

Rheology of polymer melts and solutions – tools and analysis

CHEM-LV01

Michael Hummel & Julian Selinger



Aalto University
School of Chemical
Engineering



Course content

- basics of shear rheology (shear rate, shear stress, shear strain, dynamic viscosity, difference between steady shear and oscillating)
- operation of a classical shear rheometer
- different fitting model functions
- identify and extract relevant data from scientific publications
- critical evaluation of measurement data
- basics of elongational rheology (deformation under tension, Hencky strain, strain hardening)



Intended Learning Outcomes

After this course the student...

- knows the measurement principles of the different rheological devices.
- is able to solve a rheological question and how to analyze viscoelastic systems using the fundamentals of shear rheology.
- knows the fundamentals of elongational rheology.
- can choose the right device and create an analysis protocol according to the scientific question s/he wants to answer.
- can analyze the data that are obtained and present it in a state-of-the-art manner.
- understands and can interpret the rheological data and results published in scientific journals.

Rheometer – Anton Paar Physica MCR 302

What for?

- To characterize rheological properties of liquids and gels
- Suitable for melts, solutions, suspensions and gels
- Ex: gelling behavior, flow behavior of 3D printing inks, melt behavior of polymers, etc.

Advantages

- Device comes with wide range of measurement systems and accessories
- Requires small amount of sample (as little as 50 μL)



Rheology course

Education rheometer MCR72 purchased in 2019

- air cooled Peltier temperature control system
- ball bearing system

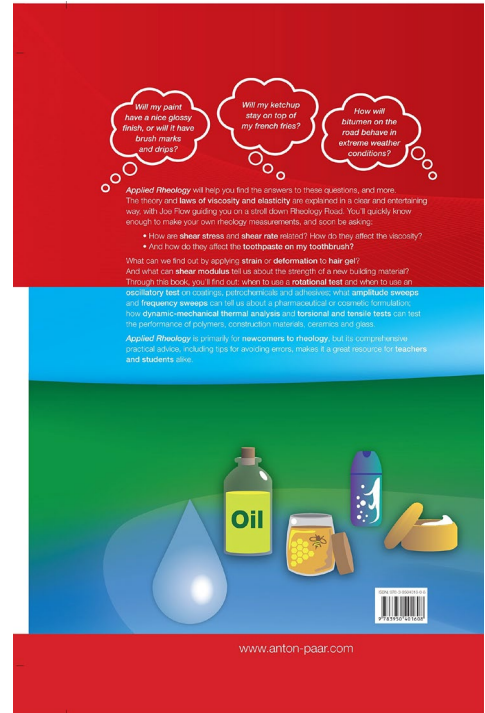
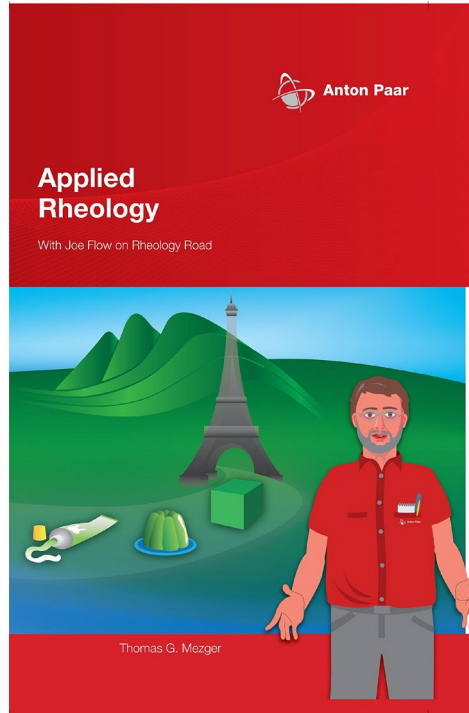


**Educational
rheometer**

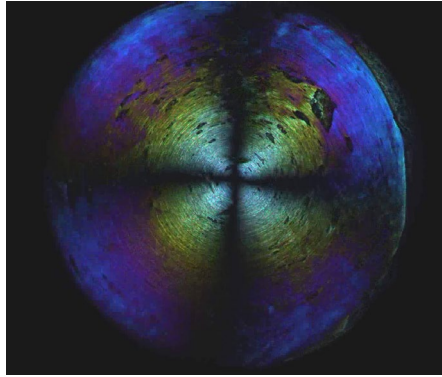
Lecture material

Thomas G. Mezger: Applied Rheology

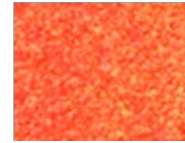
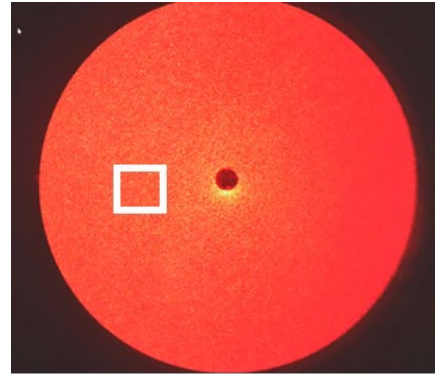
Scientific articles



Rheometer – Accessories



**Polarized light
imaging**



**Small angle
light scattering**

Rheometer – Capillary Break-up Rheometer

What for?

- To characterize extensional rheological properties of liquids
- Suitable for melts, solutions, suspensions

Advantages

- Understanding of elongational (shear-free) deformation
- Requires small amount of sample (as little as 50 μL)



Rheometer – ROSAND RH07

What for?

- To characterize rheological properties of liquids under high shear
- Suitable for melts, solutions, suspensions

Advantages

- Characterization of polymer or suspension rheology across a range of shear rates and temperatures
- Assessment of extrusion behaviour for processes such as injection moulding and hot melt extrusion
- Measurement of material elasticity and related properties such as die swell



Structure – draft

Session	Date	Topic
1	2.5.	Introduction
2	5.5.	Basics & Tools
3	9.5.	Yield point, t- and T-dependent flow behavior
4	12.5.	RheoCompass - analytics, mastercurve
5	16.5.	Oscillatory measurements
6	19.5.	t- and T-dependet osciallation
7	24.5.	MCR302 accessories
8	26.5.	
9	31.5.	Capillary rheometer
10	2.6.	



Pre-assignment

What rheological problem do you currently have in your research?