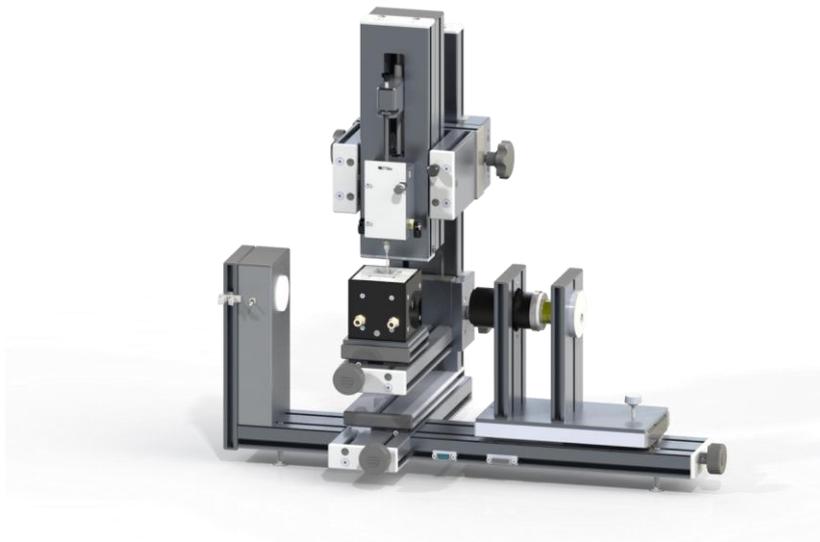




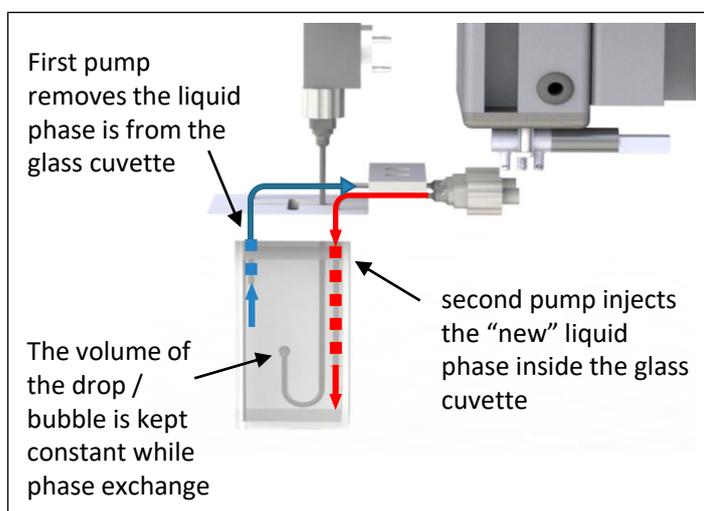
TRACKER™  
*Phase Exchange*



# TRACKER™ DENSE PHASE EXCHANGE

The measurement of surface or interfacial tension based on the analysis of the shape of the drop or bubble, provides useful information on the kinetics of adsorption of surfactants. However, it does not allow the study of desorption kinetics. Thus, the question of reversibility of adsorption is difficult to assess by this technique alone.

The DENSE PHASE EXCHANGE option completes the technique by measuring the surface tension of a bubble or the interfacial tension of a drop formed in a liquid which is exchanged during measurement. The ideal mixing conditions are established by stirring and maintaining a constant flow rate inside the cuvette.



The module is more suitable for exchanging liquid phases. It allows a solution studied in the cuvette to be replaced by another solution while keeping the volume of the drop constant. The user chooses the liquid flow rate, and the software controls the injection cycles.

The surfactant solution studied is either added to the cuvette (loading) or removed from the cuvette by rinsing with water (washing), which makes it possible to directly study the **kinetics of adsorption / desorption** of surfactants such as proteins, polymers... at the interfaces. It also provides information on the interactions between these surfactants at the interface.

DENSE PHASE EXCHANGE option is fully driven by the software. It can be performed:

- During measuring
- Out of measurement

⇒ It's possible to program sequences

- periods with Dense phase exchange
- periods without Dense phase exchange

⇒ The sequence can be started

- At a chosen time (defined by the user)
- with the start of the experiment
- at any time by a click on start

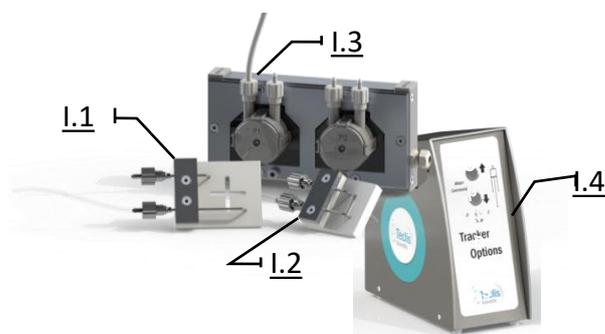
⇒ It's possible to change the speed of the exchange

- the speed of the pump can be changed at any time (between 0% and 100% maximum speed of the pump)
- The minimum speed 0,1ml/min
- The maximum speed of the pump is around 20ml/min (depending on the viscosity of the liquid)

⇒ Any kind of measurement can be done while Dense phase exchange in the cuvette

- Interfacial tension measurement
- Interfacial rheology : Oscillations, pulses...

⇒ The speed of the pump is stored. It can be displayed by choosing Pump Speed in the Display Parameters



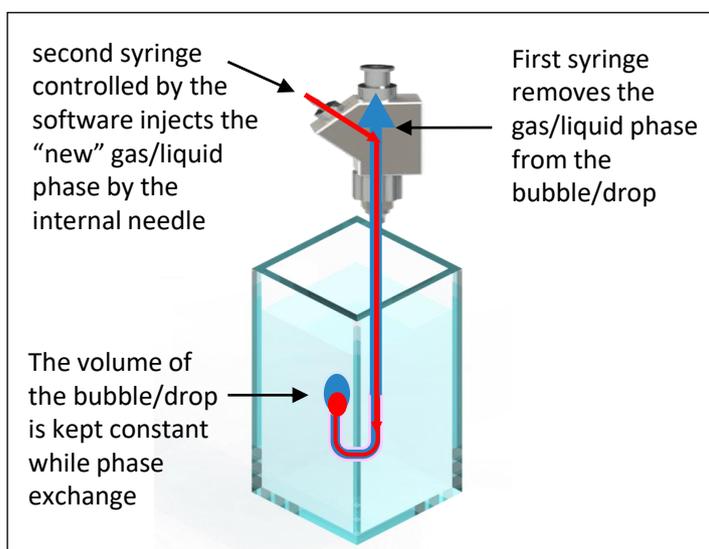
Dense Phase exchange To change the phase in the cuvette during measurement	1.1	Cover for cuvette 25ml
	1.2	Cover for cuvette 5 mL
	1.3	Double pump
	1.4	DPE Electronic Command

Technical specifications	
Compatibility	TRKS, TRKH, TRKCMC
Exchange Rate	0,1 – 20ml / min
System	Liquid / Gas - Liquid /Liquid

# TRACKER™ DROP PHASE EXCHANGE

The measurement of surface or interfacial tension based on the analysis of the shape of the drop or bubble, provides useful information on the kinetics of adsorption of surfactants. However, it does not allow the study of desorption kinetics. Thus, the question of reversibility of adsorption is difficult to assess by this technique alone.

The DROP PHASE EXCHANGE option completes the technique by measuring the surface tension of a bubble whose gas is exchanged or the interfacial tension of a drop whose liquid is exchanged during experiment, thanks to a double coaxial capillary, while maintaining its volume constant. The exchange rate can be set, and the software controls the injection cycles.



The module provides the same measurements as the phase exchange in the cuvette. It is rather suitable for gas exchange, but it can be very useful to study smaller volumes and essential to exchange opaque oils which can only be measured by making a drop of oil in clearer water.

Finally, the DROP PHASE EXCHANGE option allows you to **measure the sequential adsorption of different components at a liquid / liquid interface**, in addition to the classic simultaneous adsorption measurement from a mixed solution. Thus, for example, the movement of pre-adsorbed proteins after the successive addition of another surfactant can be successfully studied by this technique.

DROP PHASE EXCHANGE option is fully driven by the software. It can be performed:

- During measuring
- Out of measurement

⇒ It's possible to program sequences

- periods with Drop phase exchange
- periods without Drop phase exchange

⇒ The sequence can be started

- At a chosen time (defined by the user)
- with the start of the experiment
- at any time by a click on start

⇒ It's possible to change the speed of the exchange

- the speed of the syringe can be changed at any time (between 0% and 100% maximum speed of the syringe )
- The minimum speed of the syringe 0,0µl/s
- The maximum speed of the syringe is around 20µl/s (depending on the viscosity of the liquid)

⇒ Any kind of measurement can be done while Drop phase exchange in the cuvette

- Interfacial tension measurement
- Interfacial rheology : Oscillations, pulses...

⇒ The speed of the pump is stored. It can be displayed by choosing Pump Speed in the Display Parameters



Drop Phase exchange To change the phase within the drop during measurement	H.1	Support for double syringe
	H.2	3-way valve for double syringe
	H3	DPE Electronic Command

Technical specifications	
Compatibility	TRKS, TRKH, TRKCMC
Exchange Rate	0,01 -20 µl/s
System	Liquid / Gas - Liquid /Liquid

## APPLICATION NOTE

### HOW TO CONTROL THE SURFACE PRESSURE USING TRACKER™ PHASE EXCHANGE

The presence of surface-active molecules at an interface changes its physico-chemical properties. The amplitude of these changes, that can be characterized by surface pressure, depends strongly on the surface concentration. The surface pressure ( $\Pi$ ) is defined as the difference of interfacial tension between a pure interface and an interface in the presence of surface-active molecules.

$$\Pi = \gamma_0 - \gamma$$

Where  $\gamma_0$  corresponds to the interfacial tension between the two pure phases and  $\gamma$  the measured surface tension. A good understanding of surface-active laden interfaces as a function of surface pressure requires varying the surface concentration. The control of this concentration can be complex. Indeed, the surface pressure at the equilibrium is governed by the adsorption kinetics of the molecules and their initial concentration.

Phospholipids are major components of lipid droplet monolayers and biological membranes and play a significant role in their structuring and stabilization.

An oil/water interface coated with phospholipids has been used to produce interfaces with different surface pressures, as shown in Figure 1.

The drop tensiometer Tracker™ allows precise real-time control and modulation of the surface pressure of the interfaces.

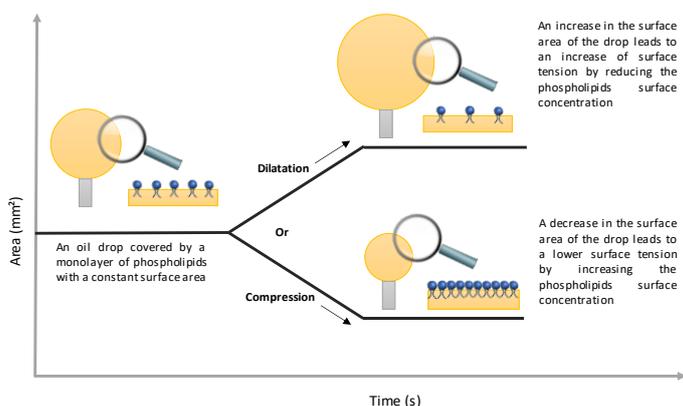


Figure 1 : Drop area as function of the time of a phospholipid-coated oil/water interface during an experiment

The **Experimental Protocol** consists in 4 steps:

1. An oil drop (triolein) is formed in a buffer solution.
2. At  $t = 100$  sec, a preparation of unilamellar (100 nm) large vesicles of phospholipids is injected to reach a concentration of 0.005% (w/w) in the buffer solution
3. After an adsorption time of 1500 sec, **the aqueous phase is replaced by a fresh buffer solution to remove non-adsorbed phospholipids.**
4. The surface pressure is then simply controlled by increasing or decreasing the interface surface area.

Figure 2 shows the surface tension as a function of time for an oil/water interface. The initial tension is 32 mN/m and is consistent with the literature [1-4].

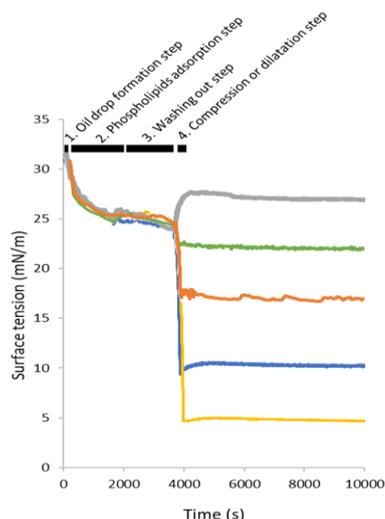


Figure 2: Variation of the interfacial tension at the triolein/water interface as a function of time. Surface pressure reaches final values of (grey) 5 mN/m, (green) 9 mN/m, (orange) 16 mN/m, (blue) 22 mN/m and (yellow) 28 mN/m.

After injection of the phospholipids, the surface tension decreases slowly over time; the phospholipids adsorb at the interface. Exchanging the aqueous phase stops the phospholipids adsorption and only the variation of the drop surface area allows to modify the surface pressure of the phospholipid monolayer. In this example, one expansion of the drop area was performed to decrease the surface pressure (i.e. increase the tension); and four compressions were performed to increase the surface pressure (i.e. decrease the tension).

#### CONCLUSION

The surface pressure of an interface can be controlled using the drop tensiometer Tracker. Specific or custom-made interfaces can be made to mimic different interfacial systems and to study rheological properties at different interfacial pressures. Thus, it is possible to figure out the building-blocks of an interface and to study the adsorption of one or several molecules sequentially added or to determine the exclusion pressure of molecules.

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