrophilic properties achieved by sand blasting of its surface. The platinum plate is easily cleaned and durable in use. Only occasional calibration is needed and the balance is electronically zeroed with the software.



$F = \delta_p glwt + 2\pi (t + w) \cos\phi - \delta_l gtwh$

Where:

δ_p = Density of the plate
δ_l = Density of the liquid
l, w, t and h, dimensions of the plate as shown
g = The gravitational constant
ϕ = Contact angle of the liquid on the plate
π = Liquid surface tension

If t is neglible compared to w

$F = 2\pi \cdot w \cdot \cos\phi$

and when the plate is completely wetted ($\cos\phi = 1$)

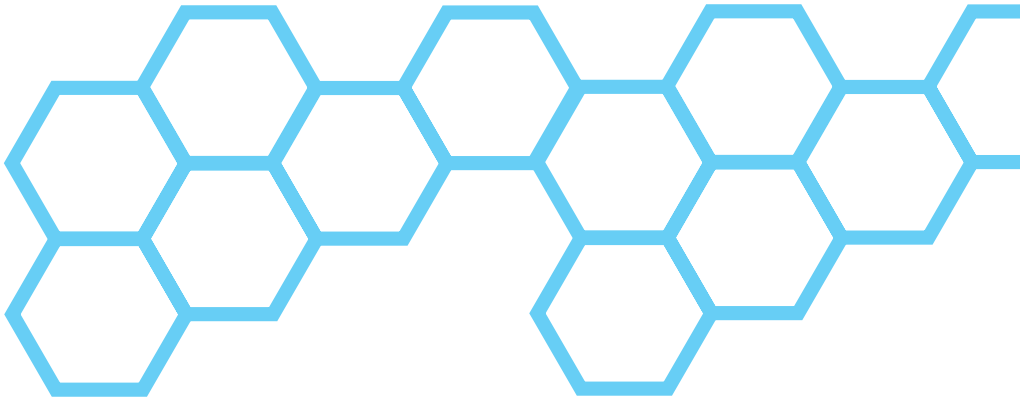
$F = 2\pi \cdot w$

Film pressure calculation formula by the Wilhelmy plate method.

Specifications

	system 1	*system 2*	*system 3*
troughs			
effective surface area	530x150 mm^2	530x150 mm^2	2x(775x120 mm^2) 2x(540x55 mm^2) Minialt.
subphase volume	0.75 l	0.95 l	5.5 l 0.95 l Minialt.

film area control	
barrier speeds max/min	0.01 mm to 800 mm/min, inaccuracy less than 1%
film balance system	
method of measurement	Wilhelmy plate method with platinum or paper plate
pressure measuring range	0 to 250 mN/m
accuracy	4 μN/m
film deposition system	
dipping speed	
-standard range	0.1 to 85 mm/min
- optional range	0.2 to 170 mm/min
dipping cycles	unlimited
delays	0 to 9999 sec
dipping well	37 mm (w) x 116 mm (l) x 93 mm (d)
substrate size	100 x 100 mm (larger on request)
Voltage	220 V, 50/60 Hz, 176-264 V, 40/440 Hz 110 V, 50/60 Hz, 90-132 V, 40/440 Hz



The Company

KSV Instruments Ltd, Helsinki, Finland, is the leading global provider of routine, research and characterization instruments to surface chemistry and Langmuir-Blodgett film applications.

Langmuir film Products

Ranging from manual, educational apparatuses to fully equipped high performance R&D grade multi/alternating layer LB-troughs KSV offers the widest range of Langmuir systems in the world.

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