

Reometri e Reometria: una tecnica correlata con la gradevolezza applicativa nei prodotti

Corso Valutatori della Gradevolezza dei Prodotti Cosmetici

19 e 20 Maggio 2026

Portfolio Reometri HAAKE Thermo Scientific



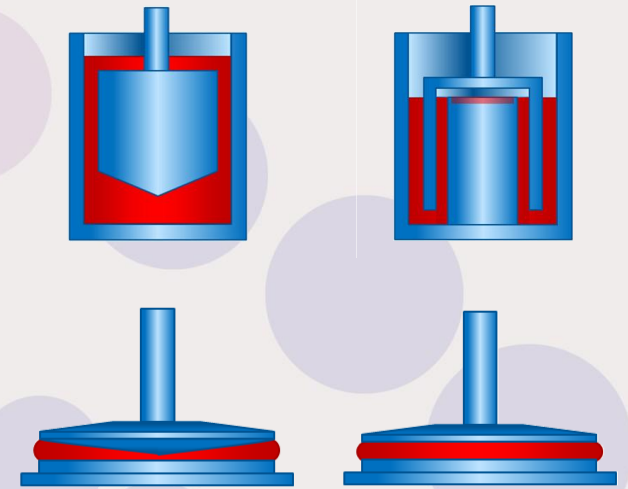
Portfolio Reometri HAAKE Thermo Scientific



Scelta della geometria

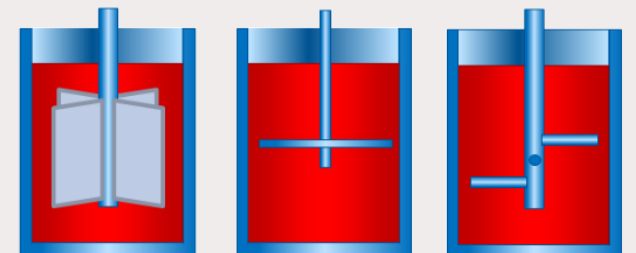
Absolute Measurement

The geometry factors A and M can be calculated for the measuring geometry



Relative Measurements

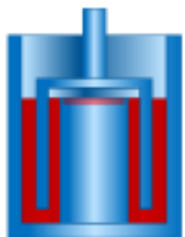
The geometry factors A and M cannot (entirely) be calculated for the measuring geometry



Scelta della geometria

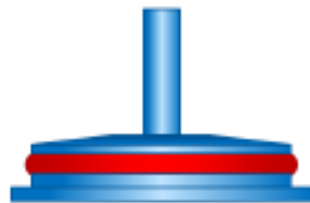
Low to medium viscosity, easy to clean

Coaxial cylinders

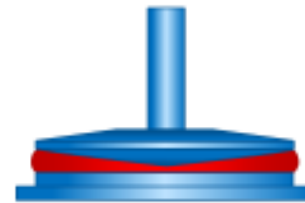


Medium viscosity to paste like, difficult to clean

Parallel plates
(with particles)



Cone/plate
(without particles)

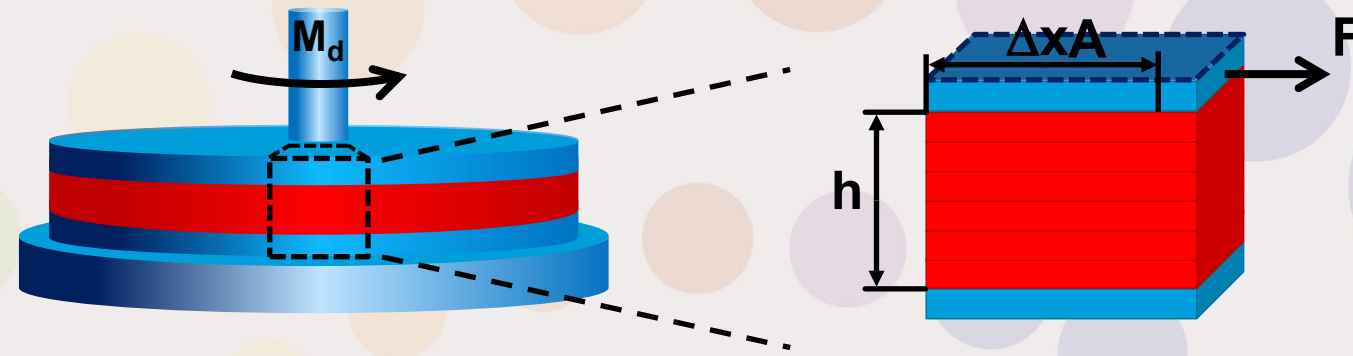


Inhomogeneous sample, large particles

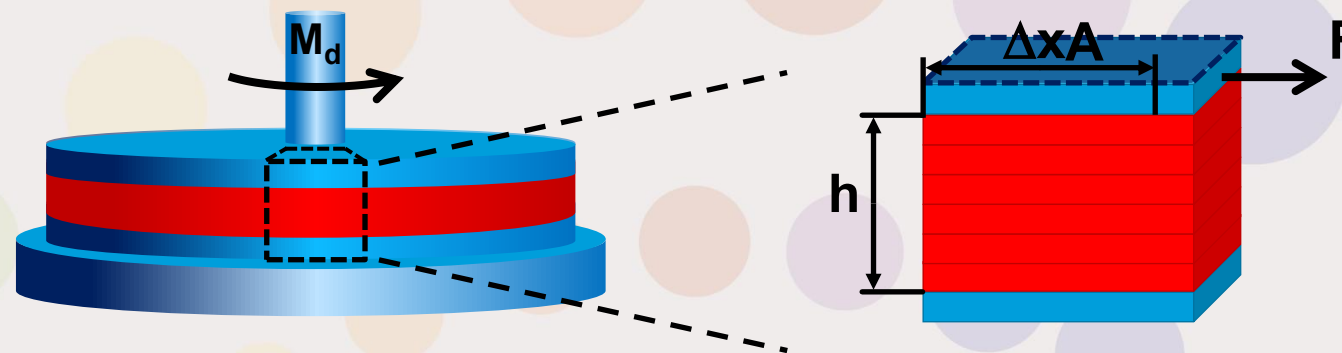
Vane rotors and special geometries



Definizioni



Definizioni



Shear stress

$$\tau = \frac{\text{Force } F}{\text{Area } A}$$

Unit: Pascal (Pa)

Deformation

$$\gamma = \frac{\text{Displacement } \Delta x}{\text{Gap } h}$$

Unit: - or %

Shear rate

$$\dot{\gamma} = \frac{\text{Change of deformation } \Delta\gamma}{\text{Time } \Delta t}$$

Unit: 1/s

Determination of the dynamic shear viscosity

Newton's law of viscosity

$$\text{Viscosity } \eta = \frac{\text{Shear stress } \tau}{\text{Shear rate } \dot{\gamma}}$$

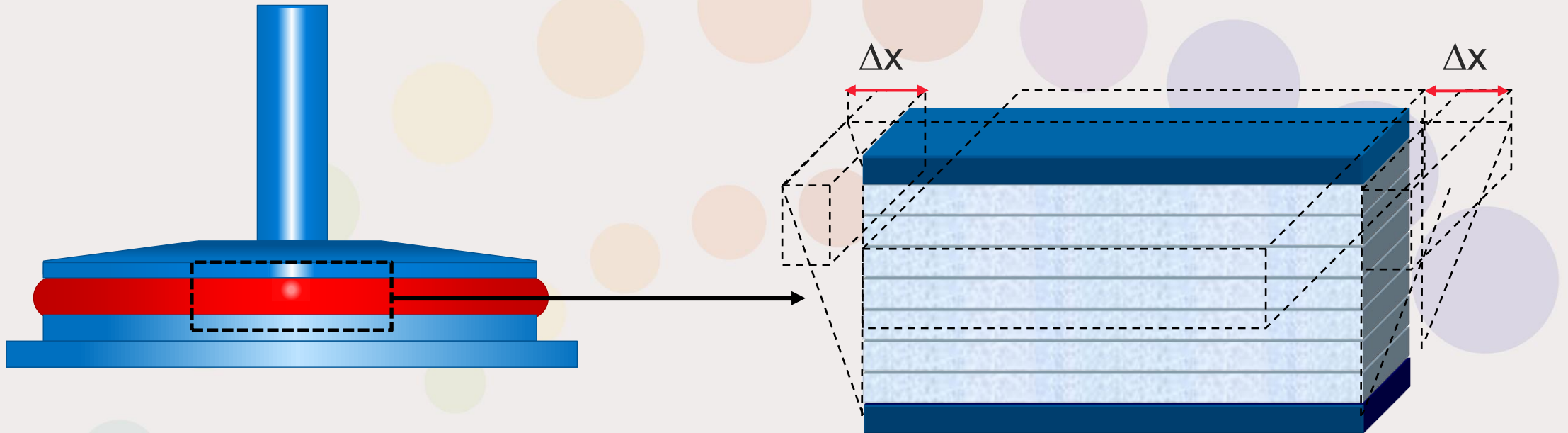
Shear stress τ : Pascal (Pa)

Shear rate $\dot{\gamma}$: 1/s

Viscosity η : 1 Pa·s = 1000 mPa·s = 1000 centi Poise (cP)

Principle of measurement

A material is exposed to a sinusoidal oscillatory excitation

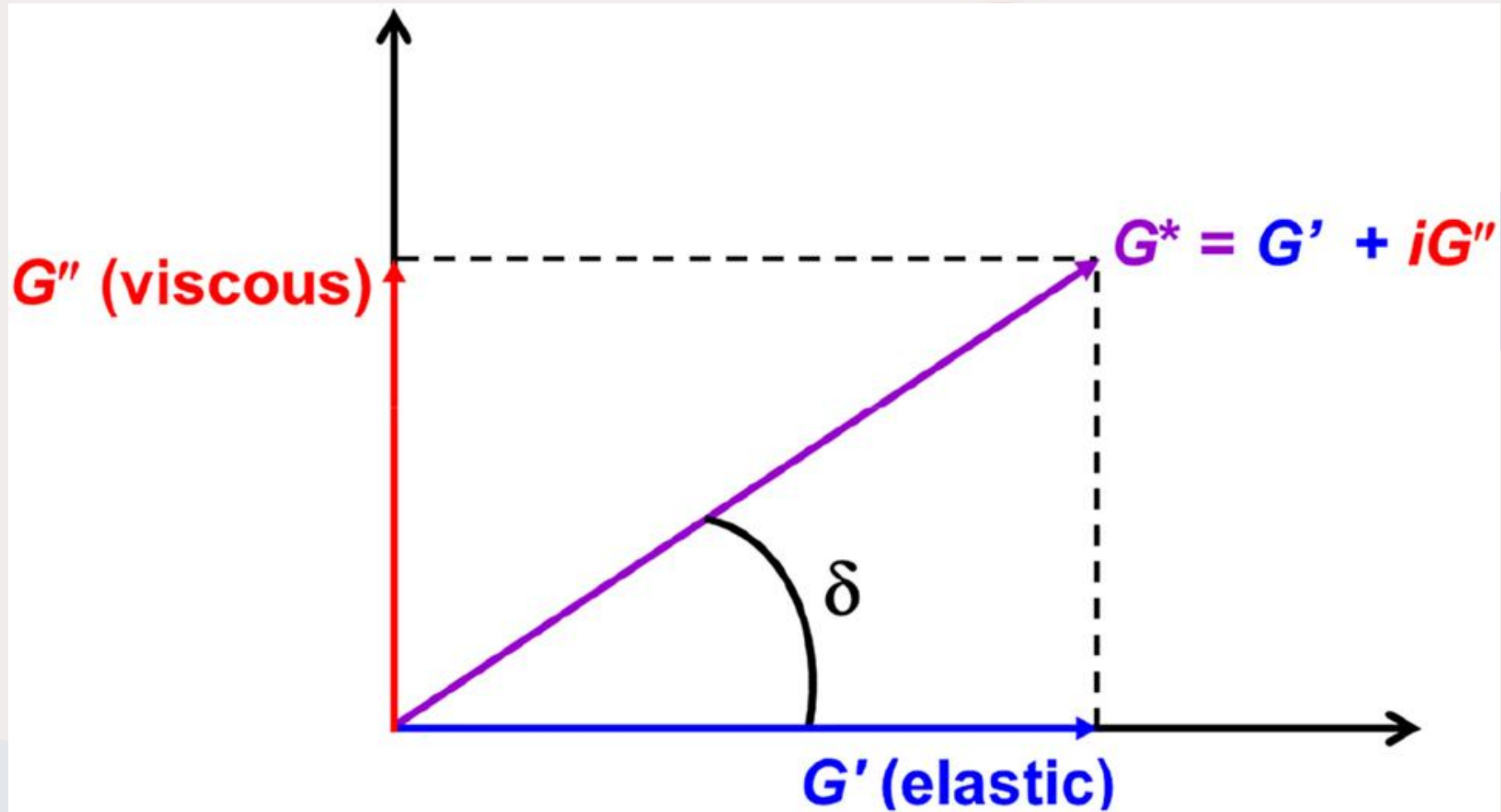


Oscillatory tests can be performed with a preset maximum amplitude (Δx) of either

- shear stress τ (controlled stress CS mode) or
- deformation γ (controlled deformation CD mode)

at a single or multiple frequencies f .

Results of oscillatory tests



Oscillatory test methods

Oscillatory tests in controlled deformation CD or controlled stress CS

Amplitude Sweep

$$G', G'', \delta \dots = f(\gamma_0 \text{ or } \tau_0)$$

- Increasing the amplitude of applied stress or deformation signal
- Determination of linear viscoelastic range (LVR)

Frequency Sweep

$$G', G'', \delta \dots = f(f \text{ or } \omega)$$

- Changing frequency while keeping amplitude constant
- Determination of material character at different time scales

Time sweep

$$G', G'', \delta \dots = f(t)$$

- Sample recovery after sample loading or high shear
- Investigation of curing and cross linking reactions
- Stability tests

Temperature Sweep

$$G', G'', \delta \dots = f(T)$$

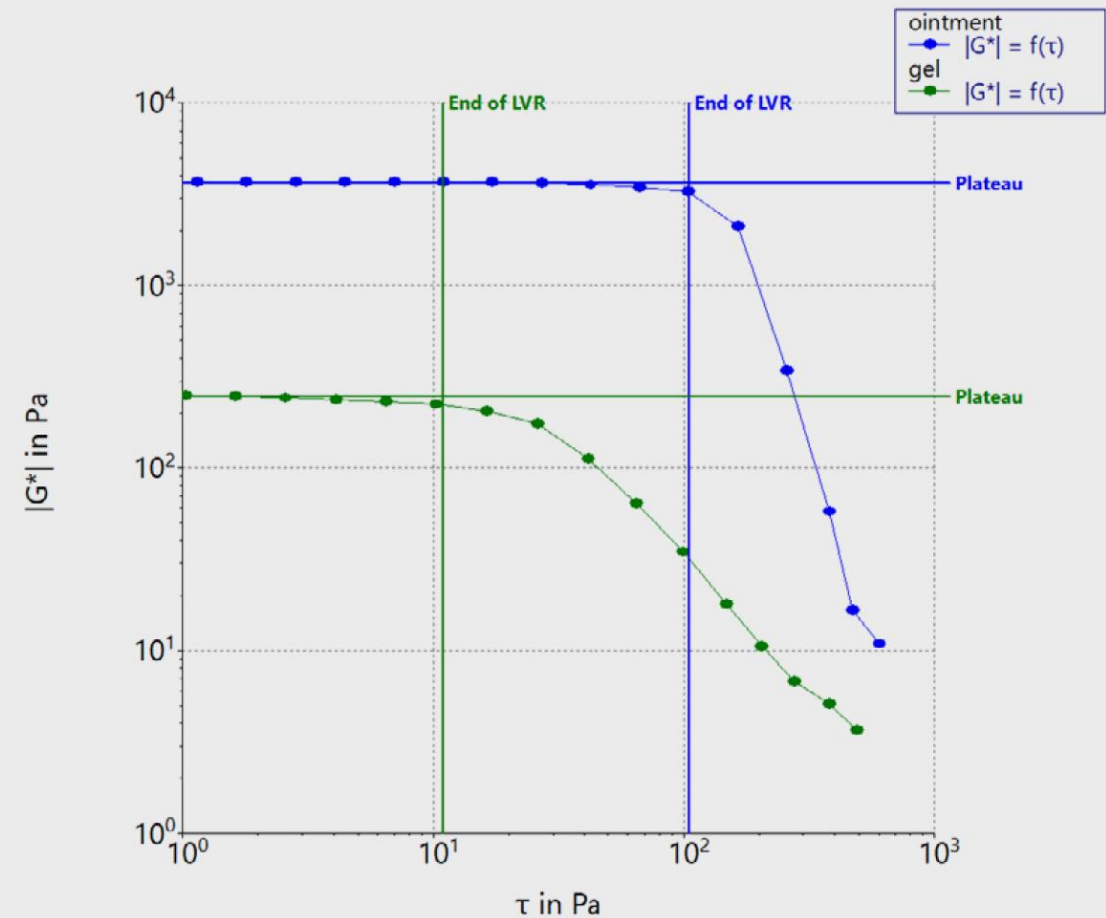
- Determination of temperature depending phase transitions and structural change

Oscillatory test methods

Amplitude Sweep

$$G', G'', \delta \dots = f(\gamma_0 \text{ or } \tau_0)$$

- Determination of the linear viscoelastic range (LVR)
- Within the LVR
 - rheological parameters are independent of applied deformation / stress
 - The microstructure of sample does not change

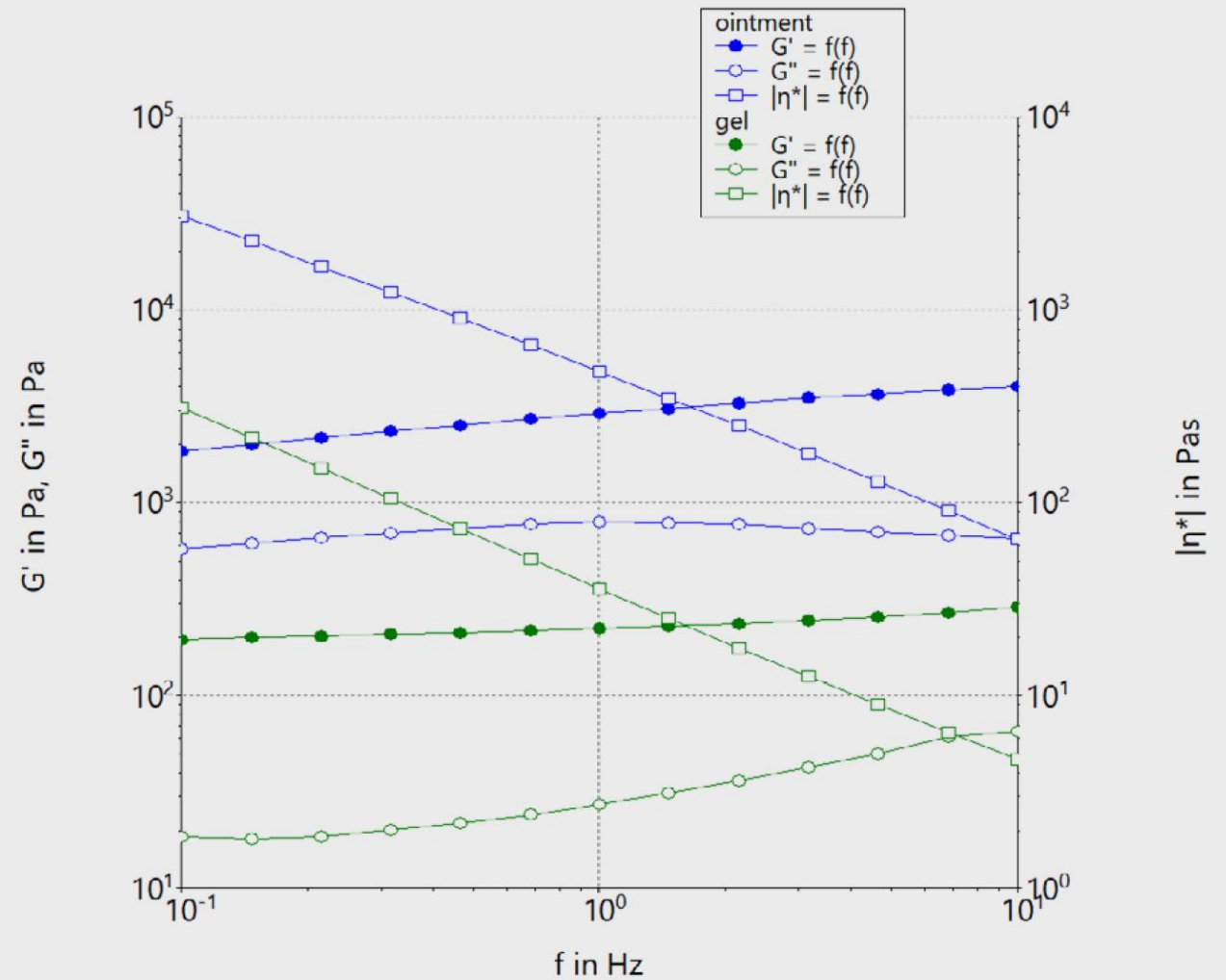


Oscillatory test methods

Frequency Sweep

$$G', G'', \delta \dots = f(f \text{ or } \omega)$$

- Determination of material character at different time scales
- Performed within the linear viscoelastic range (LVR)
- Provides the rheological 'fingerprint' and reveals the viscoelastic character of the tested material



Oscillatory test methods

Frequency Sweep
 $G', G'', \delta \dots = f(f \text{ or } \omega)$

- a) viscoelastic fluid

liquid soap

- b) viscoelastic fluid

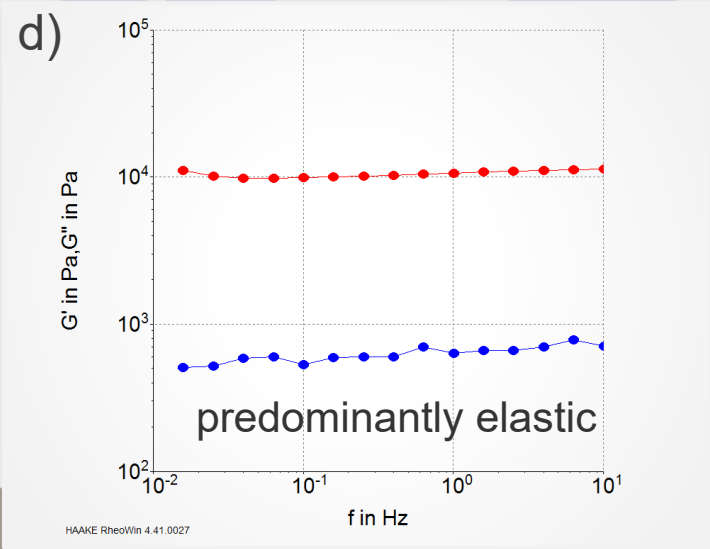
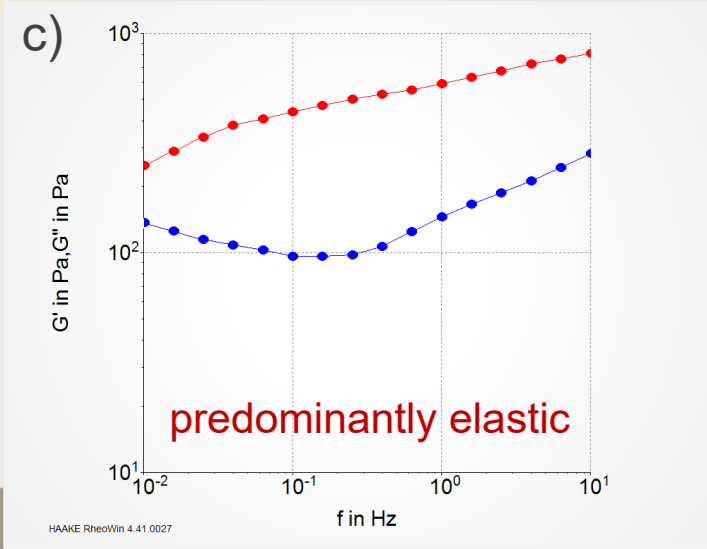
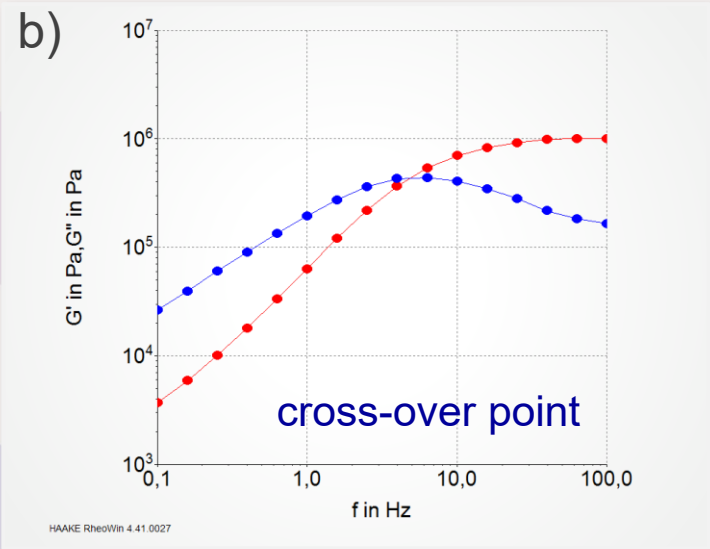
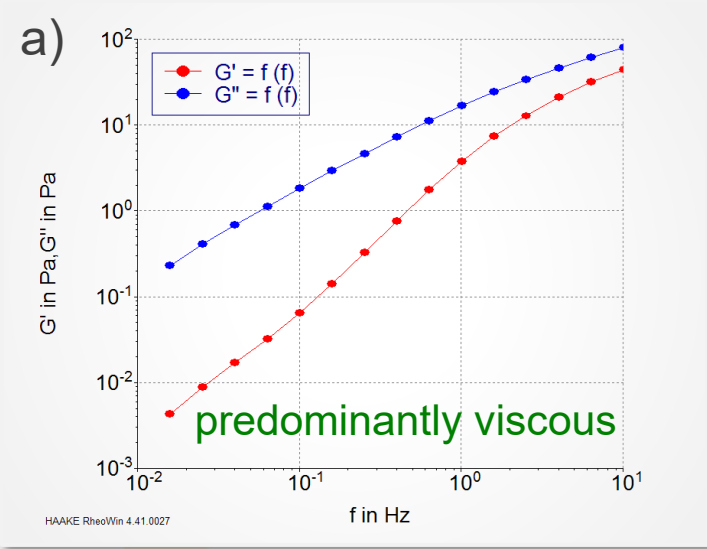
play putty

- c) viscoelastic solid

soft lotion

- d) viscoelastic solid

stiff cream



Definition of yield stress

The yield stress (also referred to as yield point) is the minimum shear stress required, to

- overcome reversible elastic behavior and
- cause irreversible plastic deformation

A yield stress can be a desired material property

- to avoid spreading and provide structure
- to avoid sedimentation of dispersed particles
- to avoid sagging of a paint film or coating on a vertical wall

However, it can also cause undesirable results

- incomplete drainage of containers
- additional energy and capital costs can be required when initiating flow of a yield stress fluid through a pipeline system or production facility



Definition of yield stress

Many materials present in our everyday life exhibit a yield stress

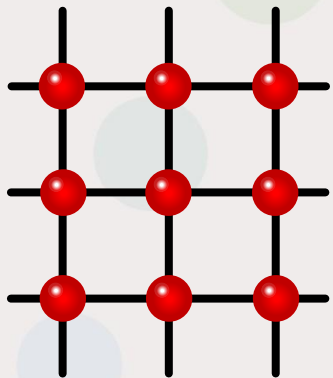
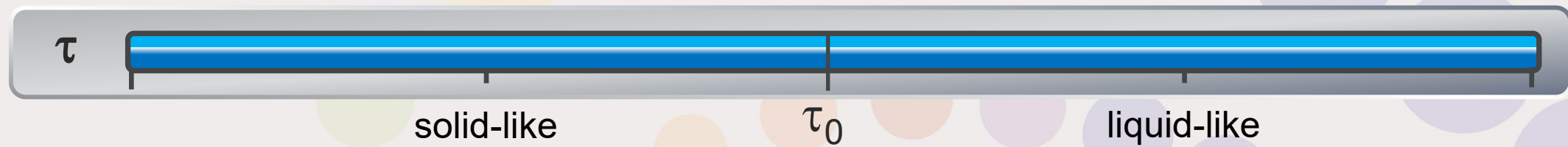
- Cosmetics, paints & coatings, building materials, foodstuff...



- Some typical values are:
 - ketchup ~ 15 Pa
 - body lotion ~ 15 Pa
 - facial cream ~ 50 Pa
 - toothpaste ~ 200 Pa

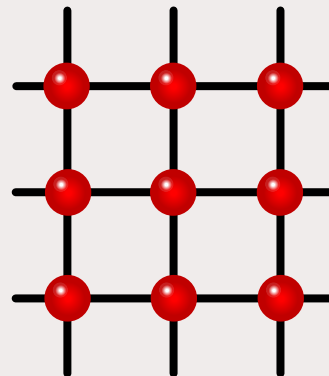
Definition of yield stress

What happens to the microstructure of a yield stress material when the applied shear stress is increased?



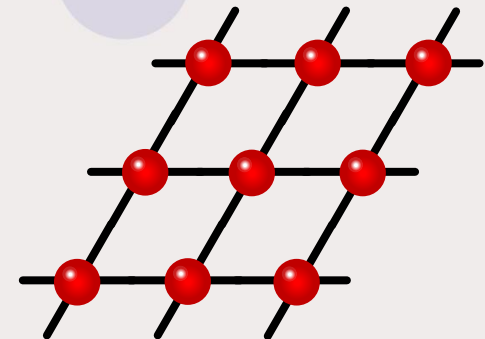
sample at rest

$$\tau < \tau_0$$



elastic deformation

$$\tau > \tau_0$$



flow

Determination of a yield stress

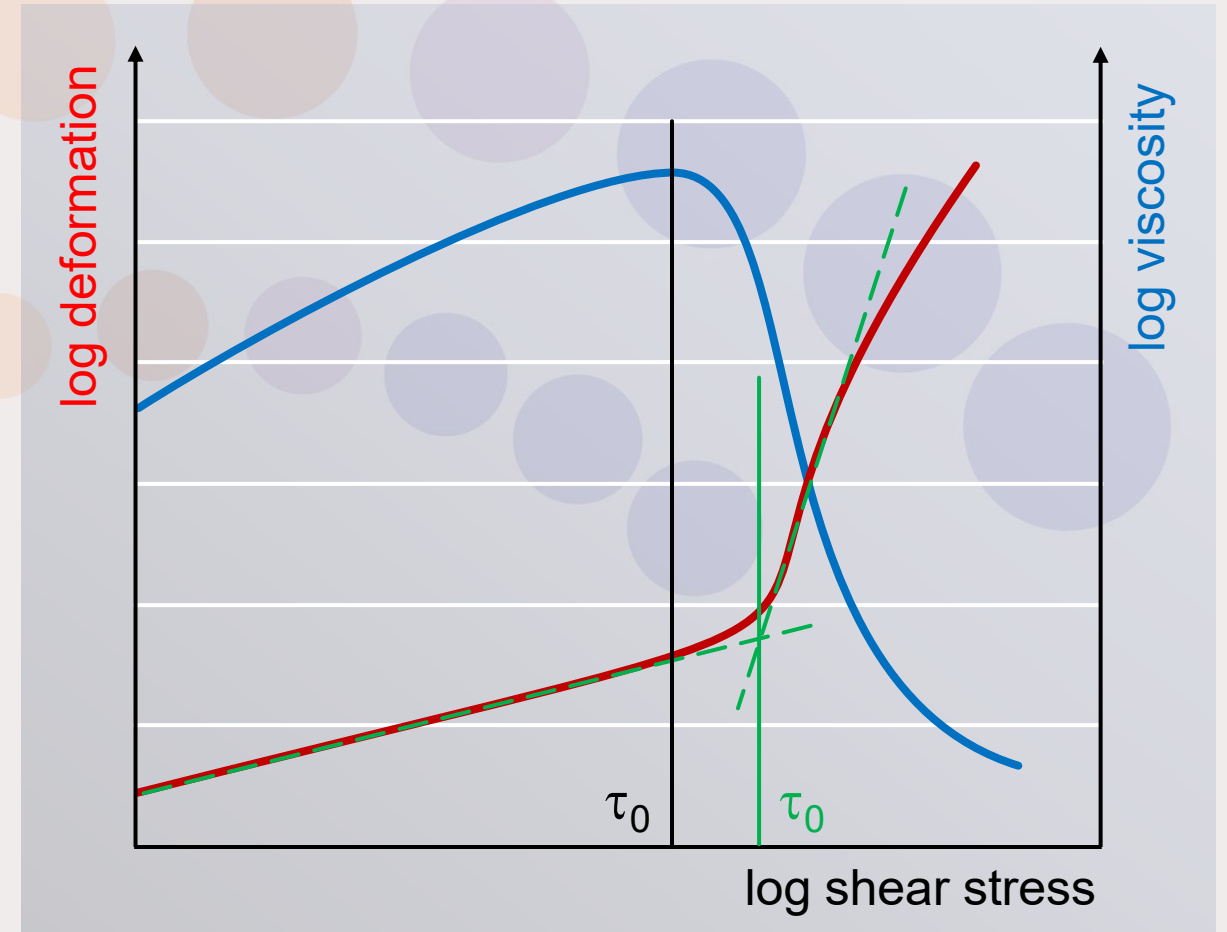
Shear stress ramp test

The yield stress τ_0 can be determined by performing a shear stress ramp test and evaluating the

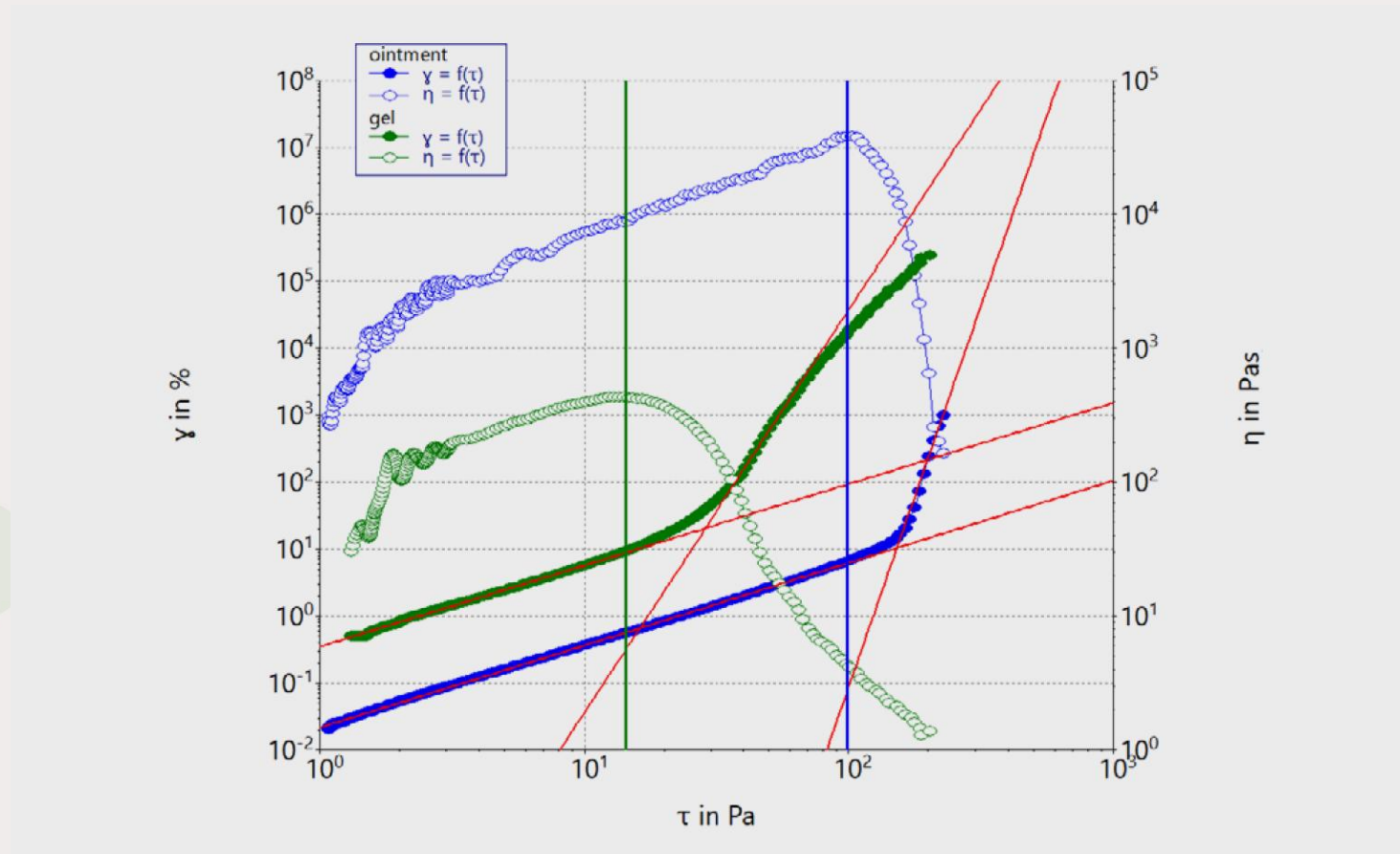
- slope of the deformation signal; or
- maximum in viscosity (easier to evaluate)

The two different evaluations will provide different values for the yield stress

- For consistent results, always use the same evaluation!

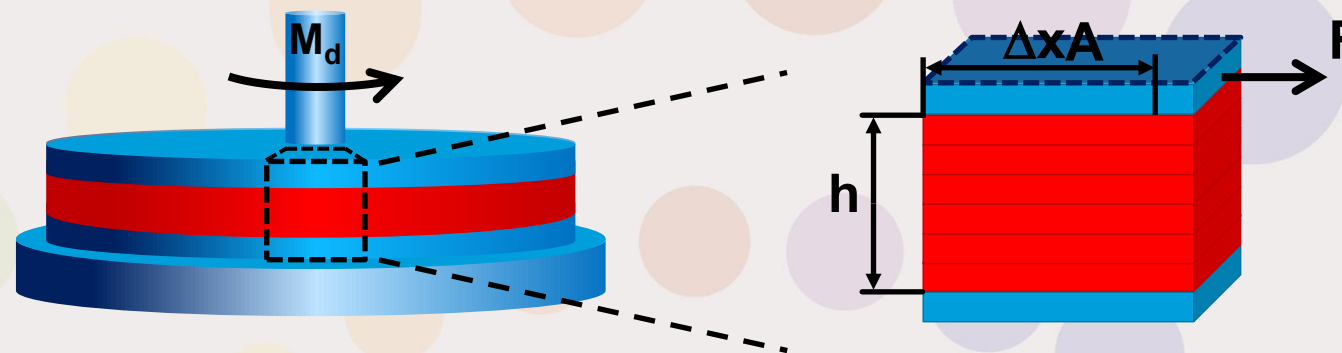


Determination of a yield stress



- Different determination methods will provide different values for the yield stress
- For best comparability of different samples always use the same determination method

Definizioni



Shear stress

$$\tau = \frac{\text{Force } F}{\text{Area } A}$$

Unit: Pascal (Pa)

Deformation

$$\gamma = \frac{\text{Displacement } \Delta x}{\text{Gap } h}$$

Unit: - or %

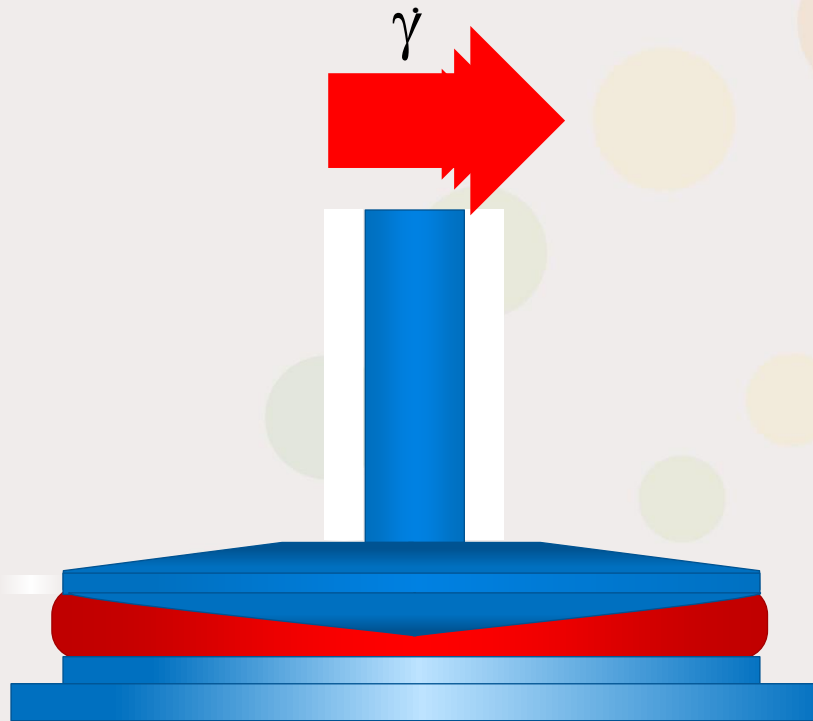
Shear rate

$$\dot{\gamma} = \frac{\text{Change of deformation } \Delta\gamma}{\text{Time } \Delta t}$$

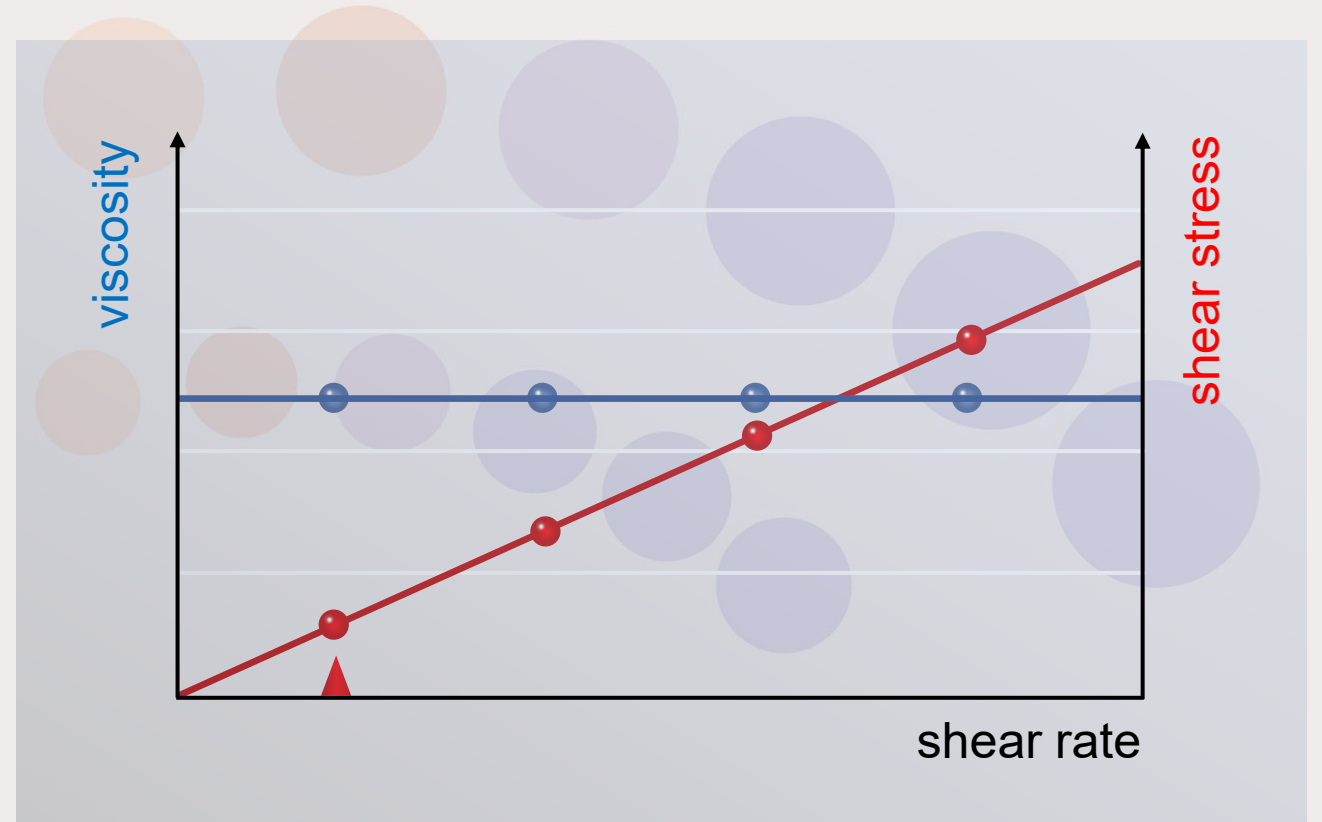
Unit: 1/s

Shear rate-independent flow behavior

Newtonian flow behavior $\eta \neq f(\dot{\gamma})$



Flow in a cone & plate geometry



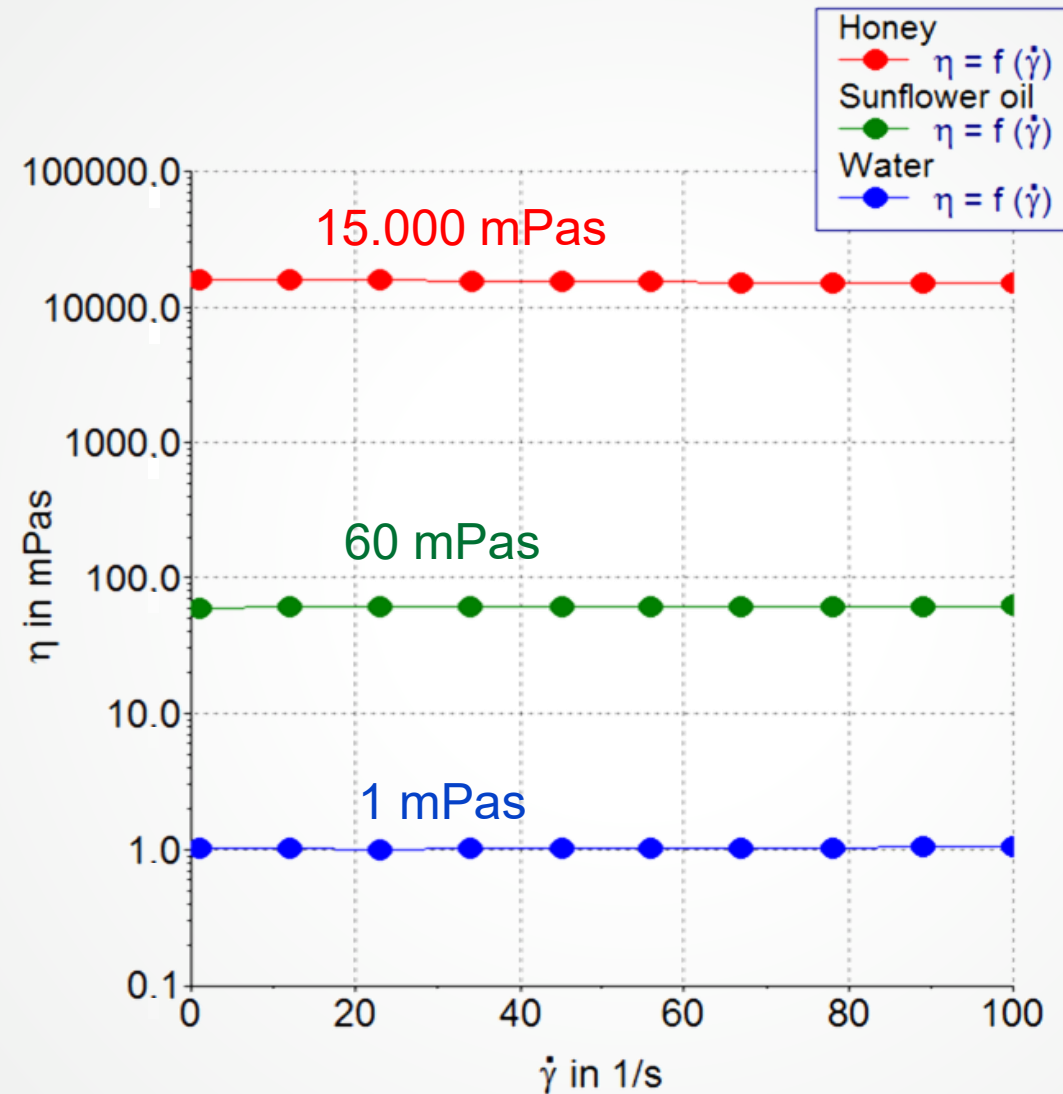
- Viscosity is independent of the applied shear rate
- Proportionality between shear stress and shear rate

Shear rate-independent flow behavior

Examples for Newtonian flow behavior

Only 'simple' fluids show an entirely Newtonian behavior:

- Water, organic solvents
- Mineral and vegetable oils
- Dilute solutions or suspensions



Shear rate-dependent flow behavior

Examples for non-Newtonian flow behavior

More complex fluids have a shear rate depending viscosity:

- Emulsions
 - Cosmetic creams and lotions
 - Butter and mayonnaise
- Suspensions
 - Paints and coating
 - Ceramic slurries
- Polymer melts and solutions
- ...

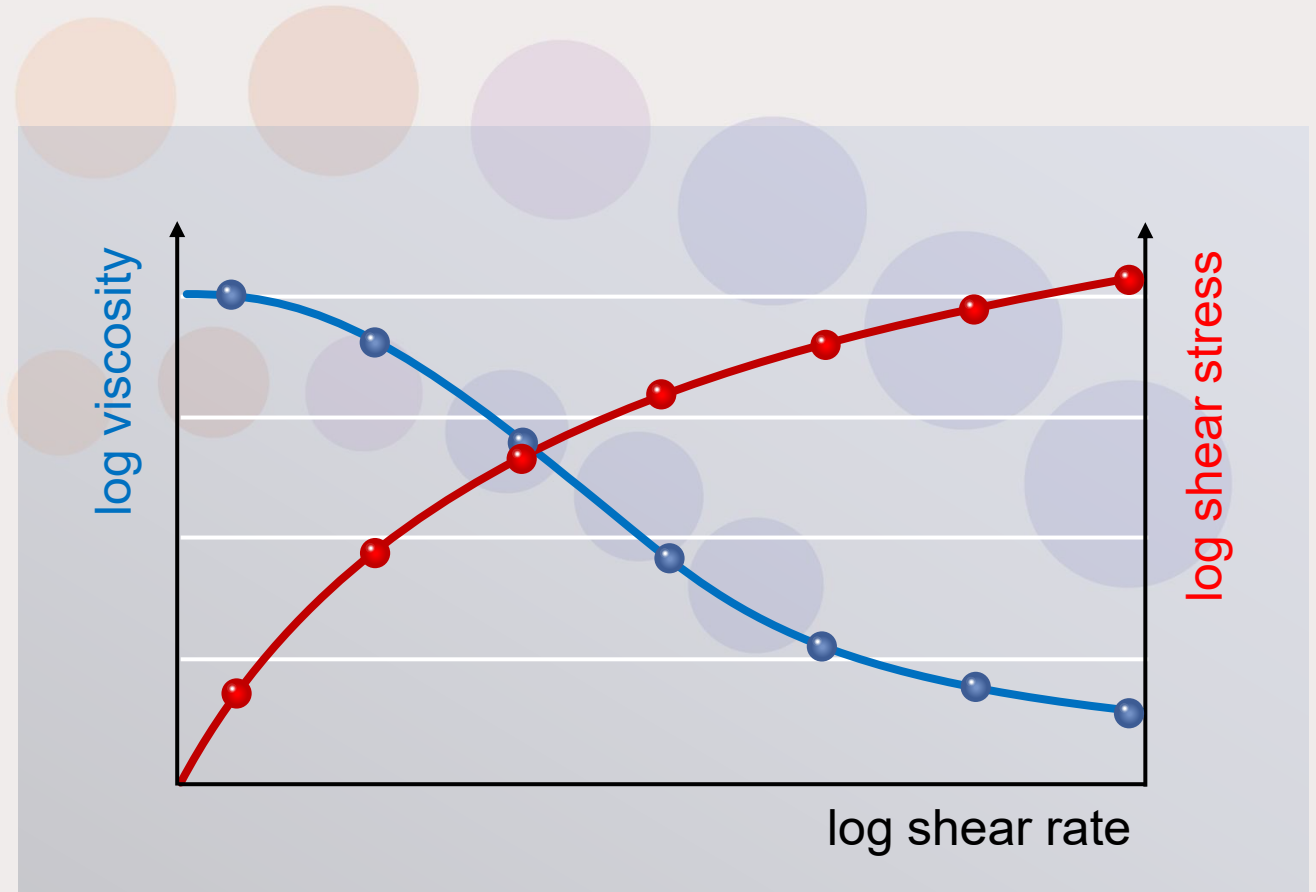


Shear rate-dependent flow behavior

Non-Newtonian flow behavior $\eta = f(\dot{\gamma})$

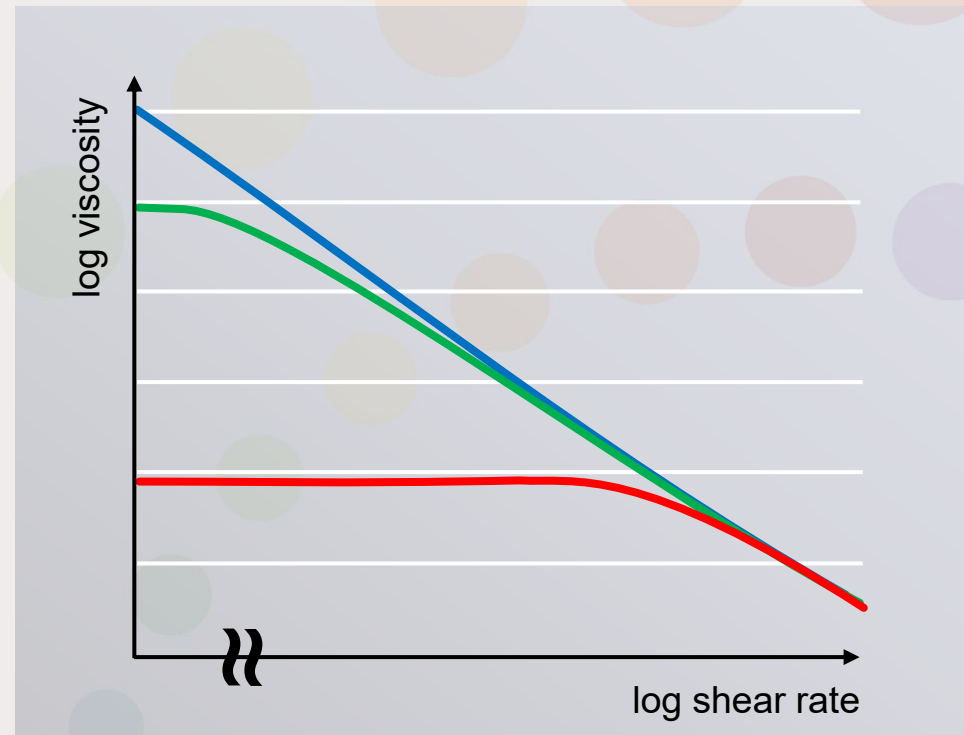
Shear thinning:

- From a critical value on, the viscosity decreases with increasing shear rate
- At very high shear rates the viscosity becomes constant again
- No constant ratio between shear stress and shear rate anymore
- Shear thinning behavior is also referred to as pseudo-plastic behavior



Definition of yield stress

Steady state shear step test



true yield stress (theoretical)

apparent yield stress

viscoelastic fluid

A yield stress τ_0 can be linked to the absence of a (measureable) zero shear viscosity η_0 via a steady state shear step test.

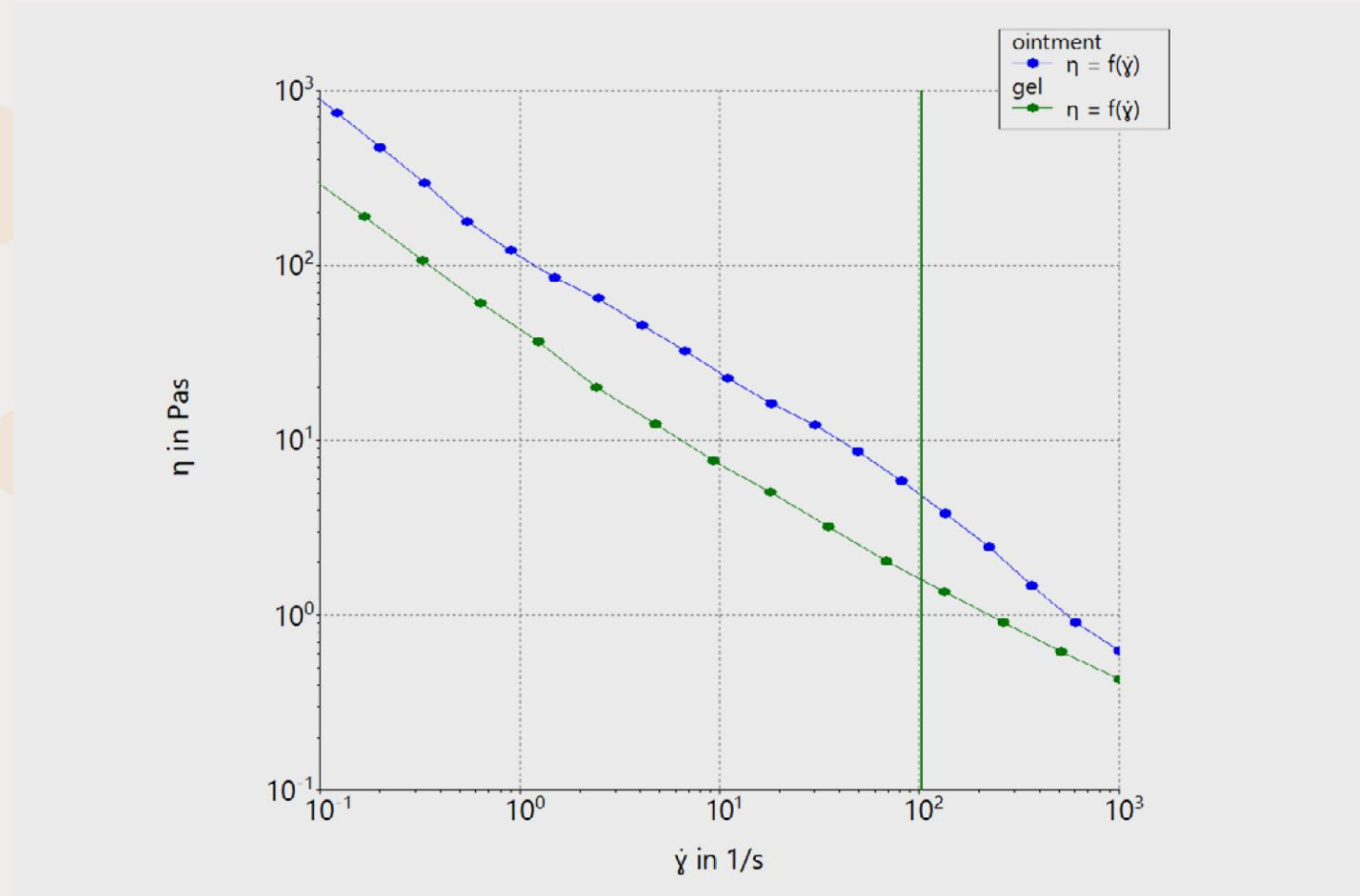
Shear rate-dependent flow behavior

Shear thinning behavior

Both formulations show shear-thinning behavior over the entire shear rate range, with the ointment having the higher viscosity overall.

High viscosity at low shear rates is usually a desirable behavior as it extends shelf life and makes the product easier and more accurate to apply to specific skin areas.

A low viscosity at higher shear rates makes it easier for the consumer to spread and rub the product in and allows for faster absorption through the skin.





COSMETICO SICURO PIACEVOLE EFFICACE STABILE