The Sonorheometer

A New Setup for Rheological Analysis upon Ultrasonication

Kaja Liepert [1*], *Davide Ret* [1], *Robert Liska* [1], *Patrick Knaack* [1]

[1] Institute for Applied Synthetic Chemistry, Technische Universität Wien, Getreidemarkt 9, 1060 Vienna

*Contact: kaja.liepert@tuwien.ac.at

You can find us here!

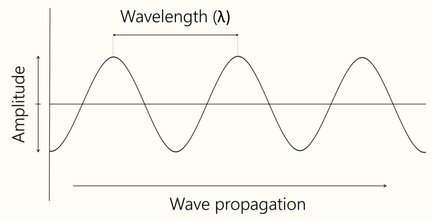
Motivation

Ultrasound (US) is widely used in **research** and **industry** (e.g. food processing, cosmetics, oil and gas industry, medical applications or polymer processing), exploiting an ultrasonic trigger for controlled drug release, viscosity control, and many applications more. Hereby, especially the low kHz-range has shown promising regarding a viscosity decrease in thixotropic systems.[1,2]

To investigate the **rheological properties** of formulations upon an ultrasonic trigger, a novel setup was developed, allowing ***in situ*** **rheological measurements during ultrasonication**.

Context

Propagation by oscillation/displacement of molecules – acoustic pressure

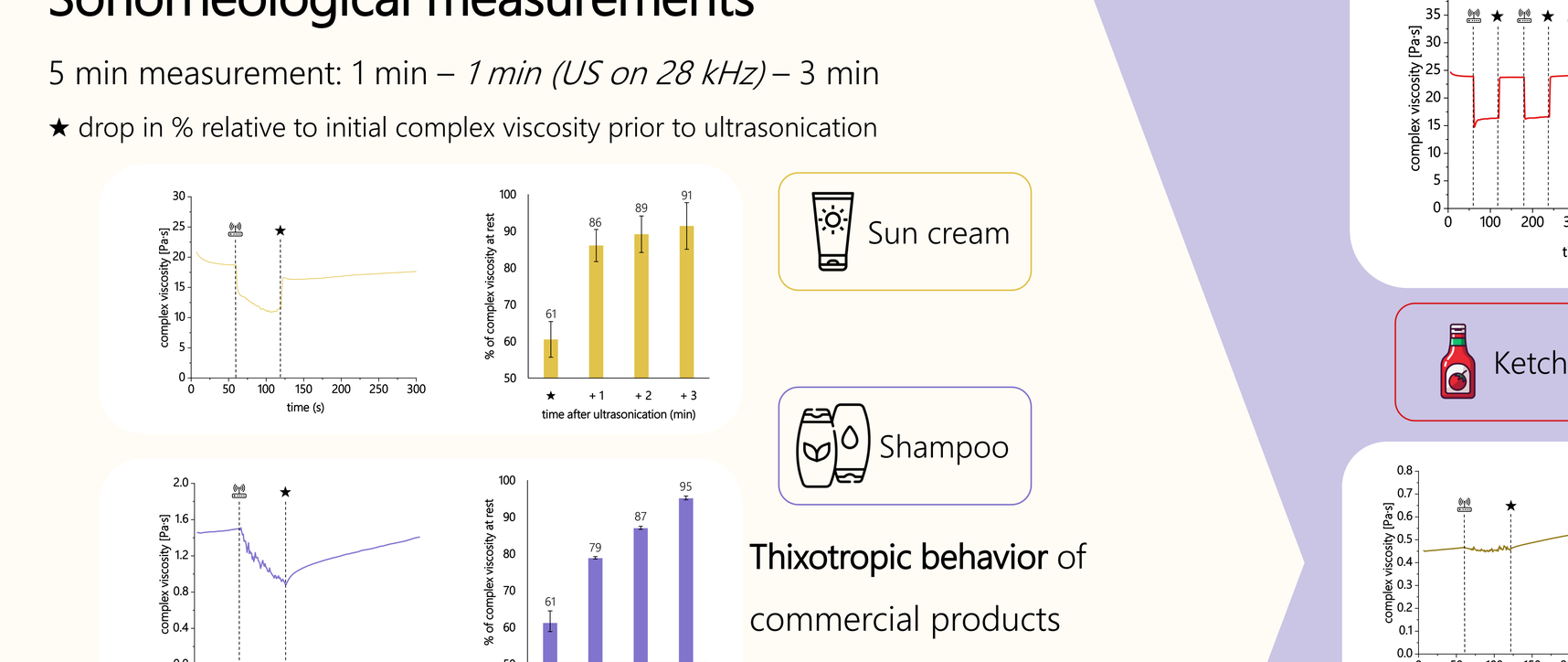


Ultrasound frequency range ≥ 20 kHz

Medical applications 2 – 15 MHz (e.g. sonography)

Echolocation of animals, e.g. bats or dolphins in the lower kHz range

Human hearing range ~20 Hz – 20 kHz



Pictures were created with BioRender.com

Concept

- Anton Paar MCR 302e rheometer
- Plate-plate geometry
- PTFE stamp (⌀ 20 mm)
  → chemical /thermal stability
  → damping properties
- Custom made bottom plate – US transducer
- Ultrasound frequencies: 28 kHz or 1 MHz
- US via continuous sine signal
- 1 min *rest* – 1 min *sonication* – 3 min *recovery*

Sonorheological measurements

5 min measurement: 1 min – *1 min (US on 28 kHz)* – 3 min

★ drop in % relative to initial complex viscosity prior to ultrasonication

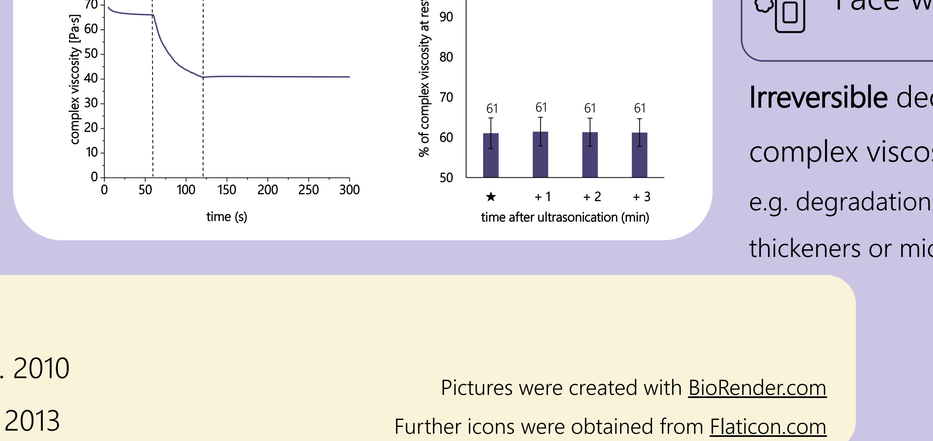
Sun cream

Shampoo

Thixotropic behavior of commercial products

- drop in complex viscosity upon ultrasonication
- recovery as ultrasonic trigger is stopped

Tooth paste



Ketchup

Thixotropic behavior in **four consecutive** *rest – sonication – recovery* cycles

Paint

Weak to no thixotropic behavior (**Newtonian fluid**)
→ curing over time

Face wash

Irreversible decrease in complex viscosity
e.g. degradation of polymer thickeners or micellar networks

Projektass. Kaja Liepert, MSc
Technische Universität Wien
Institute of Applied Synthetic Chemistry
Division of Macromolecular Chemistry
*Email: kaja.liepert@tuwien.ac.at

References:

[1] Ngoc N. *et al.* Ultrason. Sonochem. 2010

[2] Venegas-Sanchez J. *et al.* Polym. J. 2013

Pictures were created with BioRender.com

Further icons were obtained from Flaticon.com