BOROSA
ACOUSTIC LEVITATION

DATA SHEET / Acoustic Levitator L800

for high-temperature and high-pressure applications

L800

INDUSTRIE PREIS 2015
KATEGORIESIEGER

ADVANTAGES

- contact-free measurements of droplets even under harsh conditions
- avoidance of distortions by elimination of wall-contact between sample and cannula
- droplet-shape is controllable (disc-shape or spherical-shape)
- accurate and more realistic measurements
- plug & play apparatus with intuitive control
- short initial training phase
- easy cleaning

FUNCTIONS

- ideally suited for mass-transport, particle formation, gelation and crystallization measurements
- observation of reactions and crystal growth inside the droplet
- automatically determination and documentation of the droplet-volume over time
- upgrading with spectroscopic devices is possible to measure e.g. concentrations and phase equilibria
- work area
  pressure = 0.1 MPa - 20 MPa, temperature = 253 K - 453 K

SINGLE-DROPLET MEASURING APPARATUS

The laboratory device L800) is well-suited for accurate measurements of mass-transport mechanisms of acoustically levitated droplets.

The specifically developed software detects the levitated sample automatically and analyzes the contour of the droplet. With this information the volume of the rotationally symmetric sample can be measured and documented.

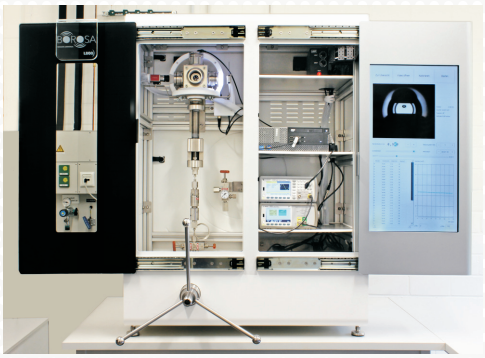
After every measuring a data sheet with all important parameters (e.g. time, temperature, pressure, volume, horizontal and vertical droplet-diameter etc.) and picture material (pictures or a video) of the droplet will be stored on the PC.

With the help of the measured and stored volume-time-diagram it is possible to calculate valuable physical properties regarding the mass transport. These include:
Diffusion- and mass transport coefficients.

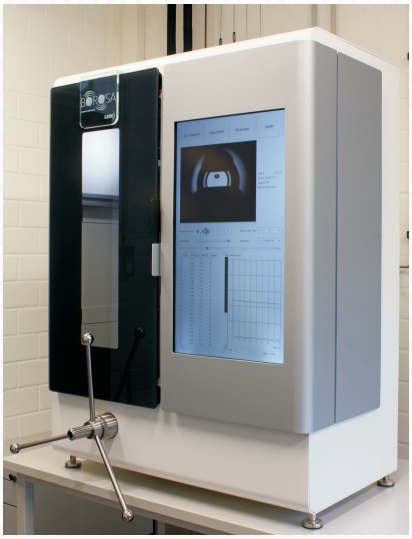
Measurements and studies of gas hydrates, crystallizations, particle formation, gelation and melting processes can be done due to the large working range of the L800).

COMPONENTS L800

- 1 x measurement-cell (1.4571)
- 1 x acoustic levitator (titanium alloy)
- 3 x sapphire-crystal windows
- 1 x droplet-injection-unit
- 1 x thermal insulation
- 1 x measurement-cell mounting bracket
- 1 x three-way-valve
- 1 x analog pressure indicator, fine-control-valve and bursting-disc holder
- 1 x pressure transmitter
- 1 x thermocouple
- 1 x manual spindle-press
- 1 x rotating joint
- 1 x LED backlight
- 1 x camera
- 1 x zoom-objective, 12 x zoom, 12 mm fine focus
- 1 x positioning table x, y, z for the camera
- 1 x frequency generator
- 1 x amplifier
- 1 x PC incl. Microsoft Office package
- 1 x SOFTWARE LMs – Levitation and Measurement software
- 1 x touchscreen display (27“, full HD)
- 1 x safety glass sliding door
- 1 x complete set of sealing gaskets
- 1 x bursting-disc
- 1 x aluminum-housing, powder-coated



L800 opened



L800 closed

BOROSA Acoustic Levitation GmbH
T +49 (0) 234 / 357 860 57
info@borosa.de
www.borosa.de

BOROSA

ACOUSTIC LEVITATION

BOROSA Acoustic Levitation GmbH

/// laboratory equipment

Works with Ultrasound

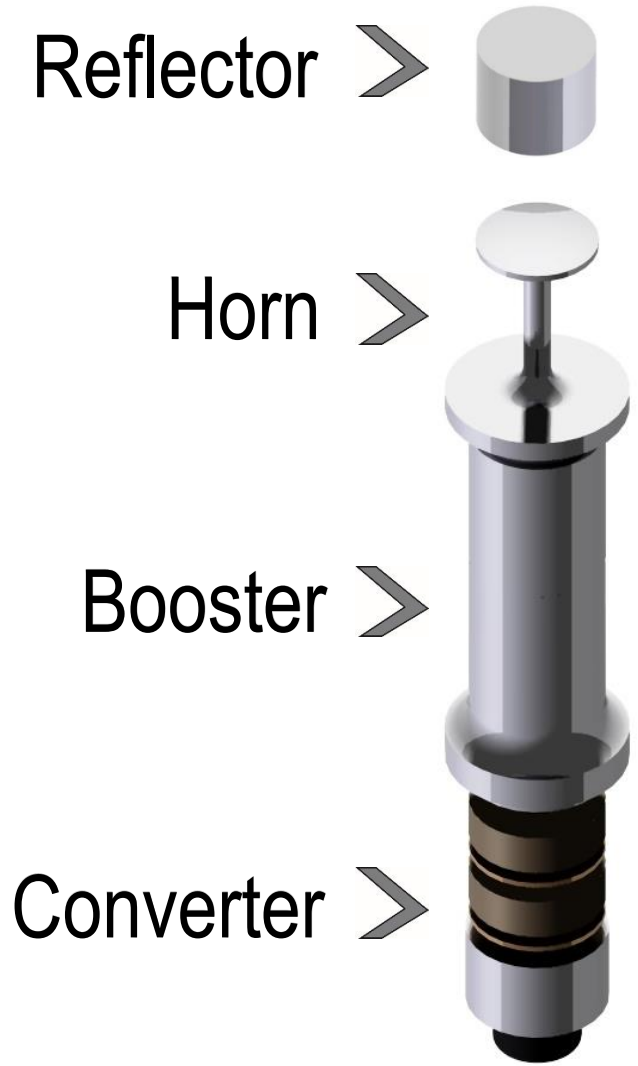
1 Loudspeaker
+
1 Reflector

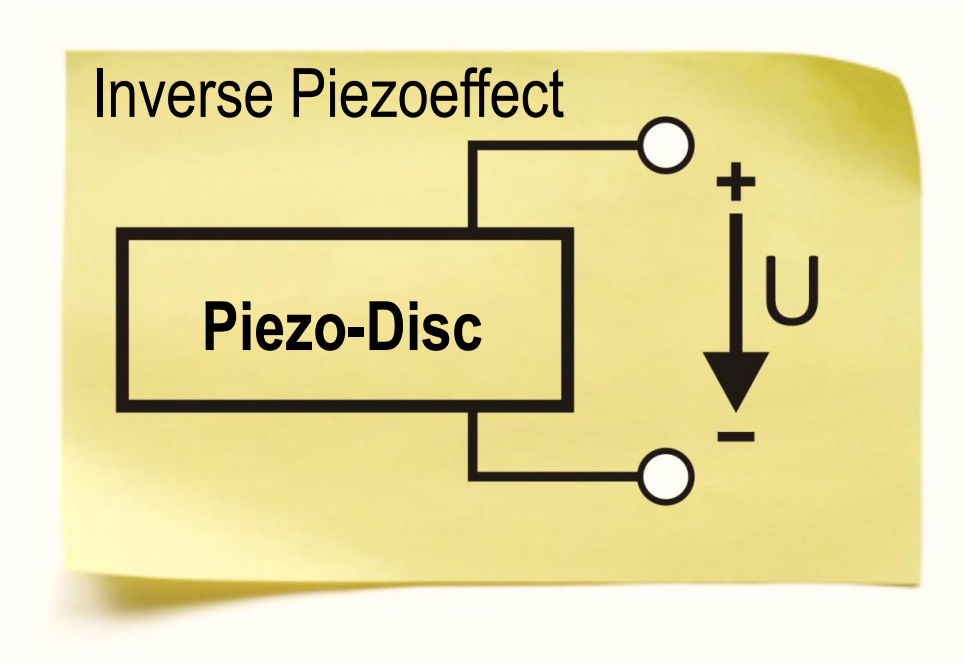
One-Droplet Measurement Apparatus

Contact-Free

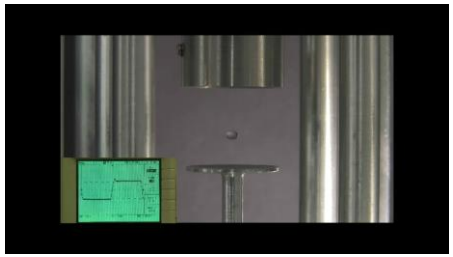
No contamination

What is acoustic levitation?



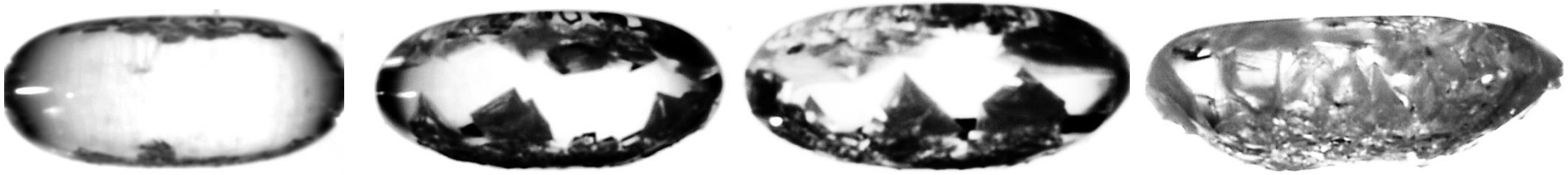


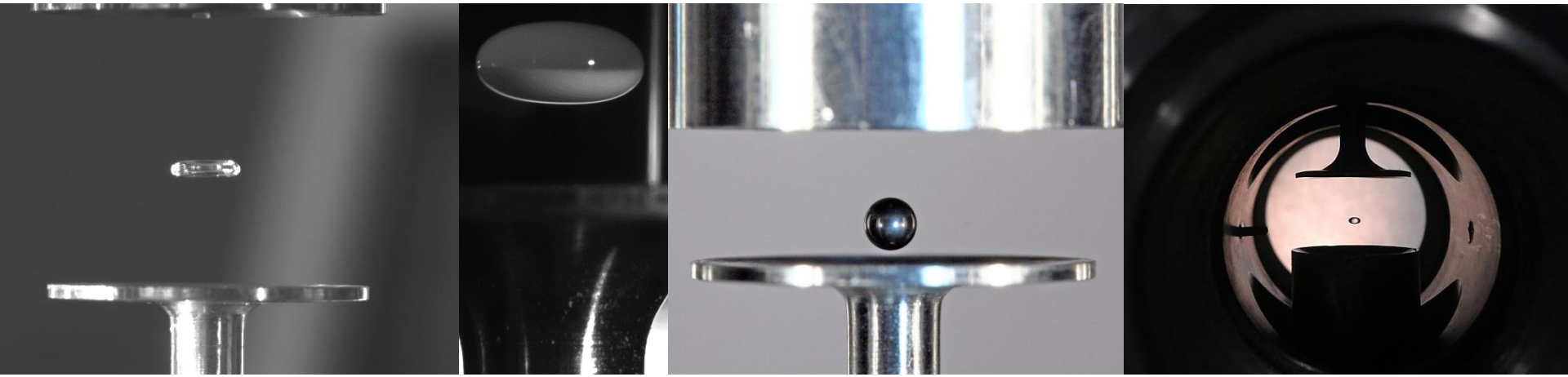
Piezoceramics



What is acoustic levitation?

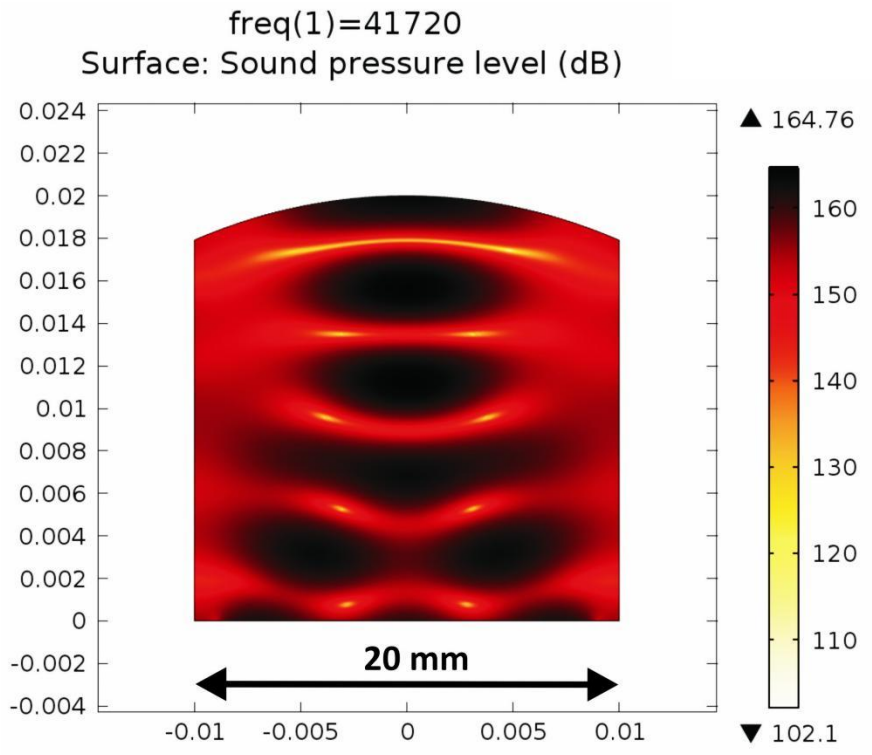
BOROSA
ACOUSTIC LEVITATION

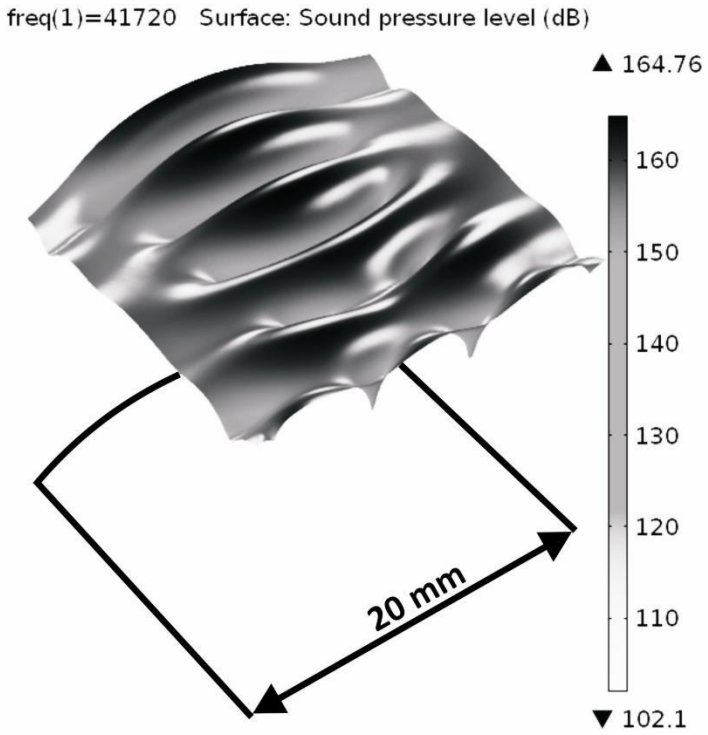




What is acoustic levitation?

165 dB → 3556,6 Pa → 0,03556 bar



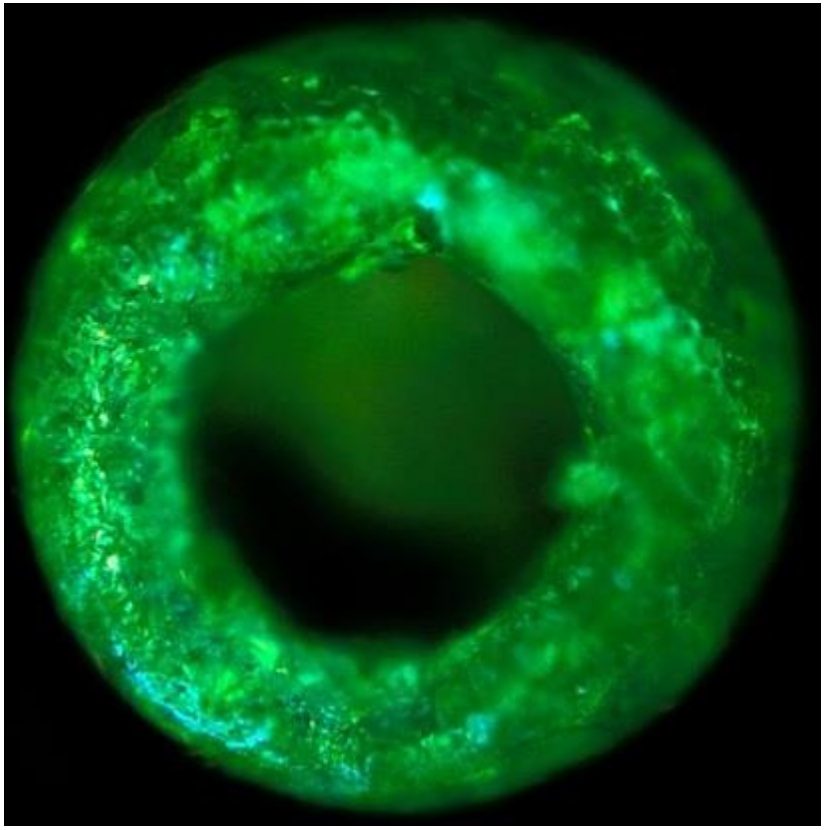


Acoustic Levitation

BOROSA
ACOUSTIC LEVITATION

Areas of Application

- mass transport
- reactions
- drying & gelation
- crystallization
- melting & solidification point
- measurement of concentrations
- physical properties



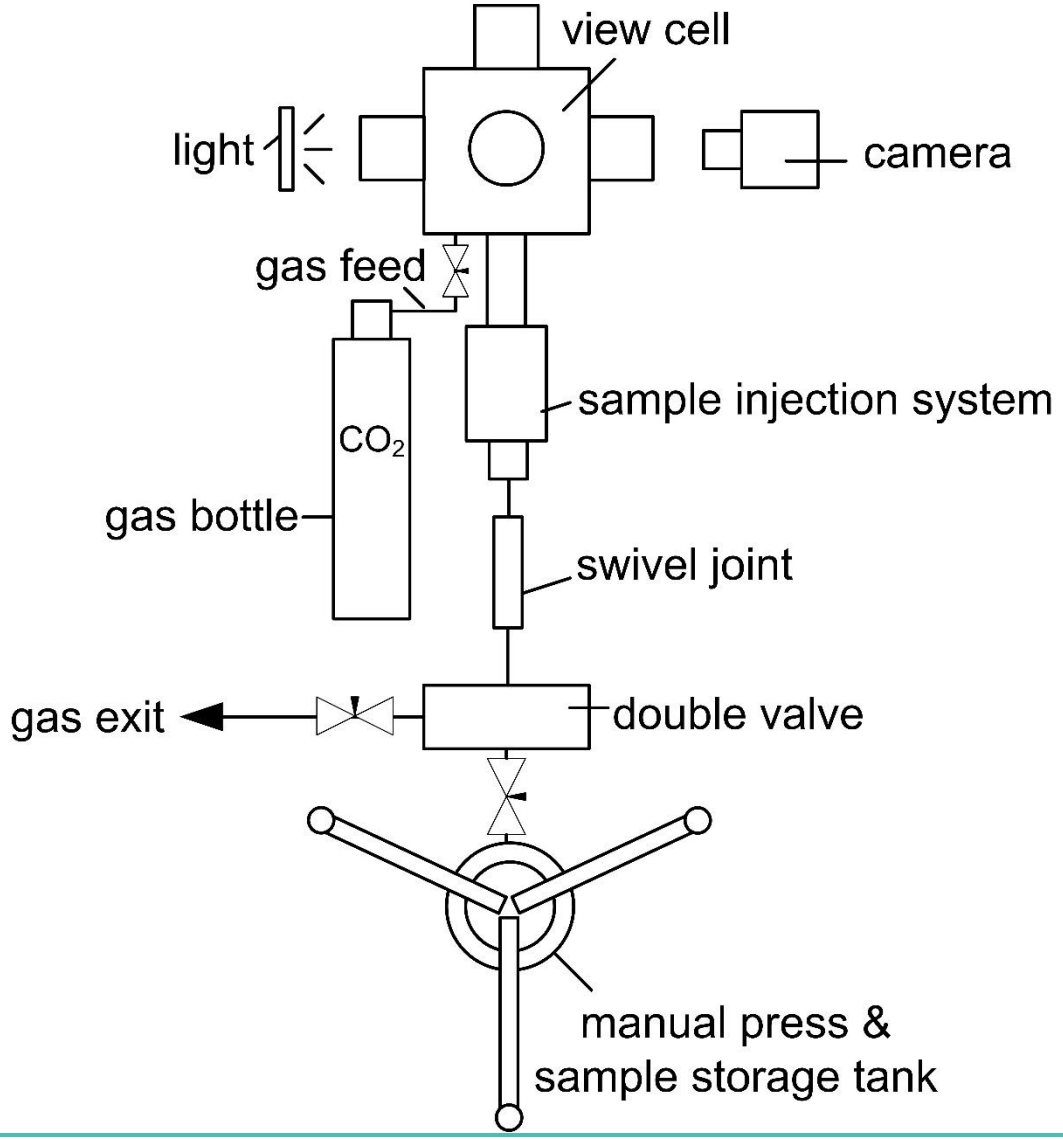
Chloroform-Cu-complex

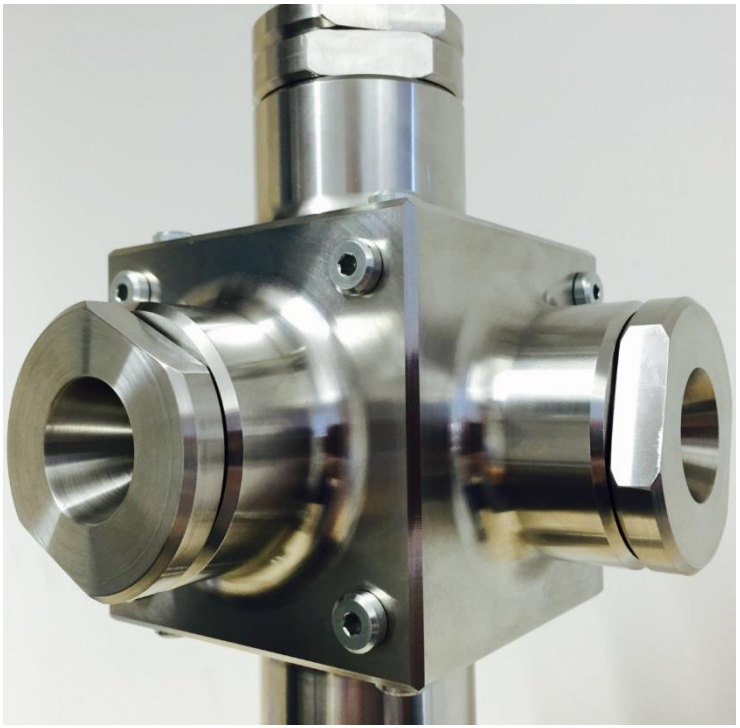
Contact-free experiments

BOROSA
ACOUSTIC LEVITATION

 # Advantages

- small amount of samples
- fast measurement time
- more measurement options
- higher data quality
- droplet shape is controllable (disk-shape or spherical shape)
- very-low-energy-requirements to levitate samples



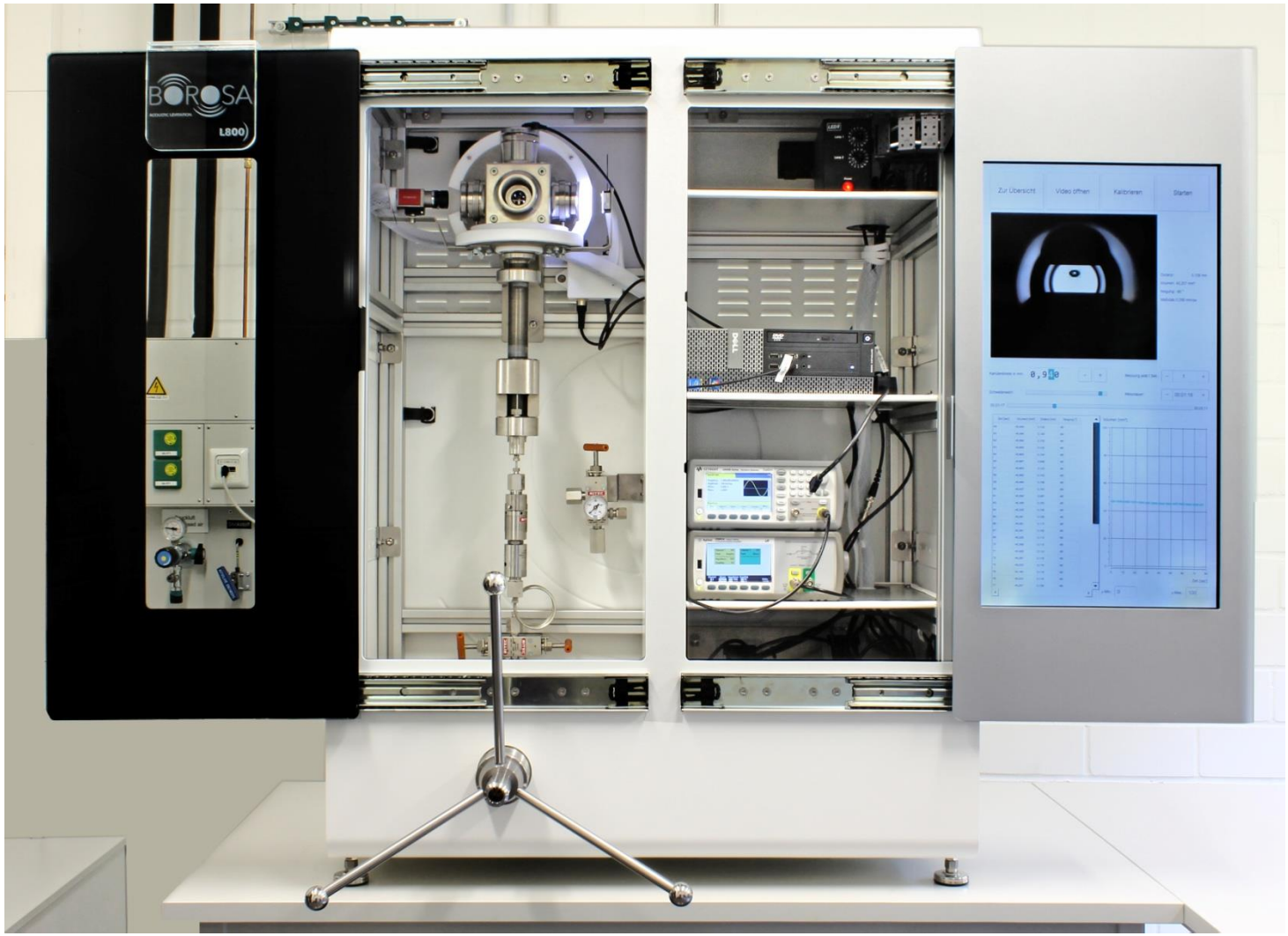


view cell (1.4571) with built-in channels for thermal fluid

L800

BOROSA
ACOUSTIC LEVITATION

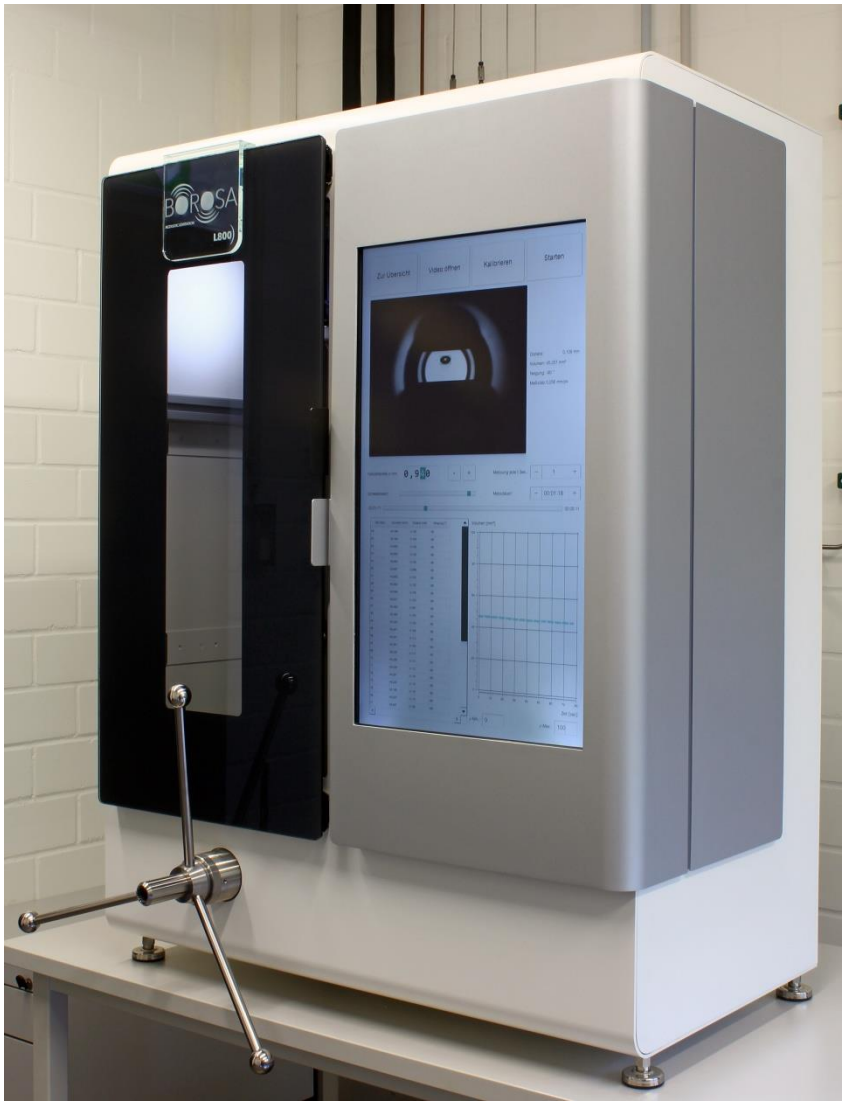
INDUSTRIE PREIS 2015
KATEGORIESIEGER

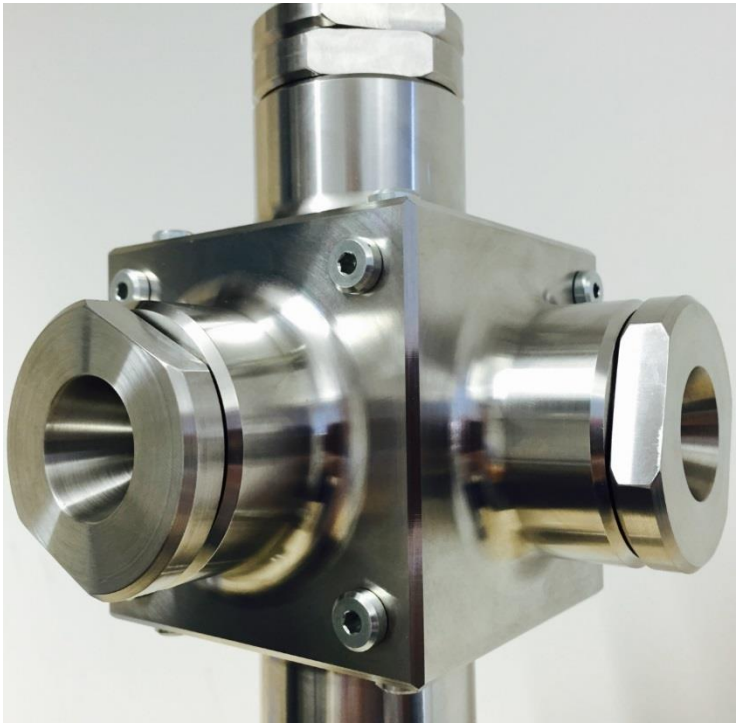


L800

BOROSA
ACOUSTIC LEVITATION

INDUSTRIE PREIS 2015
KATEGORIESIEGER



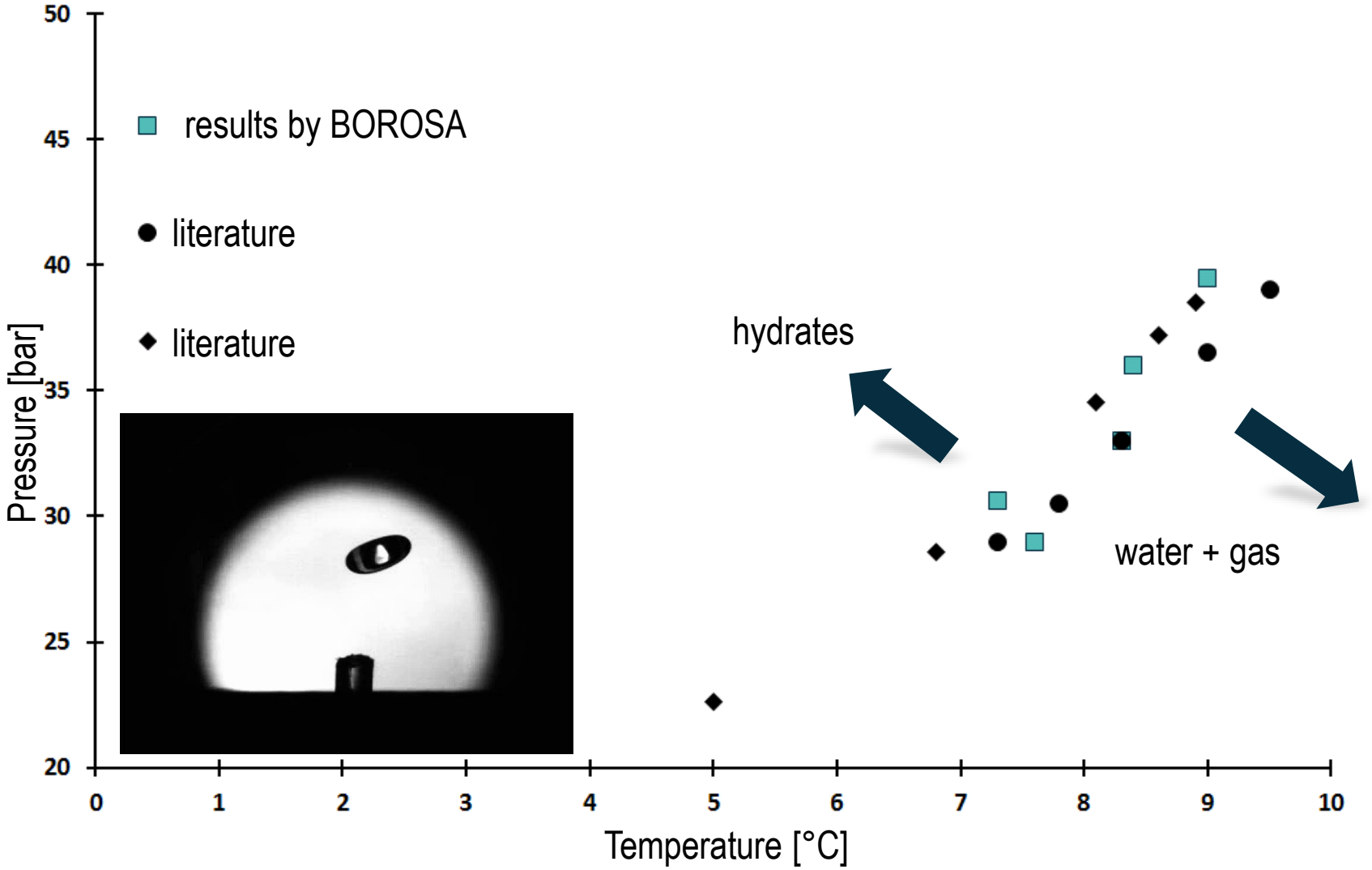


pressure: 0.1 MPa - 20 MPa

temperature: 253 K - 453 K

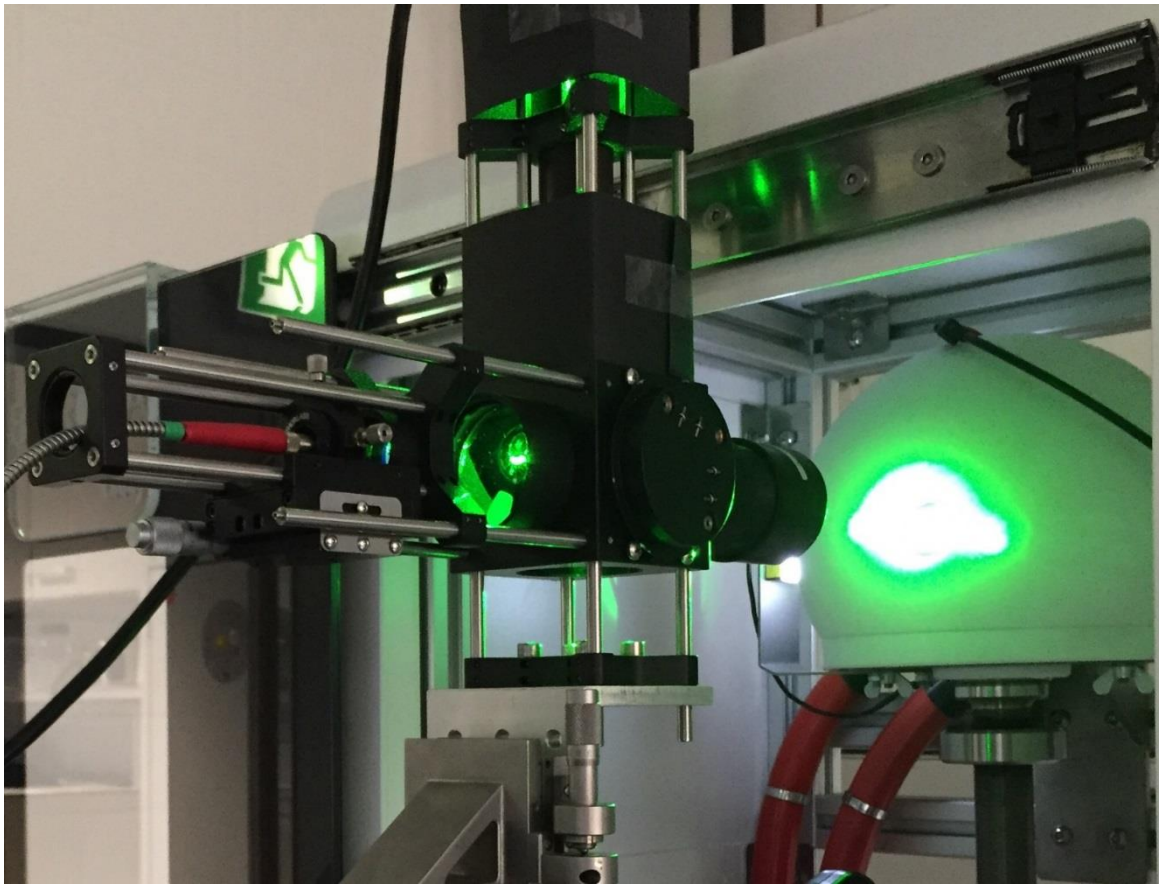
parameters are extendable!

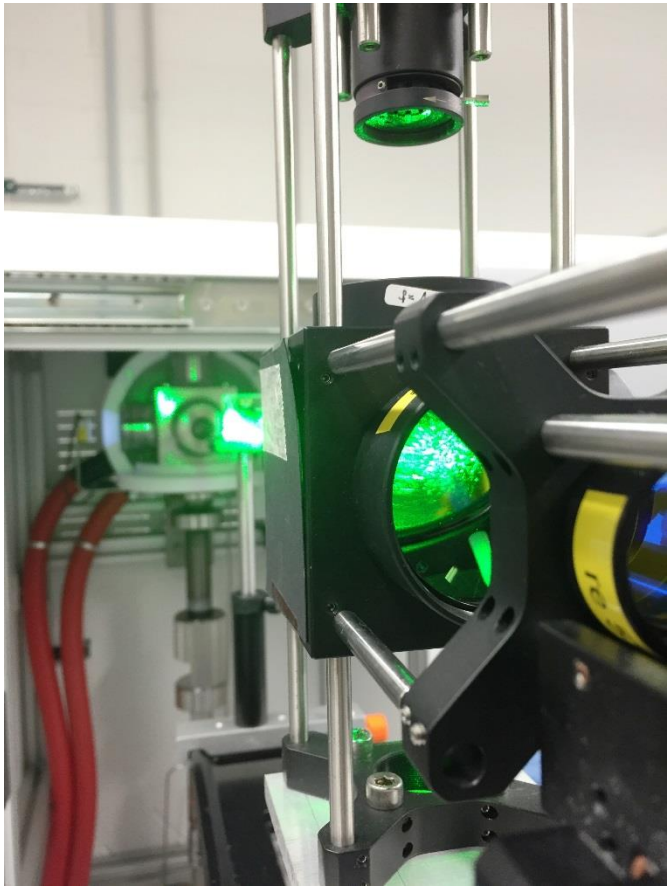
Experiments /// CO_2-Hydrate-Formation

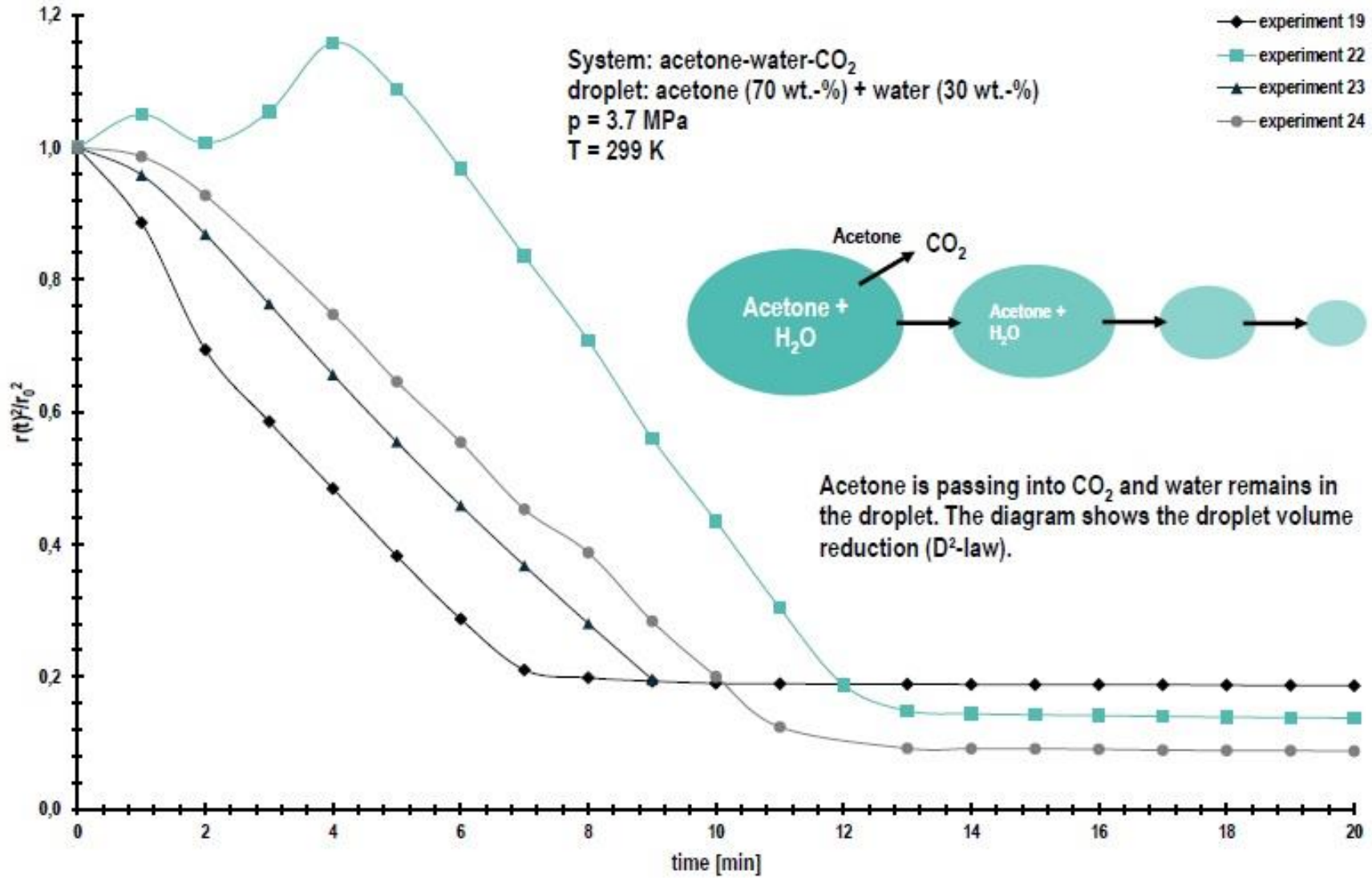


L800 meets Raman-Spectroscopy

BOROSA
ACOUSTIC LEVITATION

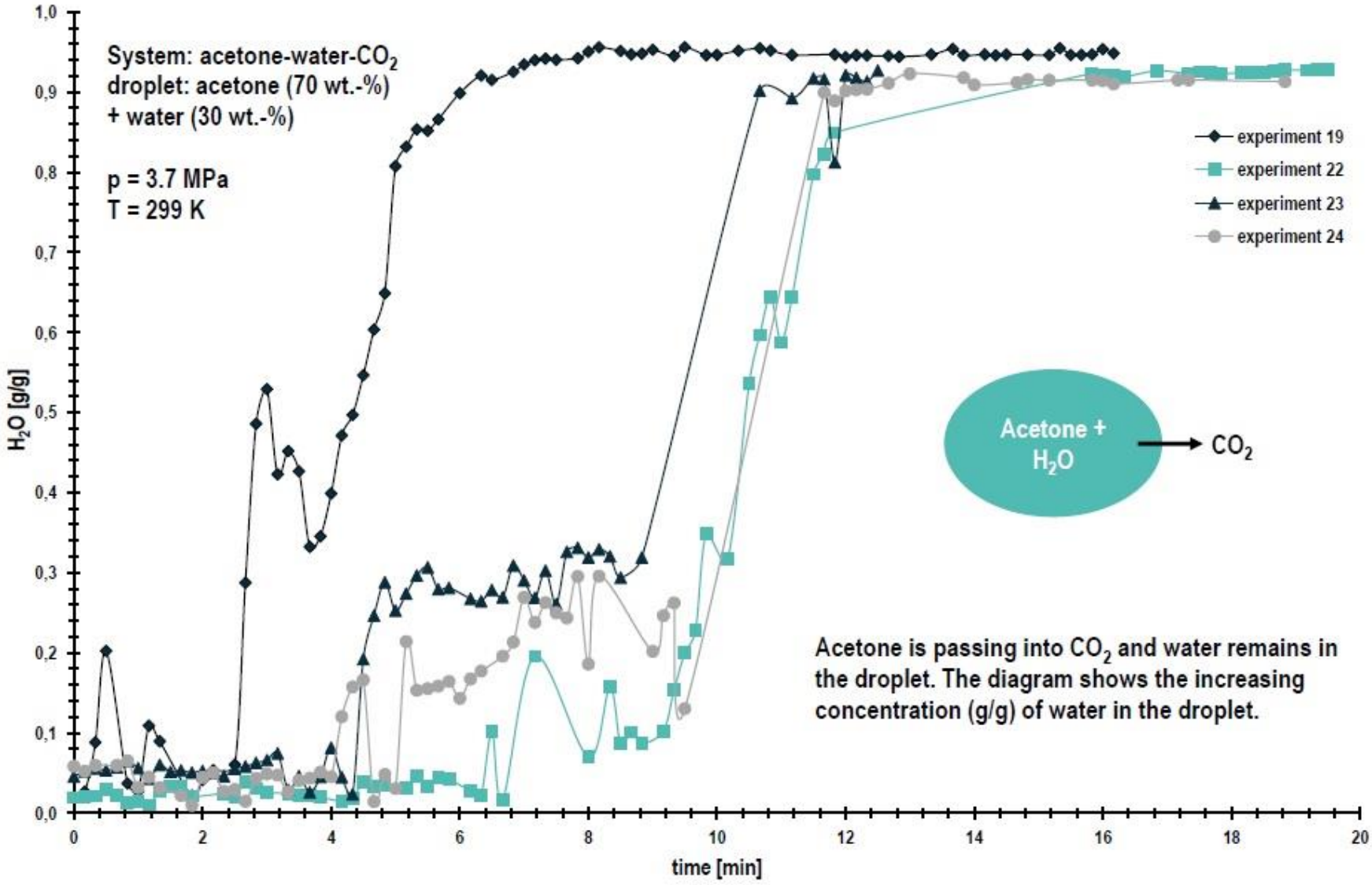




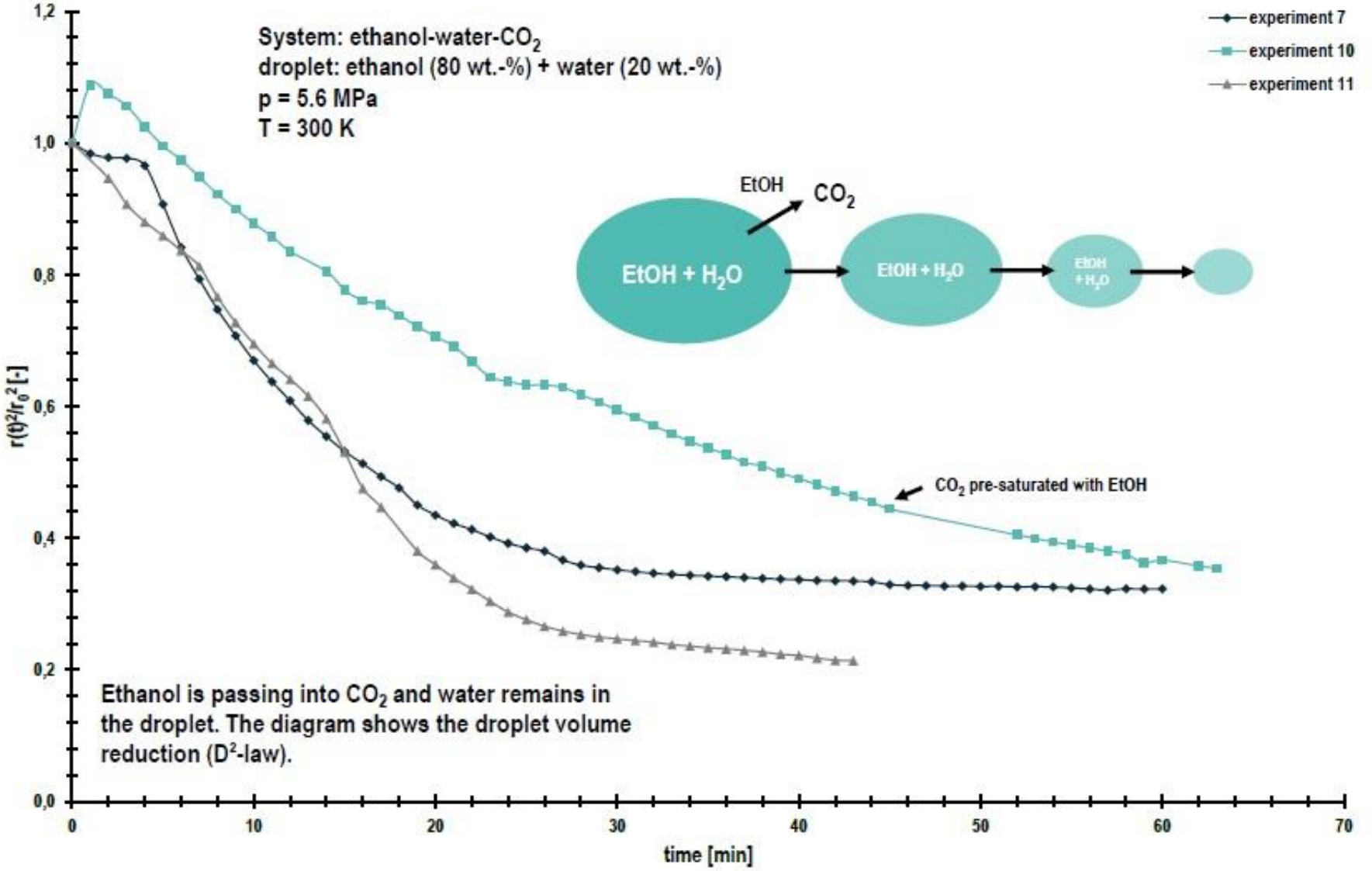

System: acetone-water-CO2
droplet: acetone (70 wt.-%) + water (30 wt.-%)
p = 3.7 MPa
T = 299 K
experiment 19
experiment 22
experiment 23
experiment 24
Acetone
CO2
Acetone + H2O
Acetone + H2O
Acetone is passing into CO2 and water remains in the droplet. The diagram shows the droplet volume reduction (D²-law).
r(t)²/r0²
time [min]
0,0
0,2
0,4
0,6
0,8
1,0
1,2
0
2
4
6
8
10
12
14
16
18
20

L800 Raman-Spectroscopy

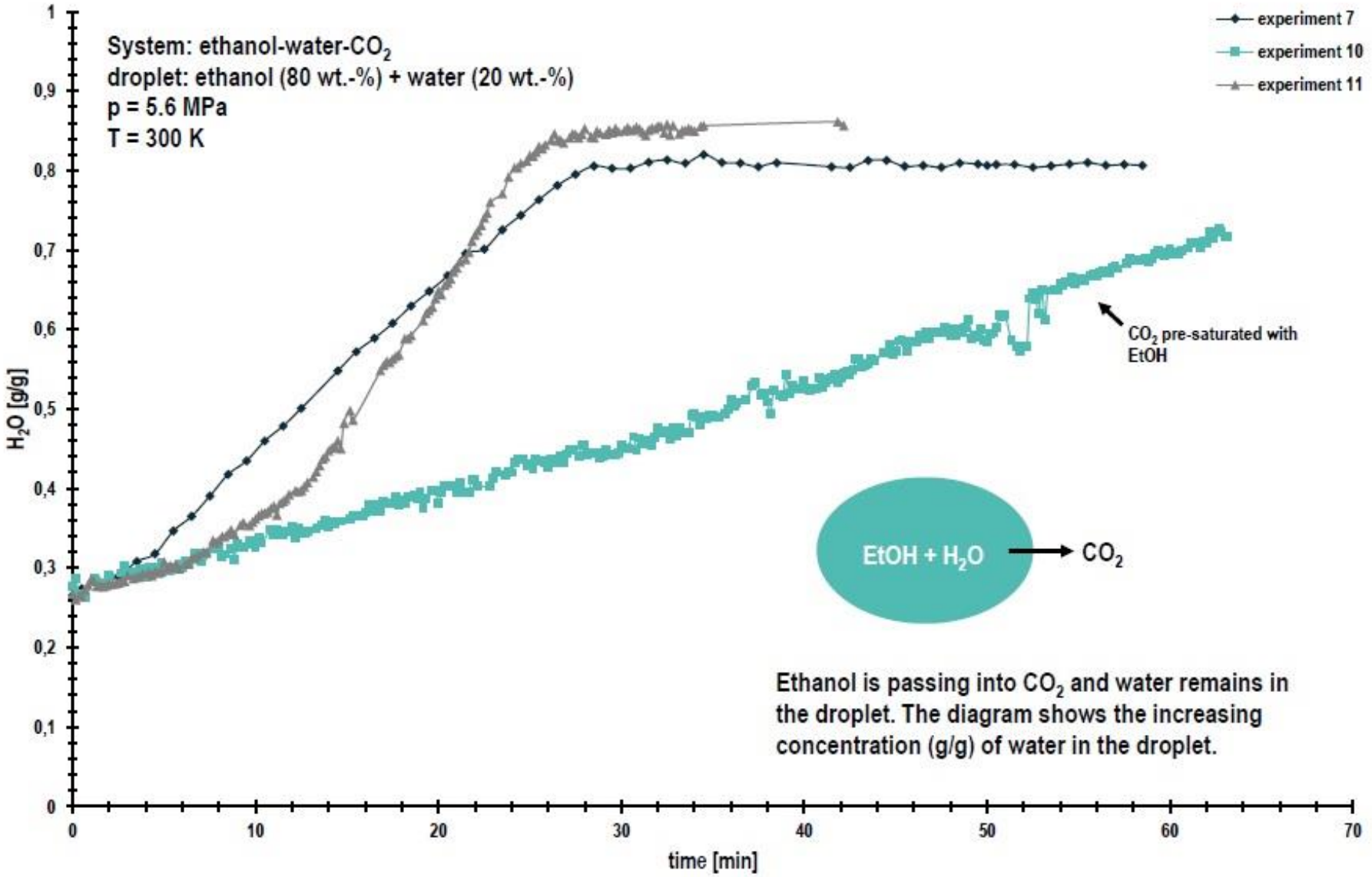
BORONSA
ACOUSTIC LEVITATION



L800 Raman-Spectroscopy

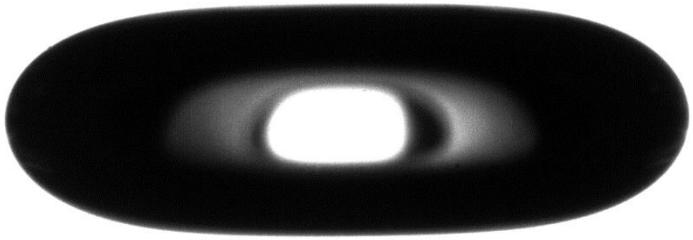


L800 Raman-Spectroscopy

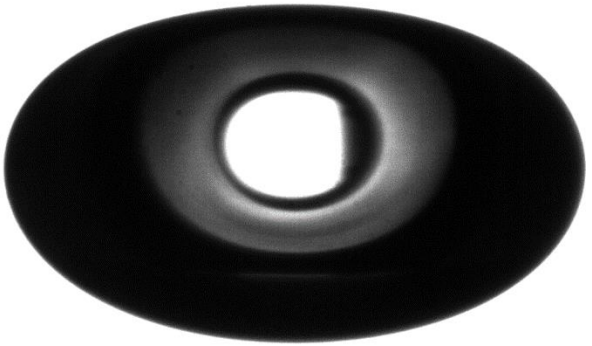


Gelation process

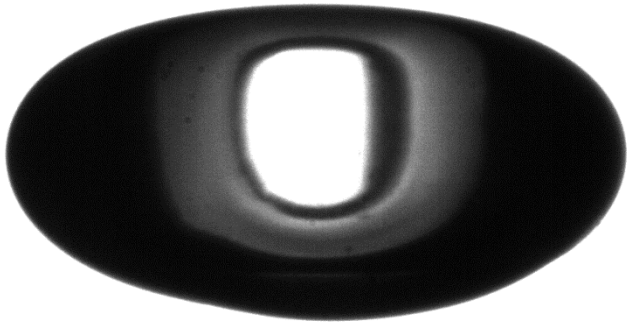
1. Start, t=0s



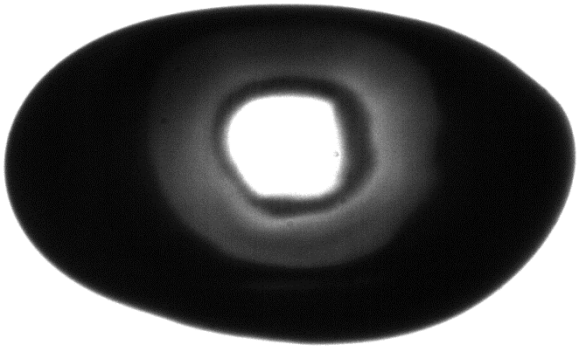
2. Evaporation of solvent



3. Droplet surface is getting rigid



4. End of gelation after 2-3 min.



silica precursor, H_2O

Methods

Interfacial tension and viscosity calculation

Ambient conditions

$$\eta_l = \frac{\tau\, \rho_l\, R^2}{5}$$

$$\sigma_l = \frac{3\,\pi\, f^2 \rho_l\, V}{8}$$

Damping constant
Liquid density
Volume
Radius volume equal sphere
Frequency

Rayleigh, Proc. R. Soc. London Vol. 29, **1879**

High pressure systems

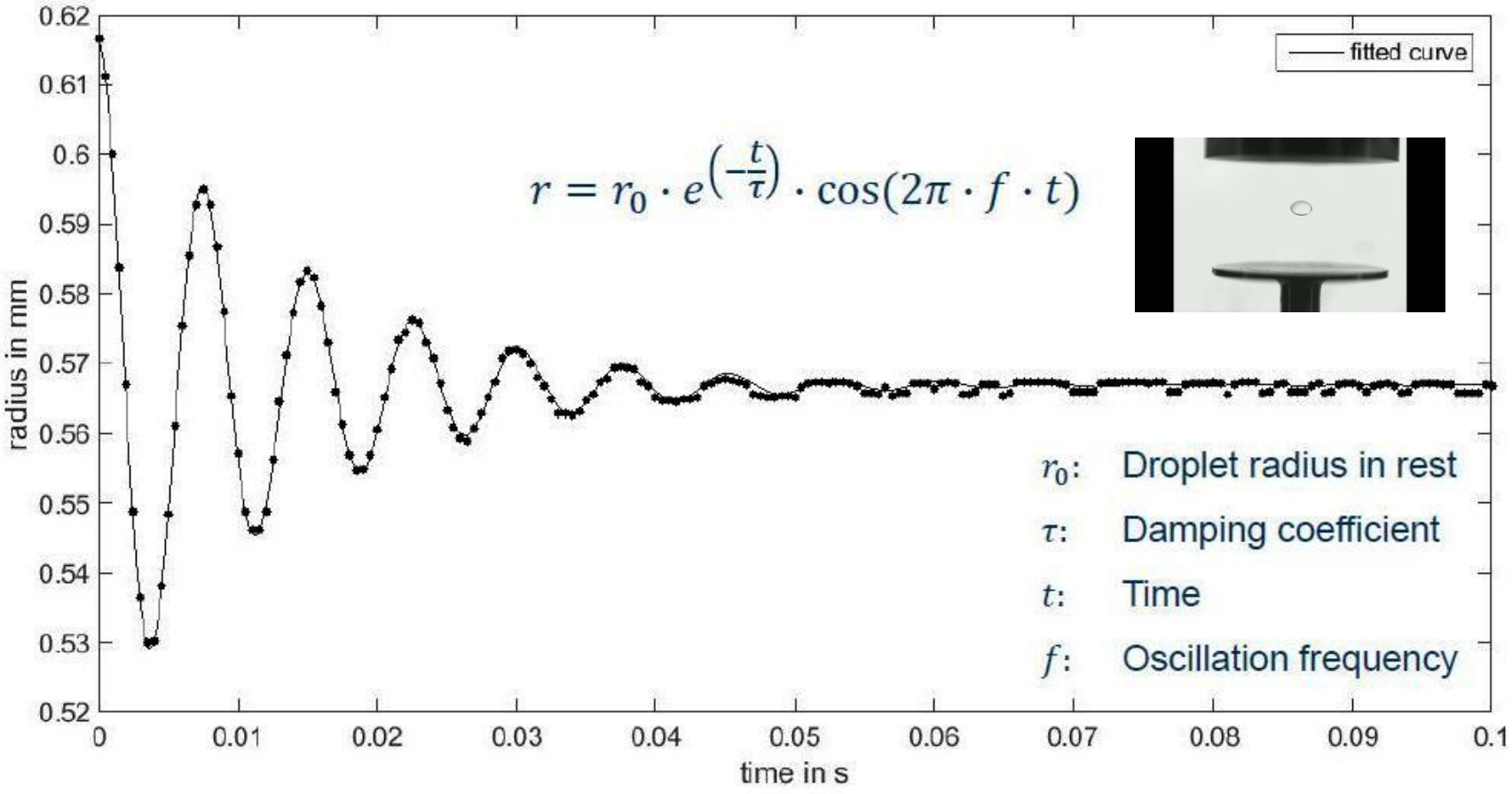
$$\eta_l = \frac{\tau\,(3\rho_l + 2\rho_{co_2})\, R^2 - 40\eta_{co_2}}{15}$$

$$\sigma_l = \frac{\pi\, f^2\,(3\rho_l + 2\rho_{co_2})\, V}{8}$$

\+
Density CO_2
Viscosity CO_2

Lamb, Hydrodynamics, Cambridge University Press, **1932**

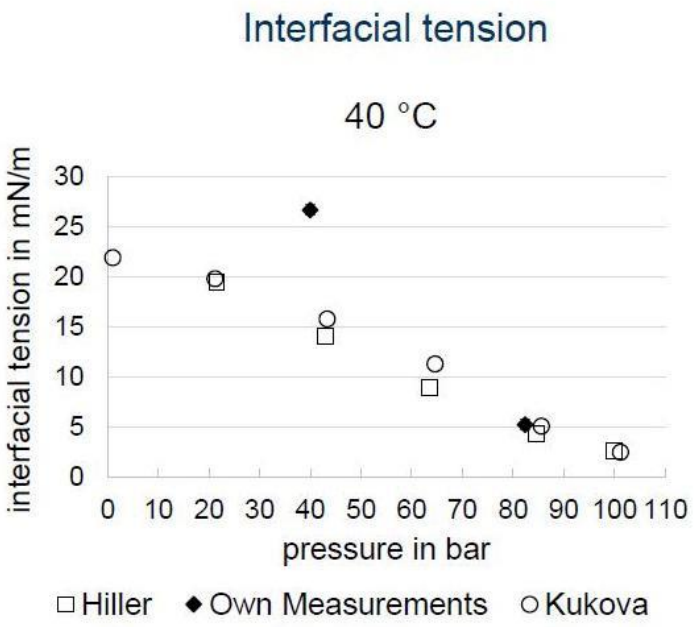
Physical Properties / preliminary studies

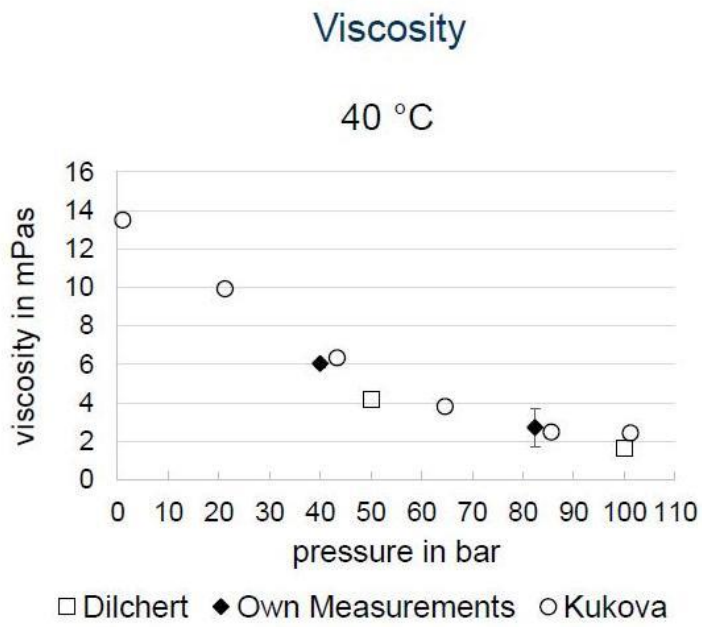


Physical Properties / preliminary studies

Results

High pressure system squalane/CO_2





Dilchert, Dissertation, University Hannover, Hannover, **1979**

Hiller, Dissertation, University Erlangen-Nürnberg, Erlangen, **1990**

Kukova, Dissertation, Ruhr-University Bochum, Bochum, **2003**

Summary

6 Measurement Options

- CO_2-Hydrate-Formation (Crystallization)
- Raman-Spectroscopy (Concentrations)
- Drying/Gelation Process (Mass Transfer)
- Physical Properties

  (Density, Viscosity, Surface Tension)

p = 200 bar

T = 180°C

INDUSTRIE PREIS 2015
KATEGORIESIEGER

BOROSA Acoustic Levitation GmbH
Technologie-Zentrum Ruhr
Universitätsstr. 142
44799 Bochum
Germany

www.borosa.de
info@borosa.de