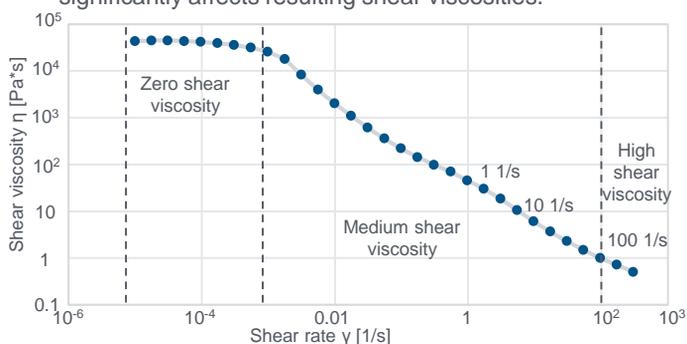


## What rheology is mainly used for:

- Quality control and impact of excipient changes.
- Understanding of behavior of formulations at rest and under stress conditions for estimation of storage stability and spreading behavior.
- Characterization of viscoelastic properties: Is the formulation more liquid- or more solid-like?

## Rotational rheology:

- Mostly determination of flow and viscosity curves, but also of yield stress (flowing of the formulation).
- Majority of dermatological formulations show shear thinning behavior, therefore the applied shear rate significantly affects resulting shear viscosities.



- When shear thinning occurs, measurements at one shear rate are not recommended.
- Within the slope of the viscosity curve varying results can be obtained and formulations might show varying slopes.
- At very low shear rates, the viscosity might reach a plateau, the so-called zero shear viscosity. This is relevant for storage stability and diffusion/penetration of APIs.
- The medium shear viscosity represents pumping processes or the spreading of the formulation.
- High shear viscosity might be reached at high shear rates (> 100 1/s) as the formulation flows and might be broken down. This is relevant for its spreading behavior.

## Geometries:

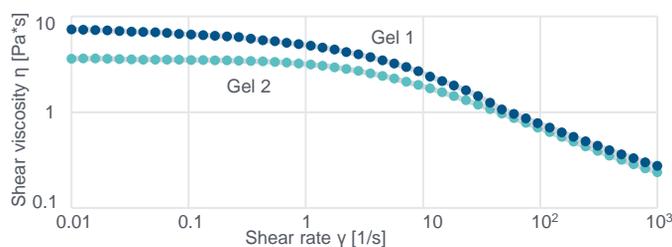
- Dependent from the formulations' viscosity different measurement geometries can be used.
- For the evaluation of the best suitable geometry method development is necessary, otherwise robust data generation might not be possible.
- High viscous formulations can be analyzed using plate – plate or cone – plate geometry dependent on particle size. Cylinder – beaker systems are suitable for liquid-like formulations or when solvent evaporation might occur.

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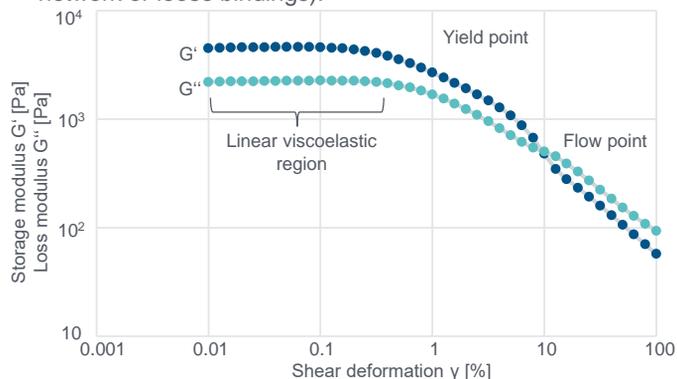
## Zero shear viscosity:

- The formulation at rest represents the state at which the skin penetration occurs.
- The zero shear viscosity also gives insight into the long-term stability, especially with regard to suspension or emulsion stability as the viscosity of the disperse phase is measured.
- Formulations with the same shear viscosities under stress might show different zero shear viscosities due to variations in the formulation composition.



## Oscillatory rheology:

- With this technique more insight into the inner structure of the formulation can be obtained.
- The storage modulus  $G'$  represents the elastic (solid-like) and the loss modulus  $G''$  the viscous (liquid-like) behavior.
- Stability predictions (range of linear viscoelastic region, flow point, behavior of storage modulus at varying frequencies).
- Differentiation between the gelling properties (built-up gel network or loose bindings).



## Method development:

- For each formulation, the method should be evaluated carefully as results may depend on selected parameters.

## Differences in linear and logarithmic data acquisition:

- Linear acquisition is suitable for higher shear rates.
- For the assessment of lower shear rates and oscillatory measurements, logarithmic acquisition is recommended, otherwise false high results might be measured.

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