BANDELIN
Ultraschall seit 1955

SONOPULS
Ultrasonic Homogenisers
Use and applications

Laboratory and process engineering

BANDELIN– Specialist of ultrasound in laboratory

SONOPULS ultrasonic homogenisers are in demand worldwide and a must for many laboratories.
The first SONOPULS ultrasonic homogeniser from our company was sold in 1964. Almost 60 years experience – that is what BANDELIN stands for.

Training courses for our sales partners and practice-oriented seminars with our users ensure a constant exchange of experience. In the process, new applications are constantly being developed. The constantly growing application database – a result of this cooperation– offers the new user great support in the selection of equipment.
In the further development of our homogenisers, we not only focus on today's customer needs, but also have future requirements in mind. The functionality of the units is always in the foreground.

We can react quickly to special customer requests: Development and production under one roof, short decision-making paths and proximity to the customer make this possible.

SONOPULS ultrasonic homogenisers deliver higher amplitudes with the same electrical power by optimally adapting all components. Regardless of changing conditions in the sample to be sonicated, e.g. viscosity, the amplitude remains constant. This guarantees reproducible results.

BANDELIN is the only supplier where an ultrasonic generator can be combined with ultrasonic transducers of different power. This means that an upgrade from laboratory scale to pilot plant scale does not require the purchase of a completely new unit.

All probes and booster horns are equipped with fixed threaded pins. The advantage is obvious: quick and easy assembly with the given tools – no further aids are required!

Would you like to convince yourself of the advantages of a SONOPULS ultrasonic homogeniser?
We would be happy to offer you a unit with suitable accessories for a test setting.

BANDELIN – Ultrasound since 1955

Company portrait

We are a family-owned company located in Berlin and meanwhile run in the third generation, specialised in development, manufacturing and sales of ultrasonic devices, the corresponding accessories and application-specific cleaning agents and disinfectants.

A wide vertical range of manufacture, modern production lines and a motivated staff guarantee a high quality of the products. Our devices contribute to the success of our customers in the laboratory, medical, dental, pharmaceutical, industrial, craft as well as service.

As early as 1955, our company began developing and manufacturing high-performance ultrasonic devices. The constant expansion of the product range and a sharp rise in sales led to an expansion of the production area in 1985. In 1992, ultrasonic homogenisers and controllable, power-constant ultrasonic generators were introduced to the market.
The period from 1996 to 2004 was characterised by the development and production of innovative ultrasonic baths and immersible transducers as well as tube reactors for industrial applications. In the following years, BANDELIN's product range was expanded by new laboratory ultrasonic devices.

After the introduction of the ultrasonic bath for simultaneous cleaning and rinsing of MIC instruments, a further development was launched in 2016 for robotic instruments.

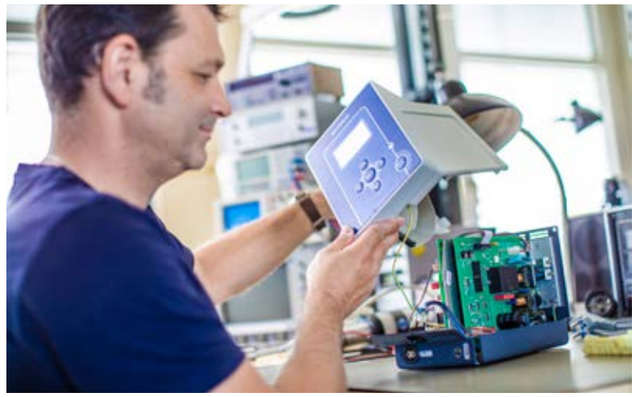
Today, the reputation of our brands SONOREX, SONOPULS, SONOMIC and TRISON stand for the high quality awareness of our employees and is equated in expert circles with ultrasound.

The most important product groups include:

SONOREX	– ultrasonic baths and reactors
SONOPULS	– ultrasonic homogenisers
SONOMIC	– ultrasonic baths for rinsable MIC and standard instruments
TRISON	– ultrasonic baths for robotic-, rinsable MIS and standard instruments
TICKOPUR	– cleaning agents
STAMMOPUR	– cleaning agents and disinfectants

We are innovation leaders in the development of ultrasonic devices and new areas of application. In the past we have registered 79 patents / utility models as well as 68 trade brands. Our participation in various committees in the development of new standards and guidelines serve to ensure the highest standards for ultrasonic applications.

As the only complete supplier of ultrasonic devices, accessories, disinfectants and cleaning agents with approvals and certifications according to DIN EN ISO 9001 and DIN EN ISO 13485, BANDELIN is the market leader. Over one million units have already been delivered to our customers.



Take a look at our Company Portrait Laboratory!

More useful videos on **youtube.com/bandelin**

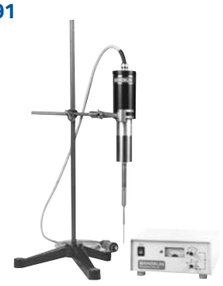
1964

SONOREX HE 1
Production of the first ultrasonic homogenisers with tube technology

1986

SONOPULS SD 9

1991



SONOPULS Series HD 70/200/400

1999

SONOPULS Series HD 2000

2004

SONOPULS Series HD 3000

2016

SONOPULS Series HD 4000

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Ultrasound in the laboratory and in process engineering

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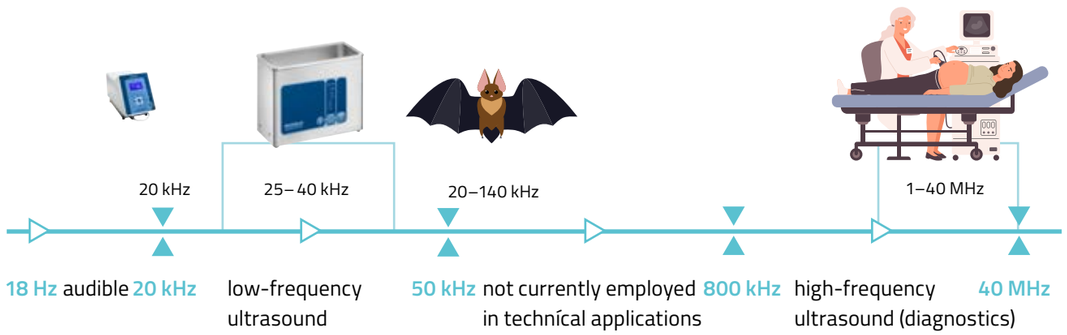
What is ultrasound? How does it work?



What is ultrasound and how does it work?

Oscillations with frequencies above 18 kHz (18,000 oscillations per second) are referred to as ultrasound. Low-frequency ultrasound is used in laboratories whilst a higher frequency range is used for medical diagnostics.

The low-frequency ultrasonic oscillations result in the generation of millions of tiny vacuum bubbles in all liquids, which then implode immediately generating highly effective pressure surges. This process is called cavitation. Low frequencies of around 20 kHz create bubbles with larger diameters and more intensive pressure surges than compared with frequencies of around 35 kHz. Low-frequency ultrasound has been used in a wide range of ultrasound baths for decades.

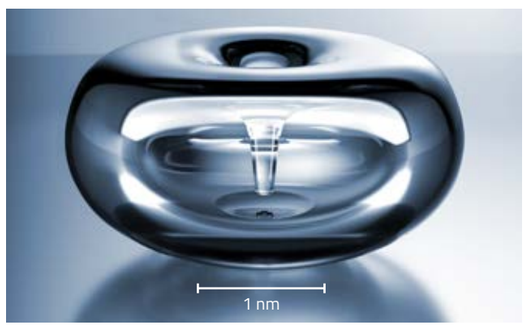
The cavitation process effectively and gently removes residual dirt from the surfaces of components immersed in the fluid as well as out of recesses and holes. Other applications include the degassing and mixing of liquids.

Cleaning with SONOREX ultrasonic bath from BANDELIN

and more useful videos on **youtube.com/bandelin**

Cavitation

Ultrasound creates an intensive pressure-pull change in aqueous liquids, resulting in very fine cavitation bubbles that grow over several cycles and then implode intensively. The resulting high shear forces and microjets of the implosions blast off all adhering contamination from the surface in a short time.



Cavitation bubble

Ultrasonic homogeniser versus Ultrasonic bath

Compared to the very widespread ultrasonic baths, the so-called ultrasonic homogenisers can be used to a much higher power density can be applied in the liquid. The sonic power is emitted into the liquid via the working tip (sonotrode). The oscillation of the sonotrode creates the described millions of tiny vacuum bubbles at the tip, which implode again very quickly, triggering pressure surges of more than 1000 bar, which lead to the dissolving of particles or mixing of solution components.

The following table illustrates the differences between ultrasonic homogenisers and baths.

	SONOPULS Ultrasonic homogeniser	SONOREX Ultrasonic bath
Volume of sample	0.1–3000 ml	ca. 10–3000 ml (in case of indirect sonication)
Amplitude [µm]	max. 280 (peak to peak)	ca. 4
Intensity [W/l]	ca. 790 (for indirect sonication)	up to 50
Frequency [kHz]	20	35/40
Sonic distribution	focused	broad
External input due to cavitation erosion	low ablation at the probe tip with direct sonication, traces of smallest titanium particles (TiAl6V4) in the sample (in case of indirect soication: no particle intrusion into the sample)	low

Compared to ultrasonic baths, ultrasonic homogenisers can be used to perform difficult processes such as production of stable emulsions, digestion of cells, acceleration of chemical processes, or extraction of substances, as these devices deliver highly concentrated, extremely high energy densities. The sound energy emitted can be regulated in a controlled manner. This makes it possible to break down certain components of the medium and leave others undamaged. The amplitude is continuously recorded and shown on the display. This makes the results easily reproducible.

Quick start –
for use of the device in laboratory

The following pages cover the methods themselves and their most diverse application options in detail, to provide a good understanding of them.
Here you will find the most important steps for a very quick start with the SONOPULS.

1

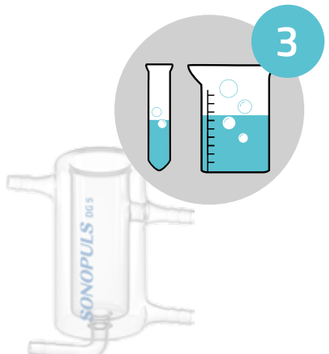
Selection of the probe that is suited to the application
The selection of the probe is primarily based on the sonication volume and the size and shape of the sample vessel.

2

Structure of an ultrasonic homogeniser
Mounting according to the instructions for use

3

Vessel selection
Narrow, taller vessels are generally better suited than wider, shallower vessels with the same volume.
The vessel should not be filled more than 2/3 with liquid (risk of splashing).
A laboratory pump and/or an external cooling system must be on hand for flow-through vessels.



4

Overview of detailed applications with information on all the details regarding use
The applications provide information on the selection of sonication parameters for special uses.

5

Selection of sonication parameters
The choice of sonication parameters depends on the sample and the process applied.
The amplitude, pulsation and process time can be set on the ultrasonic generator.
The sample temperature can be monitored with an optional temperature sensor.

6

Further notes for application
Tips and tricks
- Fixation of the ultrasonic converter
- Immersion depth of the probe
- Sonication of chunky sample material in a liquid

Use our noise protection box LS 40 for a significant reduction of noise during application.
Find out more at www.sonopuls.info or contact us!

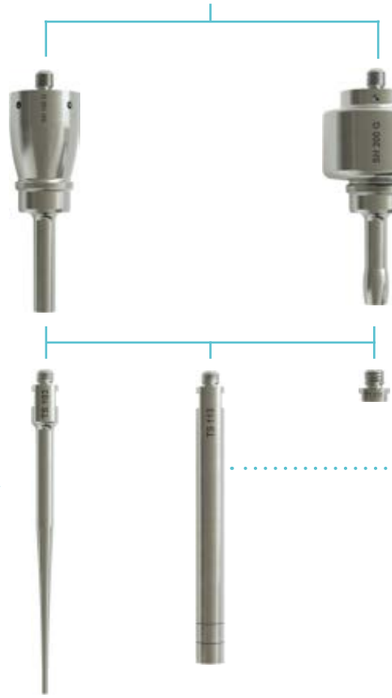
Video of the noise protection box and other useful videos on **youtube.com/bandelin**

Structure of an Ultrasonic homogeniser

Ultrasonic homogenisers are employed for a wide range of tasks in laboratories every day and the variety of devices on offer is just as varied.
A sound understanding of the basic structure of the homogenisers and the resulting application-specific selection of the individual components forms the basis for a successful application.

An ultrasonic homogeniser consists of:

- Ultrasonic generator
- Ultrasonic converter
- Standard or booster horn
- Probe



Ultrasonic generator

Conversion of inputted low-frequency mains energy of 50/60 Hz into high-frequency voltage of 20 kHz.
All process parameters and sequences are displayed on the generous touch display.

Ultrasonic converter

Conversion of the electrical voltage supplied by the generator into mechanical oscillations in the same frequency.

Standard and booster horns

Are resonance bodies made of a high-strength titanium alloy tuned to the frequency of 20 kHz and amplify the amplitudes of the mechanical vibrations coming from the ultrasonic transducer.
The amplification factor of the amplitude depends on their geometry.

Probes

They transmit the mechanical oscillations to the sample. The oscillations are only emitted from the tip, not the sides. A high amplitude means particularly intensive sonication. The design of some probes allows them to generate multiple amplitude intensifications. Consequently, the probes attain the highest ultrasonic power densities in liquids.

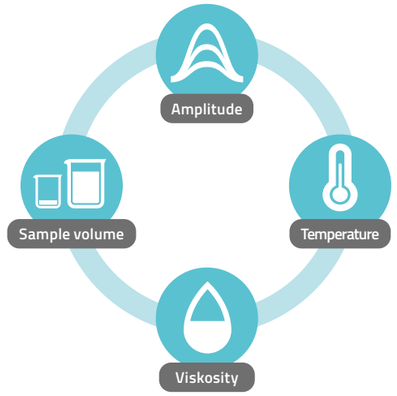
Factors for the reproducibility of ultrasound sonication results

Understanding of the terms „power“ and „amplitude“

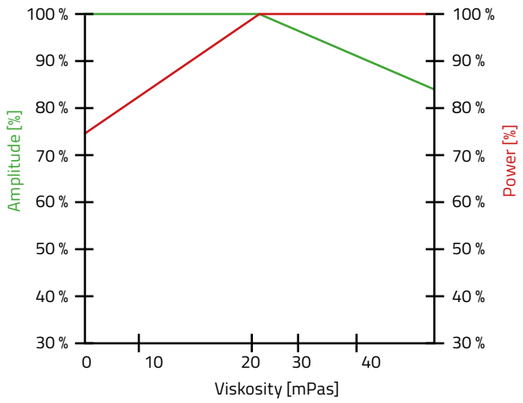
The electrical power rating [W] is not the only decisive factor in the selection of an ultrasonic homogeniser. This value indicates the power consumption of the ultrasonic generator, but not the power applied to the sample. The amplitude (longitudinal motion) of the probe in relation to the sample quantity is the decisive factor for the efficiency and reproducibility of the sonication result.
SONOPULS ultrasonic homogenisers deliver higher amplitudes than customary market devices, with the same electrical power consumption.
Amplitude and intensity are directly related; a low amplitude means a low intensity. In order for the sonication results to be reproducible, the amplitude, temperature, viscosity and volume of the sample, among other things, must always be the same. The power of the generator is not the decisive parameter here. The power relates in a variable ratio to the amplitude/intensity. A lower power is required for sonication of water for the same amplitude than for sonication of highly viscous samples.

At a viscosity below 20 mPas, the generator changes the power to keep the amplitude constant. At higher viscosities, the generator reaches the power limit, cannot apply any further power, and this reduces the amplitude.

Factors for the reproducibility of ultrasound sonication results

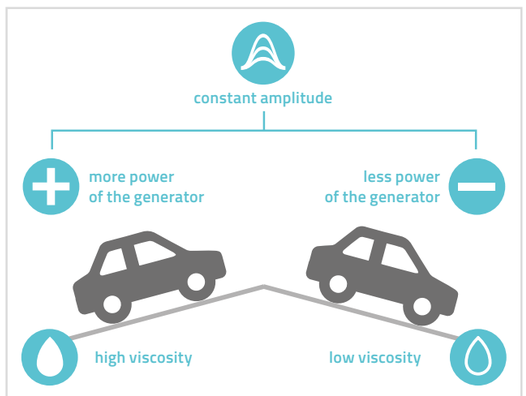


Amplitude and power as a function of viscosity



Example

The higher the viscosity of the medium to be sonicated, the more power is required to reach the same amplitude! This can be compared to the speed of a car: Objective: 40 km/h (= amplitude), more power is required to maintain this speed when driving uphill.



Measurement of power

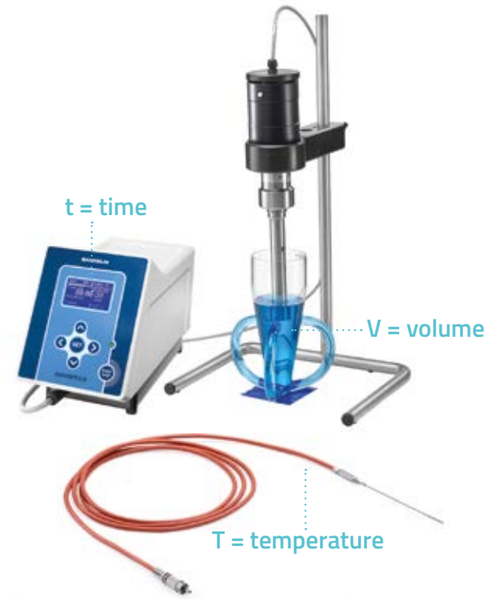
When describing test designs, power is specified as power density in W/cm2, in relation to the sound-emitting surface of the probe.
When determining this measurement, the mains intake of the ultrasonic homogeniser is often regarded as the basis. The losses, which could be significant in the generator and all the way to the probe, are disregarded.
The specification of electrical area power density using the power input and the probe radiation surface is therefore only a rough estimate.
At the 2nd Meeting of the European Society of Sonochemistry (ESS) in September 1991, the principle of calorimetric measurement of power was presented as a suitable process by Rotoarinoro et al. , under the title „Power dissipation measurements in sonochemical reactors“.
In order to determine the applied power, the vessel, ideally a Dewar vessel or another vessel used in everyday laboratory practice, should act as a test vessel. This vessel is filled with water. The water is sonicated and the temperature increase is measured for a defined period of time. In the calorimetric measurement, the heat quantity ΔQ can be determined using the heat capacity C and the temperature difference ΔT.
This results in the applied power, taking into account the time difference Δt.
Here, the following formula2 applies:

$$P = \frac{\Delta Q}{\Delta t} = \frac{c \cdot m \cdot \Delta T}{\Delta t}$$

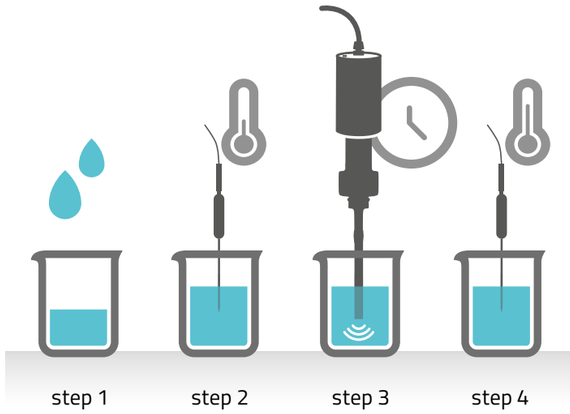
The following applies:

P	power [W]
ΔQ	supplied energy, in this case the amount of heat [Ws]
Δt	time [s]
ΔT	temperature difference [K]
m	test water mass [kg]
c	specific heat capacity $[\frac{J}{kg\,K}]$

The volumetric power density can be calculated taking into account the water volume.



Representation of the experimental set-up of a calorimetric measurement for power determination



Homogenisers are not controlled under constant electrical output! SONOPULS ultrasonic homogenisers are controlled by the AMPLICHRON circuitry at a constant probe amplitude.
When conducting a reaction and reproducing it, the constancy of the amplitude is of special importance. All effects resulting from warming of the probe or changes in viscosity are thus eliminated. This means that the measurement of power must be performed in accordance with the described procedures to obtain reproducible results, always using identical liquids and the same starting temperatures.

1 Rotoarinoro, A., M. Wilhelm, J. Berlan, H. Delmas: „Power dissipation measurements in sonochemical reactors“, in: Bericht zum 2. Symposium des ESS; 1991; Seite 109 f.
2 Notice: The formula is only sufficiently accurate for small volumes.

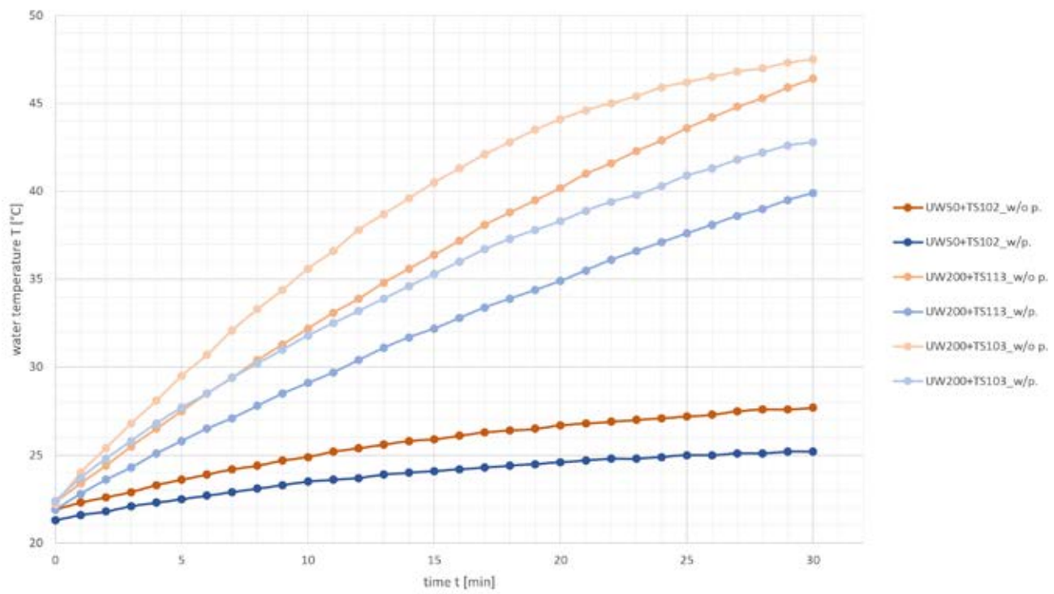
The AMPLICHRON procedure

The AMPLICHRON procedure developed by BANDELIN guarantees a constant amplitude and supports reproducible results, independent of changing conditions in the sample to be sonicated. The relative amplitude in per cent is specified for BANDELIN devices and shown on the display. If the actual value of the amplitude does not conform to that of the set value, e.g. due to probe wear (see chapter 3) or the viscosity of the medium being too high, this is easily identifiable and allows for conclusions to be drawn regarding the reproducibility of the results!

Pulsation

All SONOPULS ultrasonic homogenisers have a pulse function. This enables the total sonication time to be divided into active sonication times and rest periods. This intermittent process limits the temperature increase of heat-sensitive samples. This is particularly important for the sonification of very small quantities or resistant microorganisms with long sonification times.

Temperature rise at 20% relative amplitude sonication with (w/p.; EIN: 60 s, AUS: 20 s) and without (w/o p.) pulsation



The SONOPULS
Ultrasonic homogeniser

02

SONOPULS Product overview

The right homogeniser with matching accessories for every task.

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SONOPULS Series HD 4000

Ultrasonic homogenisers HD 4050, 4100, 4200 and 4400

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SONOPULS Series HD 4000 Ultrasonic generator

Explanation of the ultrasound generator and its operation.

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SONOPULS Series HD 4000 Ultrasonic converter

Presentation of the various Ultrasonic converter.

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SONOPULS Standard and booster horns

Overview of the different standard and booster horns.

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The most important areas of application and features.

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SONOPULS – Probes

Overview of the different probes with the most important key facts.

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Sonocation vessels for direct and indirect sonication

Different types with and without cooling as well as practical accessories.

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SONOPULS HD 4000 – Graphic: devices and accessories

Schematic overviews of all possible combinations of devices and accessories.

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Stand, Sound proof box, Temperature sensor and Foot switch

Work more comfortably with the right accessories.

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LABOCOOL LC 200 Recirculating chiller

Effective cooling during probes sonication with the SONOPULS Ultrasonic homogeniser.

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SONOPULS Product overview

The optimum equipment can be put together for the respective application due to the large variety of devices and accessories:

- Selection of the SONOPULS serie
- Typee of probe
- Direct or indirect sonication
- Sonication of larger volumes in flow-through
- Cooling during sonication

Even after purchasing a unit for a single initial application, there are many possibilities for adapting it to further applications by purchasing various accessories at a later date.

	Series HD 4000
Sample volumes in the – batch operation – flow-trough operation	0.5–3000 ml up to 100 l / h
Possible probes Ø [mm]	2 / 3 / 4.5 / 6 / 9 / 12.7 / 16 / 19 / 25 / 32 / 38
Possible configurations: Ultrasonic generator GM, Ultrasonic converter UW	GM 4200 + UW 200 or UW 100 or UW 50 GM 4400 + UW 400 or UW 200
Relative amplitude	10–100 % (adjustment range depending on sample type)
Automatic amplitude limitation	after entry the sample type on the generator
Pulsation	working intervals 0.2–600 s resting intervals 0.3–600 s
Time setting	9 h 59 min 59 s or continuous operation
Display elements	alphanumeric LC display
Power display	in kJ
Temperature display and measurement	optional, -10 to 120 °C temperatur sensor required, optional acoustic signal or switch off
Batch operation Sequencing	✓ several batches in sequence
Remote control	RS 232 (Sub-D)
Error diagnosis	✓
Operating frequency	20 kHz
Data memory	9
Functional check	✓
Mains connection	230 V~ (±10 %), alternative 115 ~ (±10 %), 50/60 Hz (außer HD 4400)

SONOPULS series HD 4000
Ultrasonic homogenisers

SONOPULS HD 4050

for volumes 0,5–100 ml
(depending on the probe)

- Deliverable probes Ø:
  2 / 3 / 4.5 / 6 / 9 mm

Ready-to-use set:

Ultrasonic nominal power max. 50 W

- Ultrasonic generator GM 4200
- Ultrasonic converter UW 50
- Probe TS 102, Ø 2 mm
  (for Volumina 0.5–20 ml)

Code No.
4050 – EU plug CEE 7/7
4050-GB – GB plug BS 1363
4050-CH – CH plug SEV 1011: T12
4050-1 – US plug NEMA 5-15

SONOPULS HD 4100

for volumes 2–200 ml
(depending on the probe)

- Deliverable probes Ø:
  2 / 3 / 4,5 / 6 / 9 / 13 mm

Ready-to-use set:

Ultrasonic nominal power max. 100 W

- Ultrasonic generator GM 4200
- Ultrasonic converter UW 100
- Standard horn SH 100 G
- Probe TS 103, Ø 3 mm
  (for volumes 3–50 ml)

Code No.
4100 – EU plug CEE 7/7
4100-GB – GB plug BS 1363
4100-CH – CH plug SEV 1011: T12
4100-1 – US plug NEMA 5-15

SONOPULS HD 4200

for volumes 5–1000 ml
(depending on the probe)

- Deliverable probes Ø:
  3 / 4.5 / 6 / 9 / 13 / 16 / 19 / 25 mm

Ready-to-use set:

Ultrasonic nominal power max. 200 W

- Ultrasonic generator GM 4200
- Ultrasonic converter UW 200
- Booster horn SH 200 G
- Titan flat tip TT 213, Ø 13 mm
  (for volumes 20–900 ml)

Code No.
4200 – EU plug CEE 7/7
4200-GB – GB plug BS 1363
4200-CH – CH plug SEV 1011: T12
4200-1 – US plug NEMA 5-15

SONOPULS HD 4400

for volumes 100–3000 ml
(depending on the probe)

- Deliverable probes Ø:
  13 / 16 / 19 / 25 / 32 / 38 mm

Ready-to-use set:

Ultrasonic nominal power max. 400 W

- Ultrasonic generator GM 4400
- Ultrasonic converter UW 400
- Booster horn SH 400 G
- Probe TS 425, Ø 25 mm
  (for volumes 500–2000 ml)

Code No.
4400 – EU plug CEE 7/7
4400-GB – GB plug BS 1363
4400-CH – CH plug SEV 1011: T12

SONOPULS series HD 4000
Ultrasonic generator

The ultrasonic generator transforms the mains energy input (mains frequency of 50 or 60 Hz) into high-frequency energy with a frequency of 20 kHz.
It is housed in an easy-care and robust plastic housing with connections for an ultrasonic converter, temperature sensor and foot switch.

The convenient control and display panel with back-lit LC display shows operating parameters and status information.
The ultrasound operating modes are either pulsation or continuous. The ultrasonic power is set via amplitude on the generator. The nine data memory spaces are used to quickly start recurring processes.

Ultrasonic generator GM 4200

Suitable for:
- HD 4050
- HD 4100
- HD 4200

External dimensions (l × w × d):
335 × 150 × 230 mm

Performance range:
30–150 W

Code No. 3711

Ultrasonic generator GM 4400

Suitable for:
- HD 4200
- HD 4400

External dimensions (l × w × d):
335 × 150 × 230 mm

Performance range:
60–300 W

Code No. 3715

Front side

Back side

Ultrasonic converter

An ultrasonic converter is used to convert the electrical energy supplied by the ultrasonic generator into mechanical vibrations.
All SONOPULS ultrasonic converters in the 4000 series work with an ultrasonic frequency of 20 kHz.

Ultrasound operation can be started and stopped by pressing the „START/STOP“ button on the generator or via the button on the ultrasonic converter. The Ultrasound operation is active as long as the button is pressed. The button can be used to pulse manually.

Ultrasonic converter UW 50

Suitable for:
GM 4200

Dimension:
Ø 50 × 190 mm

Cable length:
2.5 m

Code No. 3720

Ultrasonic converter UW 100

Suitable for:
GM 4200

Dimension:
Ø 70 × 170 mm

Cable length:
2.5 m

Code No. 3721

Ultrasonic converter UW 200

Suitable for:
GM 4200 / 4400

Dimension:
Ø 70 × 170 mm

Cable length:
2.5 m

Code No. 3722

Ultrasonic converter UW 400

Suitable for:
GM 4400

Dimension:
Ø 90 × 180 mm

Cable length:
2.5 m

Code No. 3723

SONOPULS
Standard and booster horns for series HD 4000

Standard and booster horns are made of a titanium alloy (TiAl6V4) in various shapes and sizes. They transmit the vibrations from the ultrasonic converter to the sample and increase the amplitude. The corresponding horn is firmly screwed to the ultrasonic converter.
All standard and booster horns are equipped with a fixed threaded spigot. This enables quick and easy mounting to the ultrasonic converter using the appropriate tool without any other aids.

Horns SH for adapting replaceable probes; horns TH have a fix peak.
With external thread for connection of different vessels by the use of a sleeve adapter.
Reaction vessels with flange DN 20 can be mounted tightly with the flange adapter FA.

Horns for replaceable samples

Standard and booster horns SH offer the possibility to connect samples with different diameters.

	Standard horns	Booster horns	
Type	SH 100 G	SH 200 G	SH 400 G
For UW	100	200	400
Code No.	3731	3732	3734

Horns with a fix tip

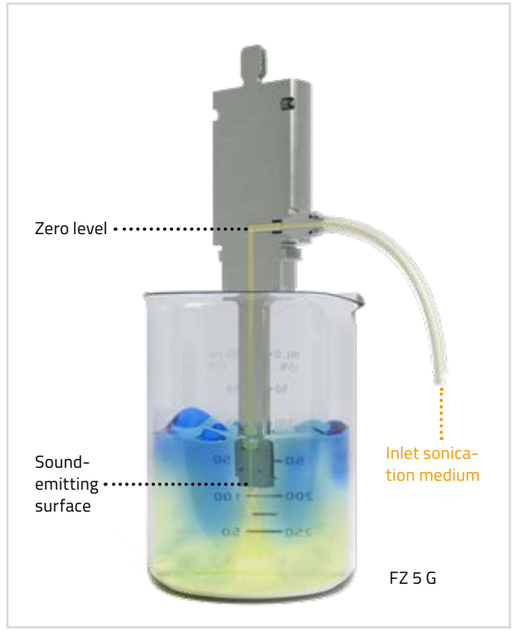
When sonicating probes in screw-on flow-trough cells, e.g. DG 4 G, use only the titanium flat tip, but not a long sample. If the sonication medium is a suspension, the medium can penetrate the screw connection titanium flat tip/horn – regardless of how tight the connection is. This leads to an overload of the generator and thus to equipment failure. To prevent the medium from penetrating, we recommend horns with a fixed working tip.

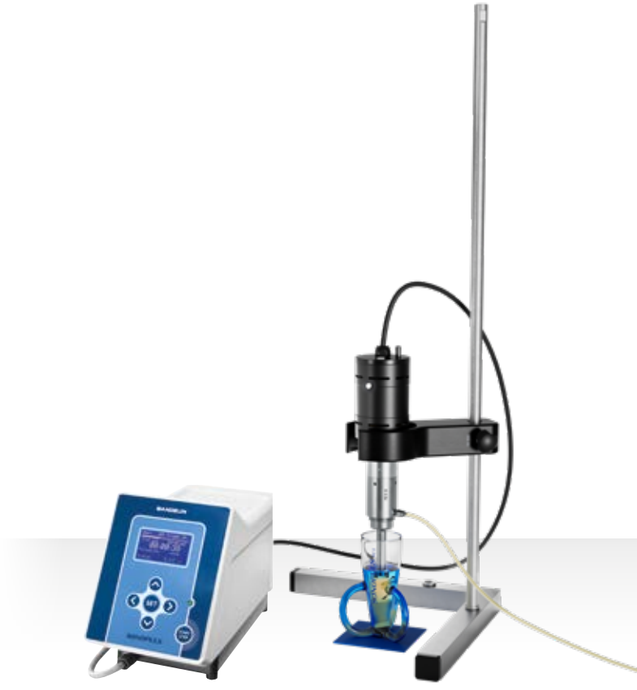
	Standard horns	Booster horns	
Type	TH 100 G	TH 200 G	TH 400 G
For UW	100	200	400
Code No.	3968	3969	3970

Flow-trough horn FZ

The premixed media are directed into the vibration-free zero plane of the flow-through horn and downwards through the channel inside to the sound-emitting surface. In the titanium flat tip, the media are subjected to the ultrasonic effect and directed into the sample vessel via the opening in the titanium flat tip.

	Flow-trough standard horn	Flow-trough booster horn
Type	FZ 5 G	FZ 7 G
For UW	100	200
Code No.	490	452





Merging of two media with the flow-trough vessel DG and the flow-trough horn FZ

Instead of a standard or booster horn, a flow-trough horn FZ is used. The first medium is fed into the sonication chamber via the inlet of the flow-trough vessel DG 4 G, the second medium via the inlet of the flow-trough horn FZ. This medium enters the sonication chamber of the DG via the opening in the sound-emitting surface of the titanium flat tip.
This way, both media can be mixed well.

The degree of sonication is determined by the amplitude at the ultrasonic generator and by the flow-trough rate of the pump. The flow-through vessel DG is equipped with a cooling jacket to prevent excessive heating, e.g. if the medium remains in the sonication chamber for a longer period of time.

Sleeve adapter NA

Vessels with the standard ground joints NS 29/32 or NS 45/40 are often used for chemical reactions in laboratories.
They are screwed onto the external threads of standard, booster or flow-through horns and inserted into a vessel with standard ground joint.

Seal ring
Material: EPDM
Hardness: 70 Shore A

Type	NA 29 G	NA 45 G
For	▪ NS 29 / 32 ▪ SH 100 G / SH 200 G ▪ TH 100 G / TH 200 G ▪ FZ 5 G / FZ 7 G with probes, Ø max. 13 mm	▪ NS 45 / 40 ▪ SH 100 G / SH 200 G / SH 400 G ▪ TH 100 G / TH 200 G / TH 400 G ▪ FZ 5 G / FZ 7 G with probes, Ø max. 25 mm
Material	PTFE	PTFE
Code No.	540	487

Flange adapter FA 3 G

With the flange adapter FA 3 G, reaction vessels with flange DN 20 can be mounted on standard or booster horns with external thread and connected samples of Ø 2-25 mm. The vibration-free coupling is achieved by the flat sealing flange, the seal ring encloses the standard or booster horn.
The sample must only be immersed about 1.5-2 cm into the medium to be sonicated. The energy loss is considerable if it is immersed too deeply.

Type	FA 3 G
For	SH 100 G / SH 200 G / SH 400 G
Compatible with	probes, Ø 2–25 mm
Material	stainless steel 1.4571
Mounting holes	4 pcs. M 10 (DIN 2573)
Code No.	474

Seal ring
Material: EPDM
Hardness: 70 Shore A

Selection and use of the probes

The probes are thermally stable, autoclavable and resistant to practically all corrosive media. They are produced from a titanium alloy (TiAl6V4 / 3.7165).

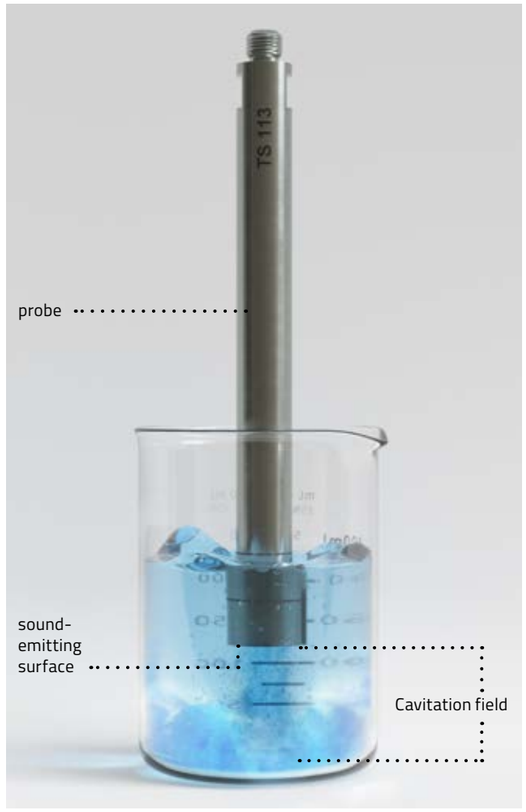
The selection of the probe depends on several factors: the desired power density, the sonication volume, the shape and size of the sonication vessel, the amplitude and the temperature sensitivity of the sample. It should be noted that the sound-emitting surface is only at the probe tip and not at the sides.
Depending on the application and the requirements of the process, some or several factors may be decisive for the selection of the probe.

Each probe has an approximate recommended range of sample volumes.
It is only a guided value to follow. The volume to be sonicated is depending on the application. For example, the 1/2" probe mounted to UW 200 can process volumes between 20 and 900 ml. Depending on size and shape of the processing vessel, it could be difficult to place the 1/2" probe into a 20-ml-vessel. In this case a micro tip may be the better option. Therefore, size and shape of the sample vessel are determining factors for selecting the appropriate probe.

Probes with a small sound-emitting surface are recommended when sonicating samples in small, slim vessels, never samples larger than 50 ml. These probes work with high intensity and are therefore designed for short processing times. Especially samples with a small sound-emitting surface (also called microtips) cause a very high heat generation in small volumes. For temperature-sensitive samples, work in pulsed mode or additionally cool the sample.

Larger volumes require a larger sound-emitting surface. For example, a 38 mm probe is better suited for sonication of 1 l sample volume than a 25 mm probe.
The use of sample vessels with a conical bottom increases the possible immersion depth and thus reduces the risk of splashing. Another way of processing very small volumes is indirect sonication. Compared to direct sonication, the power density decreases here. However, in order to break down yeast cells, for example, a very high power density is required.

The sonic distribution conforms to a row of "hemispherical shells" increasing in radius the further they are from the sound-emitting surface. The power density decreases at the same time.



The smaller the diameter of the probe tip, the higher the power density and cavitation power for the same electrical power consumption!

The cavitation process is associated with erosive material abrasion on the probe tip. This becomes evident as a "pitted landscape" on the sound-emitting surface of the probe after a period of operation. The higher the amplitude, the higher in turn the material abrasion, with the service life becoming correspondingly shorter. In other words, the smaller the diameter, the shorter the service life at the same output. If used in continuous operation (100% amplitude, no pulsation), a probe with a small radiation surface can last approx. 6 hours. The use of a probe with an appropriate radiating surface not only reduces the processing time, but the life time of the probe is increased, too. However, the majority of applications last but seconds or minutes. In some cases, this wear is undesirable as it always mixes with the medium to be sonicated (for example, in sample preparation for metal analysis or similar).
Avoidance of abrasion – see "Indirect sonication".

Basic probe designs and their application characteristics

In combination with the power of the ultrasonic generator, its design determines the maximum possible amplitude and the energy transferred to the medium. For this reason, the sound intensity transmitted to the medium is inversely proportional to the probe's sound-emitting surface. This means that probes with the smallest sound-emitting surfaces transmit the highest powers per surface [W/mm²] through high amplitudes, depending on the ultrasonic generator's electrical power consumption.

Micro tip
Conical / stepped shape, use for processing small volumes in reaction cups or centrifuge tubes

Conical probe
Conical design, use for processing medium volumes in small beakers, cooling vessels, flow-trough vessels or rosette cells made of glass

Cylindrical probe
Bar shape, use for processing larger volumes in beakers, cooling vessels, flow-trough vessels or rosette cells made of glass

Stepped probe
broad range for smallest to larger volumes of approx. µl quantities up to 3 l in beakers, cooling vessels, flow-trough vessels or rosette cells made of glass

Flat tips versus solid probes

The use of a titanium plate enables the cost-effective replacement of the „sound-emitting surface" in case of intensive and frequent use of the homogeniser. However, when using the titanium flat tip, the screw connection of titanium flat tip/horn is necessarily immersed in the sonication fluid. If the assembly is not sufficiently tight, very fine particles from the sample liquid can get into the gap and damage the contact surfaces of the system. The result is a functional failure of the unit. When using long probes, on the other hand, the penetration of sample material into the screw connection can be excluded. The use of a titanium flat tip instead of a long probe should therefore be weighed up in consideration of the sample material and the expected intensity of use.

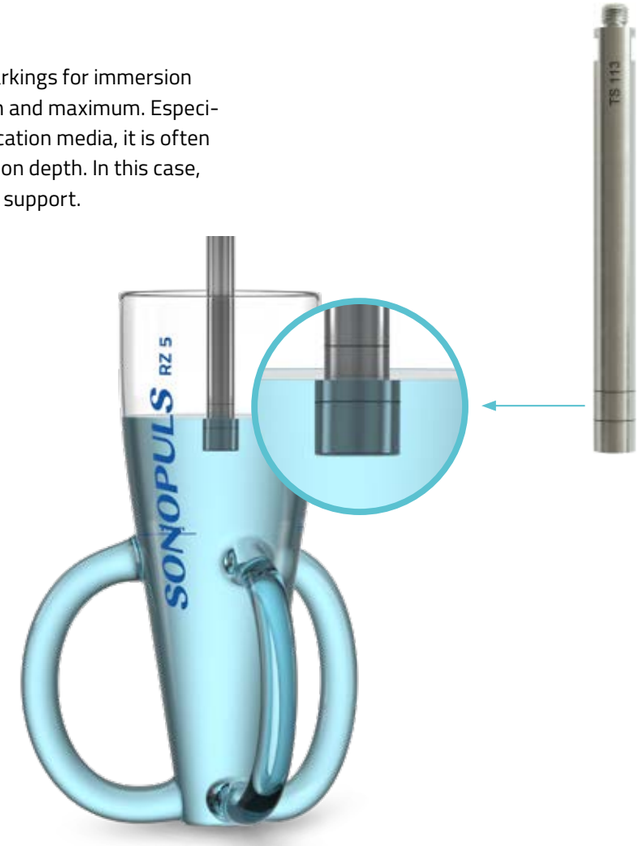
Threaded pin horn /titanium flat tip and horn/probe, cylindrical

Fixed threaded pin on the probes

All probes are equipped with a fixed threaded pin. This enables quick and easy installation on the standard or booster horn using the tool supplied.

Immersion depth mark

Cylindrical probes have two markings for immersion depth: recommended minimum and maximum. Especially with non-transparent sonication media, it is often difficult to identify the immersion depth. In this case, the markings provide optimum support.



Cavitation erosion test ASTM G32-92

Use for the standard test method according to the ASTM G32-16 standard to determine the cavitation erosion on the sound-emitting surface of a test specimen (= test probe).

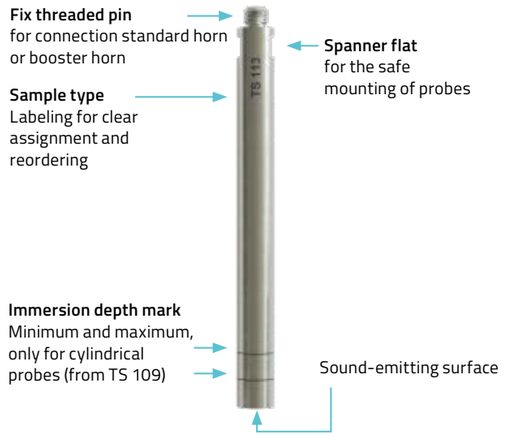
Test probe TS ASTM G32
Code No. 37461

The standard conditions for the test probe as defined by the standard are complied with:

	Standard test method ASTM G32-92	Test probe TS ASTM G32 for HD 4200
Frequency [kHz]	20 ± 0.5	✓
Dia. Sound-emitting surface [mm]	15.9 ± 0.05	✓
Amplitude (peak–peak) [µm]	50 ± 5 %	✓

SONOPULS
Probes for series HD 4000

Probes are wear parts. High power densities are created on the sound-emitting surface. This results in material removal (= cavitation erosion) even on this high-strength titanium alloy and thus limits the lifespan of the probe.
It is therefore recommended that two to three replacement probes be ordered when purchasing the device.
The probes are tuned to the corresponding operating frequency.
The lengths specified (*) may deviate slightly due to material tolerances in the titanium alloy.



Type	TS 102	TS 103	TS 104	TS 106	TS 109	TT 213	TS 113	TS 216	TS 219	TS 225
Code No.	3740	3741	3742	3743	3744	3750	3745	3746	3747	3748
Diameter [mm]	2	3	4,5	6	9	13	13	16	19	25
Length ca. [mm]	157	147	133	128	126	5	130	137	145	153
Standard horn for HD 4100	SH 100 G	SH 100 G	SH 100 G	SH 100 G	SH 100 G	SH 100 G	SH 100 G	–	–	–
Booster horn for HD 4200	–	SH 200 G	SH 200 G	SH 200 G	SH 200 G	SH 200 G	SH 200 G	SH 200 G	SH 200 G	SH 200 G
Amplitude HD 4050 HD 4100 HD 4200 (peak–peak) [µm]	 135 260 –	 105 245 320	 90 190 265	 75 160 230	 65 135 200	 – 80 140	 – 80 140	 – – 105	 – – 80	 – – 50
Volume HD 4050 [ml]	0.5–20	1–25	3–50	5–75	10–100	–	–	–	–	–
Volume HD 4100 [ml]	2–25	3–50	5–75	10–100	15–150	20–200	20–200	–	–	–
Volume HD 4200 [ml]	–	5–90	5–100	10–350	10–500	20–900	20–900	25–900	25–900	30–1000

Type	TS 413	TS 416	TS 419	TS 425	TS 425 L	TS 432	TS 438
Code No.	3752	3753	3754	3755	3759	3756	3757
Diameter [mm]	13	16	19	25	25	32	38
Length ca. [mm]	139	132	129	130	254	136	144
Booster horn for HD 4400 [mm]	SH 400 G	SH 400 G	SH 400 G	SH 400 G	SH 400 G	SH 400 G	SH 400 G
Amplitude HD 4400 (peak–peak) [µm]	260	180	130	75	75	50	40
Volume HD 4400 [ml]	100–750	250–1000	250–1500	500–2000	500–2000	500–2500	500–3000

Probe extension

The probe extension is used to extend the working length and to bridge distances in tall vessels, and is mounted between the standard/booster horn and the cylindrical probe or titanium plate. No conical probes or micro tips may be connected.

Type	TS 113 V
For HD	4100/4200
Code No.	3666

Probe extension TS 113 V between standard horn SH 100 G / SH 200 G and probe TS 113 or TT 213

SONOPULS

Sonication vessels for direct sonication

During direct sonication, the probe is immersed in the sample to be sonicated. The advantage of this method is the very high energy input as compared to indirect sonication. Refer to chapter 3 for information on selecting the appropriate vessels for your application.
All glass containers are made of borosilicate glass.

The material has very good chemical and temperature resistance and is therefore very well suited for laboratory use. The cleaning and/or disinfection can be performed using appropriate preparations, in an ultrasonic bath or in a cleaning and disinfection device.
The glass is autoclavable.

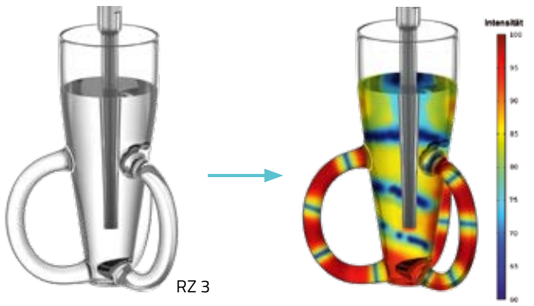
Rosette cells RZ

The rosette cells allow for a uniform and intensive sonication of liquid media. The ultrasound pressure presses the sample against the bottom of the vessel and then through the three lateral arms, enabling it to circulate well. The result is a continuous mixing of the medium. When placing the rosette cells in an ice bath, the contents are effectively cooled due to the enlarged glass surface and the good circulation.

Type	RZ 1	RZ 2	RZ 3	RZ 4	RZ 5
For dia. of samples [mm]	2–3	2–6	3–13	13–25	19–25
For HD	4050/4100 4200/		4100 4200	4200 4400	4400
Min. volume [ml]	20	30	60	260	430
Max. volume [ml]	25	50	100	410	660
Dia. internal [mm]	27	40	50	75	90
Depth [mm]	80	95	130	200	240
Code No.	3606	3607	522	3256	483

RZ 1 RZ 2 RZ 3 RZ 4 RZ 5

Intensity distribution
(distance between sample tip and vessel bottom = 3 cm)
Source: Berliner Hochschule für Technik (BHT)



RZ 3

Marking the minimum fill level

Sonication vessels for direct sonication with cooling

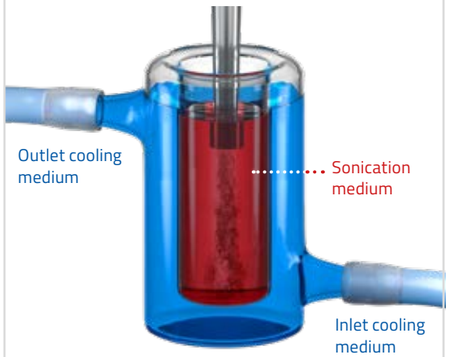
Cooling vessels KG

During sonication mechanical energy is converted into heat (through internal friction in the liquid), and thus to a more or less pronounced heating of the samples. Cooling of the medium may therefore become necessary for temperature-sensitive samples.
The sample containers can be placed e.g. in an ice bath. However, by doing so the immersion depth of the probe will not be visible. The KG cooling vessels with cooling jacket for connection to an external cooler are a better alternative. They enable a controlled temperature control during sonication.

Type	KG 3	KG 5
For dia. of samples [mm]	2–13	13–25
For HD	4050/4100 4200	4200
Max. volume [ml]	20	90
Dia. internal [mm]	20	35
Depth [mm]	55	95
Cooling jacket	✓	✓
Code No.	536	481

KG 3 KG 5

The cooling medium is pumped through the cooling jacket in a circuit with the aid of a thermostat. This allows a rapid response to a temperature increase.



KG 3

SONOPULS
Flow-trough vessels for direct sonication

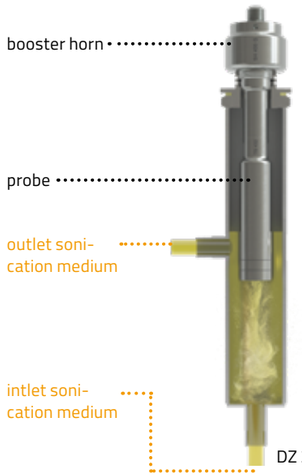
Flow-through cells are used for continuous processing of larger batches of low viscosity solutions. They are well suited for dispersing, emulsifying, mixing or homogenising.
Using a pump, the liquid is pumped from below against the sound-emitting surface of the probe, passes directly through the cavitation field, and leaves the chamber via the outlet. A pump must be provided by the user.
If intensive sonication is required, batches can also be passed through the system several times. The degree of sonication depends on the set amplitude and the flow rate.

Flow-through cell DZ 300 E

Material: Stainless steel 1.4404
The connection is made directly to the external thread of the booster horn. The DZ 300 E is particularly well suited for emulsifying, mixing and homogenising. The flow-through cell is sealed when screwed onto the booster horn. This prevents air from entering.

Type	DZ 300 E*
For HD	4400
Compatible with	SH 400 G
Max. Flow-trough rate [l/h]	130
Max. Pressure [bar]	4
Code No.	3822

* not usable with TS 438



DZ 300 E

Continuous sonication of larger volumes.
The sample is pumped into the flow-through cell via the inlet at the bottom, passes through the cavitation field and exits via the outlet. The sample can be sonicated multiple times. The degree of sonication is determined on the basis of both the amplitude and the flow-through rate.

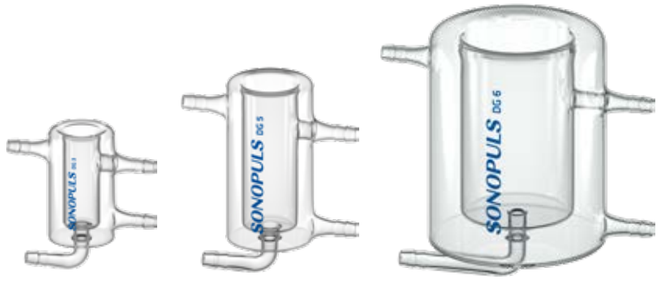
SONOPULS

Flow-trough vessels for direct sonication with cooling

Flow-through vessels DG

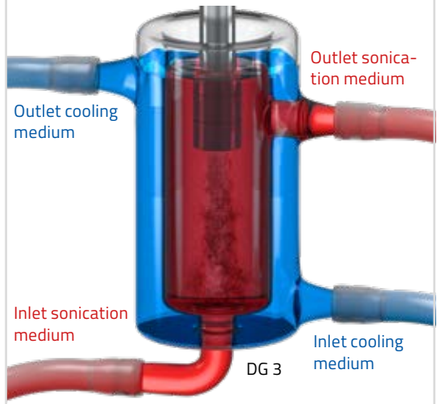
With cooling jacket. Continuous sonication of samples in flow of up to 30 l/h is possible.
The cooling jacket allows for temperature control by liquid coolant during the sonication.

Type	DG 3	DG 5	DG 6
For dia. of sample [mm]	2–13	13–25	25–38
For HD	4050/4100 4200		4200 4400
Max. Flow-trough rate [l/h]	5.6	30	30
Dia. internal [mm]	20	35	71
Depth [mm]	55	100	120
Cooling jacket	✓	✓	✓
Code No.	538	482	3819

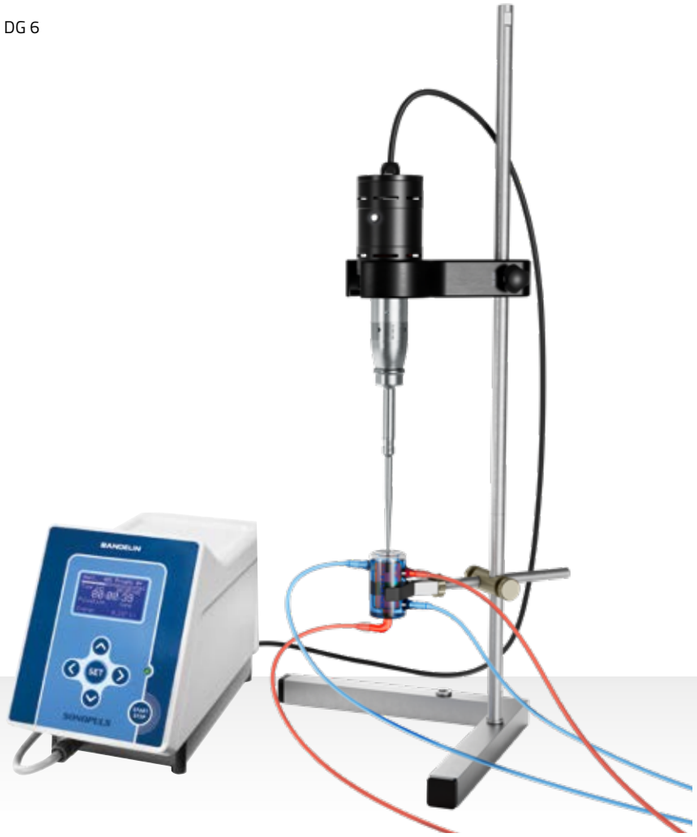


DG 3 DG 5 DG 6

The cooling medium is pumped through the cooling jacket in a circuit using a thermostat.
This allows for a quick reaction to an increase in temperature. The sonication medium is passed directly against the sound-emitting surface of the probe.



DG 3



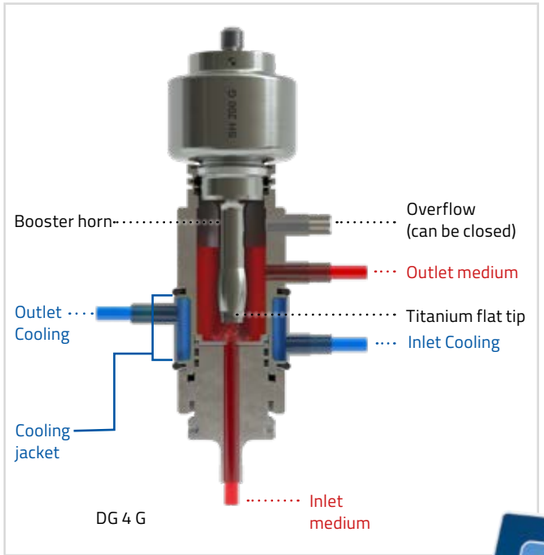
Flow-through sonication vessel DG 4 G

Material: Stainless steel 1.4301
The connection is made directly to the external thread of the standard or booster horn. The DG 4 G is particularly well suited for emulsifying, mixing or homogenising.
The sonication vessel is “hermetically” sealed when screwed onto the booster horn (the overflow is also sealed).
This prevents air from entering.
Infectious substances can also be sonicated.
The sample liquid is fed directly into the cavitation field from below via the inlet, sonicated and discharged via the outlet. An external 2-channel pump must be provided. The degree of sonication is controlled by the amplitude setting on the generator and the flow-through rate.
The medium can also be sonicated in a circuit for intensification of the process. The integrated cooling jacket regulates the sample temperature. An external cooler must be provided by the customer.

DG 4 G

Type	DG 4 G
For HD	4100 / 4200
Compatible with	SH 100/200 G with TT 213/TH 100/200 G
Max. Flow-trough rate [l/h]	50
Max. Pressure [bar]	2
Cooling jacket	✓
Code No.	3608

Bottom view DG 4 G, Baffle with hole



DG 4 G

SONOPULS
Sonication vessels for indirect sonication

Indirect sonication prevents direct contact between the probe and the sample. The function conforms with a small, high-intensity ultrasonic bath. The ultrasonic power is transferred to the sample vessels via the contact liquid, eliminating the possibility of titanium particles entering the probe.
Indirect sonication is particularly used for the sonication of the smallest sample quantities: Foaming or sample loss are excluded.
The method is well suited for the sonication of pathogenic samples – cross-contamination is ruled out. Cooling of the samples is also possible. We recommend connecting the external lab cooler LABOCOOL LC 200.

It is important that the fill level always remains constant, and that the reaction vessels do not float. Otherwise, sonication results could be impaired. The sample holder's cover plate prevents it from floating. The addition of ice chips is also a cooling option but does not help to maintain a consistent temperature. If ice chips are used, they must be located on the sides of the reaction vessels. If positioned below the reaction vessels they could influence the result negatively. The transmitted power density [W/l] is approximately 150 times higher than in a "normal" ultrasonic bath, but lower than with direct sonication with a probe.

Cup booster TR 110

Material: Titanium TiAl6V4
The cup booster TR 110 allows for intensive, indirect sonication of the smallest sample quantities, such as bacteria, in up to 14 closed sample vessels (microtubes). The uniform sound field guarantees reproducible results in all vials. Indirect sonication prevents both a contamination of the samples through probe erosion as well as cross-contamination. The ultrasonic power is transmitted through contact liquid into the respective microtubes. In addition, the cup booster possesses inlet and outlet connections so that the samples can be tempered by the reservoir. For stationary operation, the inlet and outlet connections can be shorted with the help of a hose bend.

In cooling mode, the inlet and outlet are to be connected through suitable hoses to a hose pump with a low output or to a cooling circuit.

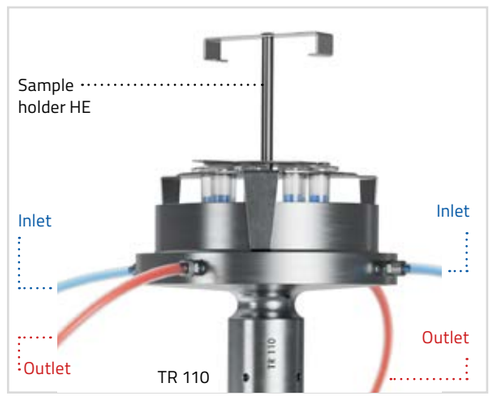
Type	Code No.	For HD	Internal dia. [mm]	Depth [mm]	Reservoir-capacity [ml]	Connection type for the hoses	Power density [W/l]
TR 110	3902	4200	110	25	190 (stationary)	M5 thread	790

Supports for any reaction vessel size

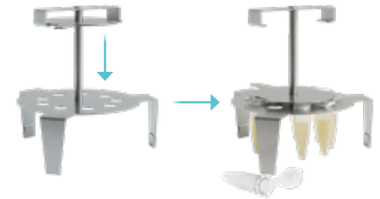
Material: Stainless steel AISI 304
The different sample holders can hold up to 14 microtubes. There are four different holders to choose from for this purpose, depending on vessel size. They are positioned on the edge of the cup booster using a curved handle.

Sample holders HE 6, HE 12, HE 13 and HE 17

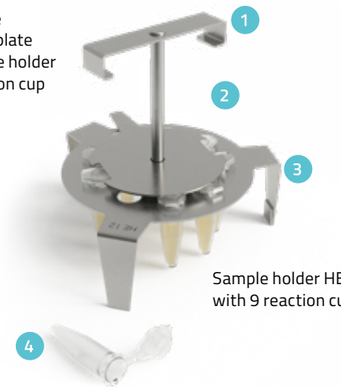
Type	Code No.	For	Dia. of holes [mm]	Capacity of holes
HE 6	3903	PCR tubes	6	14
HE 12	3904	Reaction cups 0.5/1.5/2.0 ml	11.5	9
HE 13	3905	Polystyrol tubes, long, with/without-screw cap, 5 ml	13	9
HE 17	3906	5-ml tubes	17	9



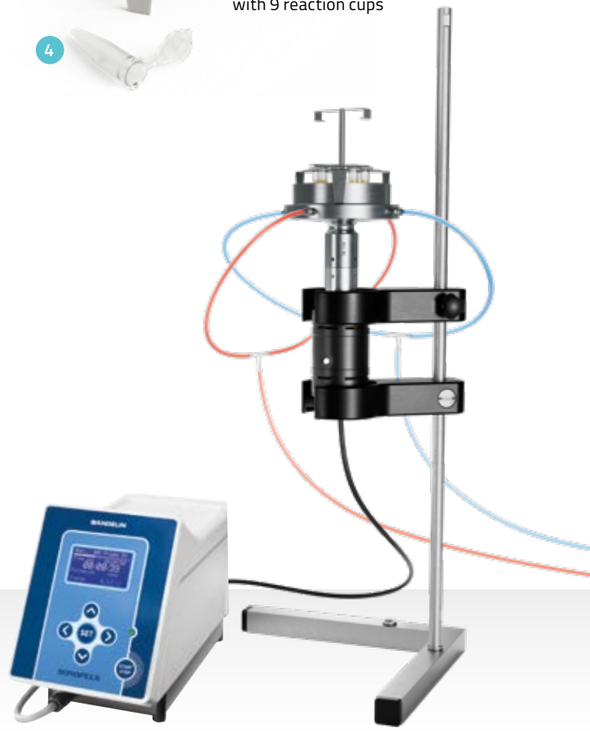
The microtubes must be submerged in the contact liquid inside the reservoir of the cup booster. The cover plate prevents the microtubes from floating during operation.



Cover plate prevents floating up



Sample holder HE 12 with 9 reaction cups



SONOPULS
Sonication vessels for indirect sonication

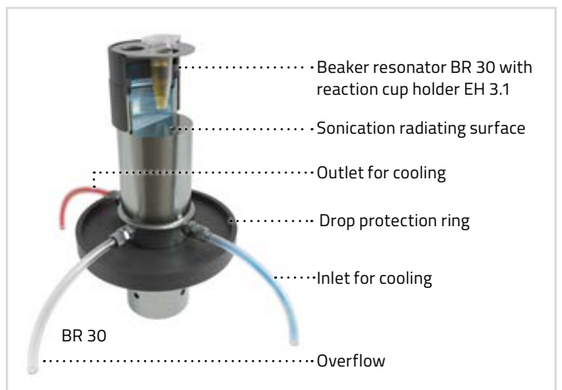
Beaker resonator BR 30

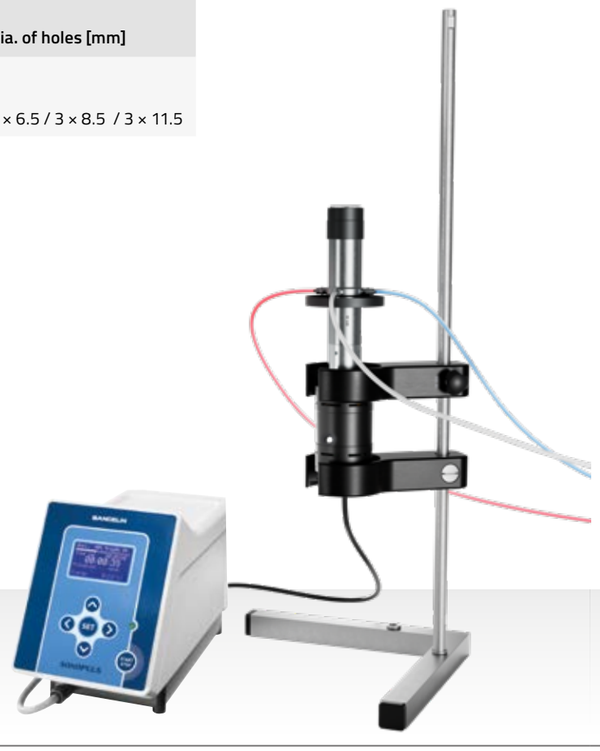
Material: Titanium TiAl6V4
The beaker resonator is designed for intensive, indirect sonication of the smallest sample quantities, e.g. bacteria in closed sample vessels (microtubes). The samples are placed in the BR 30 with the reaction cup holder EH 3.1. In addition, the beaker resonator possesses inlet, outlet, and overflow connections so that the samples can be tempered by the reservoir. In stationary operation, the inlet and outlet can be shorted with the help of a hose bend. In cooling mode, the inlet and outlet are to be connected through suitable hoses to a hose pump with a low output.
The beaker resonator is mounted directly on the ultrasonic converter. It is equipped with a fixed threaded pin for easy mounting. Quick and easy assembly with the specified tool is guaranteed.

Beaker resonator BR 30 and reaction cup holder EH 3.1

Type	Code No.	For HD	Internal dia. [mm]	Depth [mm]	Reservoir capacity [ml]	Connection type for the hoses	Power density [W/l]
BR 30	7510	4100 / 4200	32	15	12	3 hose screw connections with cap nut and sealing ring	12500

Type	Code No.	For	Material	Dia. of holes [mm]
EH 3.1	7527	3 × 1 ml or 2 ml reaction cups 3 × 0,5 ml reaction cups 8 × 0,2 ml PCR-cups	Stainless steel and POM	8 × 6.5 / 3 × 8.5 / 3 × 11.5





Cup horn BB 6

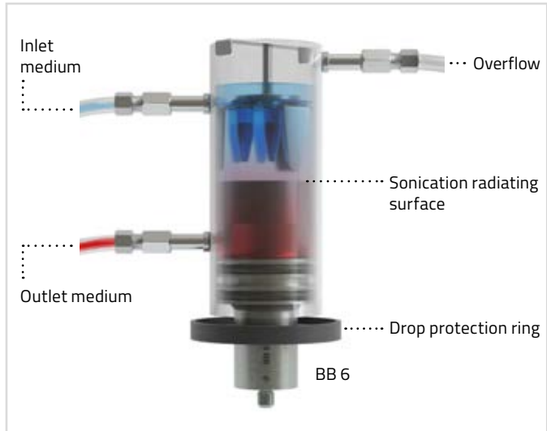
Material: Titanium TiAl6V4 / Macrolon
The cup horn is designed for indirect sonication of the smallest sample quantities, e.g. bacteria, in closed sample vessels (microtubes). The samples are placed in the BB 6 with the EH 6 microtube holder.
In addition, the cup horn possesses inlet, outlet, and overflow connections so that the samples can be tempered. For stationary operation, the inlet and outlet can be closed using the accompanying screw caps.
It is equipped with a fixed threaded pin for easy mounting. Quick, easy and direct installation on the ultrasonic converter is possible with the specified tool.

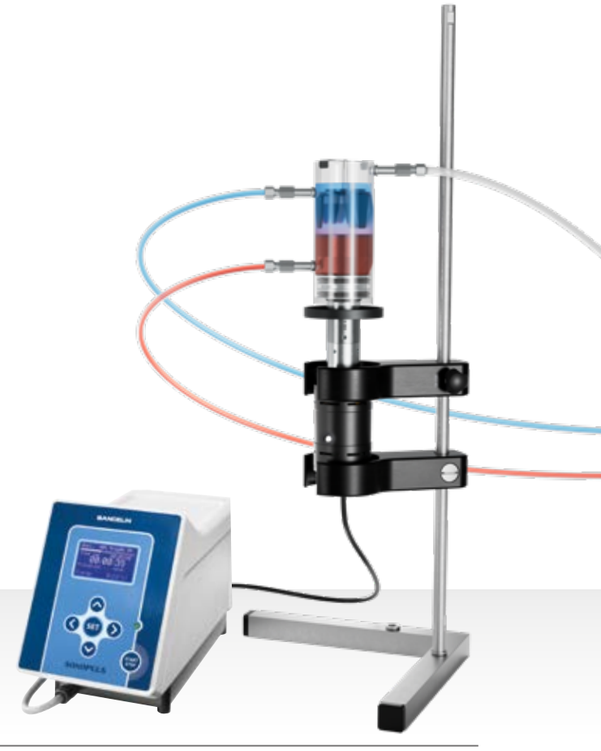
For temperature-controlled use with *the new recirculating chiller* **LABOCOOL LC 200** suitable.

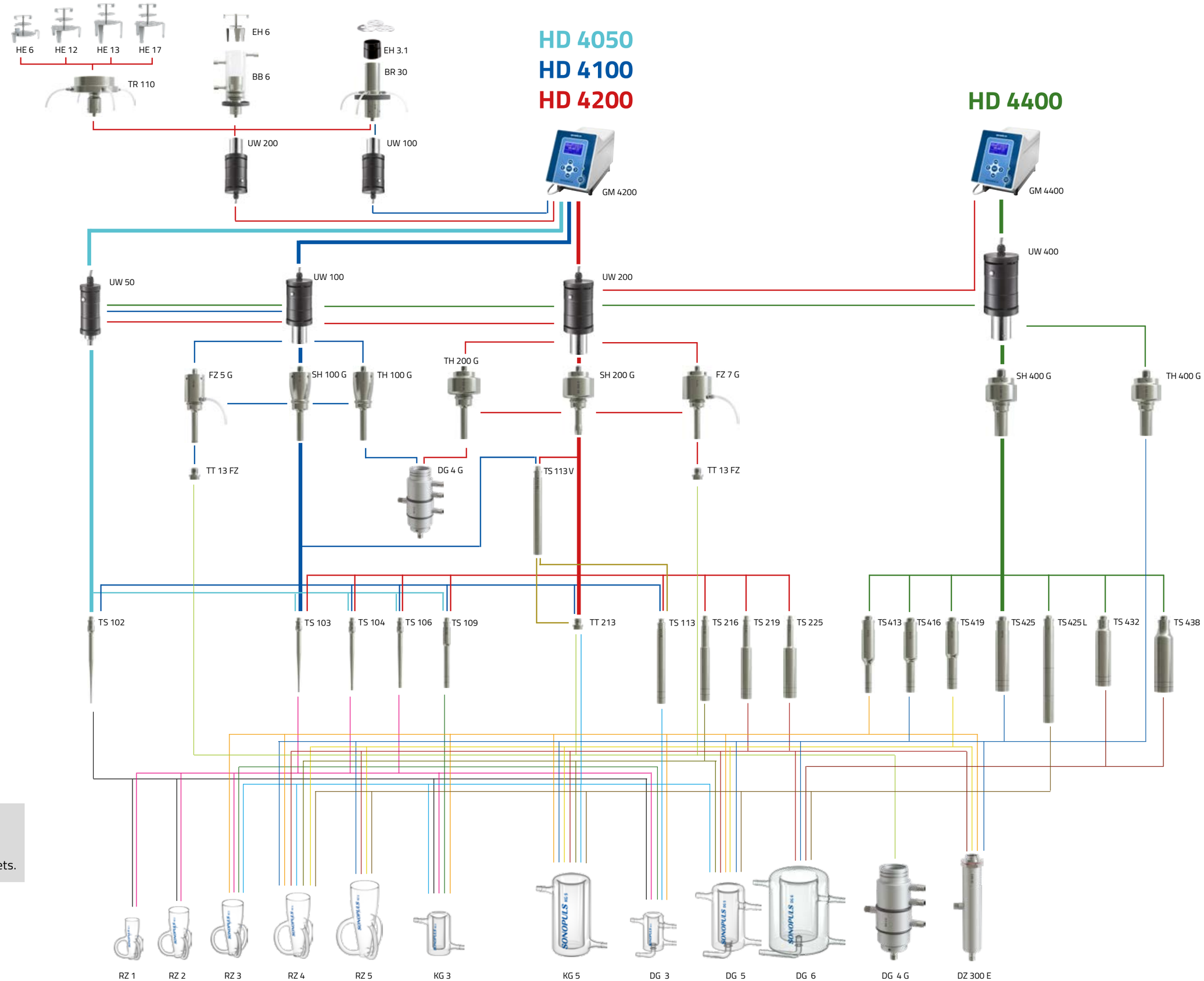
Cup horn BB 6 and reaction cup holder EH 6

Type	Code No.	For HD	Internal dia. [mm]	Depth [mm]	Reservoir-capacity [ml]	Connection type for the hoses	Power density [W/l]
BB 6	3605	4200	64	167	200	Hose fitting 5 × 3 mm	750

Type	Code No.	For	Material	Dia. of holes [mm]
EH 6	7503	6 × 1.5 / 2 ml	Stainless steel	11.5 mm







The thick lines represent the respective SONOPULS sets.

Stand, Sound proof box, Temperature sensor and Foot switch

BANDELIN already supplies a ready-to-use unit with the standard set.
For individual adaptations to the applications, an extensive range of accessories is available.

The most practical and popular accessories for the most common applications are presented in more detail below.

Possible accessories:

Stand HG 40

Sound proof box LS 40

Temperature sensor TM 50

Foot switch TS 8

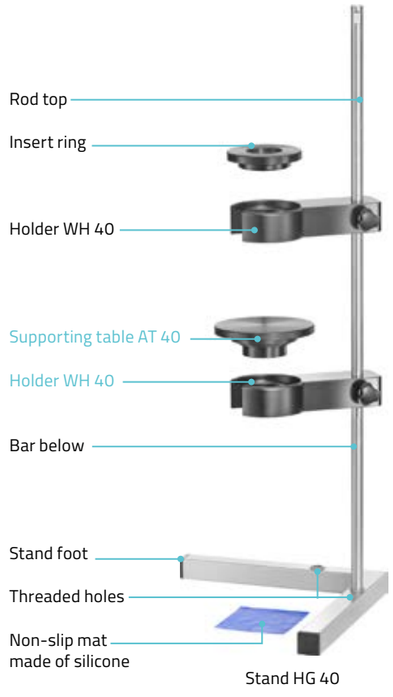
Stand HG 40

Material: Stainless steel (AISI 304) and POM
The HG 40 offers a firm stand and flexible handling for adjustment of the holder for the ultrasonic converter with probe. The positioning of the sonication vessel can be made significantly easier by using an additional holder with supporting table. Sufficient freedom of movement for the user is guaranteed.

Scope of delivery:
- Holder WH 40
- Insert ring
- Silicone non-slip mat

Optional accessories:
- Second holder WH 40
- Supporting table AT 40

Type	HG 40	WH 40	AT 40
For HD	2070.2 / 2200.2 / 3100 / 3200 / 3400/ 4050 / 4100 / 4200 / 4400		
Code No.	3681	3900	3901



Stand HG 40

One holding frame, suitable for all SONOPULS ultrasonic homogenisers

All ultrasonic converters in the 4000 series as well as those in the 3000 and 2000.2 series can be inserted in the support frame.
The supplied insert ring is required for the ultrasonic converter UW 50.

Insert ring

HD 3100 with HG 40

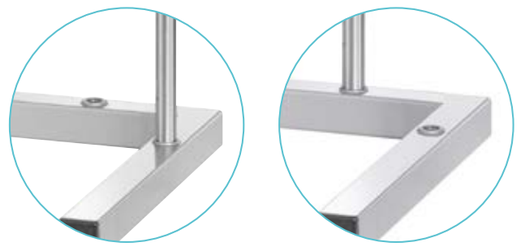
HD 2200.2 with HG 40

HD 4200 with HG 40

Flexible mounting/installation

The stand rod can be positioned to the left or right side of the stand foot. The rod is two-piece and screwed together by a thread. If both parts are mounted, the total length is 816 mm. With just one rod, the stand is 548 mm high.

The rod has a standard diameter of 16 mm. Commercially available clamps can be attached to it in order to e.g. affix laboratory vessels with a round bottom.
The WH 40 holder for the ultrasonic converter is height-adjustable and swivelling.

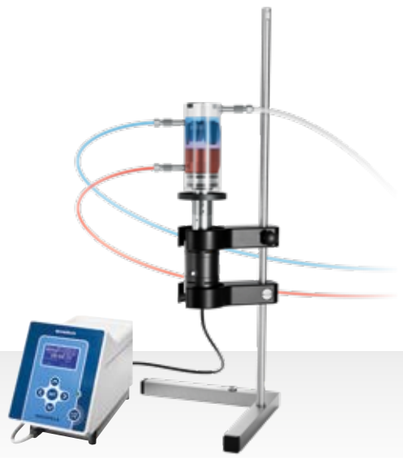


Flexible: Possible uses with direct and indirect sonication

The stand can be used flexibly for direct and indirect sonication. The scope of delivery includes a silicone non-slip mat that prevents the sonication vessel from sliding during direct sonication.

However, a second WH 40 holder is required to affix the ultrasonic converter during indirect sonication.

Direct sonication



Indirect sonication

1 Application possibilities with supporting table

Optionally, a second WH 40 holder can be used in combination with an AT 40 supporting table. This allows the vessels placed on it to be moved directly toward the probe and their immersion depth to be easily regulated.

Direct sonication with supporting table

2 Use of two ultrasonic converters

With the aid of a second WH 40 holder, another ultrasonic converter, for example, can also be attached at the same time. Variable positioning of the sonication vessel is made possible with the additional holder WH 40 and the supporting table AT 40.

Sonication of two samples on one stand

3 Convenient placement in the sound proof box

The HG 40 stand is designed so that it can be placed in the sound proof box LS 40. This ensures easy handling of the samples.
The door opening angle of the sound proof box LS 40 is 180° and the interior has sufficient space for direct and indirect applications.

Take a look at our video.

More useful videos on
youtube.com/bandelin

Temperature sensors TM

Connecting the temperature sensor to the ultrasonic generator activates temperature recording and enables user-defined temperature monitoring during the sonication process.

Sample temperatures in the range -10 to 120 C° can be measured.

High temperatures may not enter the ultrasonic converter (max. 80°C). Long-term exposure to high temperatures must be avoided!

Type	**TM 50**
For HD	4050 / 4100 / 4200 4400
Dia. of measuring tip [mm]	1.9
Sensor length [mm]	100
Code No.	3733

Foot switch TS

Instead of the “START/STOP” button on the ultrasonic generator, the device can also be operated using the foot switch. With 3 m connecting cable.

Type	**TS 8**
For HD	4050 / 4100 / 4200 / 4400
Code No.	513

Sound proof box LS 40

Cavitation produces unpleasant noises for the user and other people nearby. We recommend the use of sound proof boxes to reduce the noise level.

The housing, splash guard, drip tray and perforated plate are made of stainless steel (1.4301).

- Noise reducing by approx. 30 dB-AU
- LED interior lighting and acrylic glass for process viewing
- Removeable drip tray; made of stainless steel, easy to clean
- Splash guard, stainless steel insert inside easy to wipe clean
- Closable bushing at the rear side to accomodate lines and hoses for cooling or circulation systems or to connect a temperature sensor
- Ventilation system for reducing a process-related formation of moisture
- Door opening angle 180° for easy sample handling

Type	Code No.	Description	For HD
LS 40		Sound proof box (noise reducing by approx 30 dB (AU)) + 230-V-EU plug CEE 7/7	
	36821	Sound proof box (noise reducing by approx 30 dB (AU)) + 230-V-CH plug SEV 1011: T12	
	36822	Sound proof box (noise reducing by approx 30 dB (AU)) + 230-V-GB plug BS 1363	2070.2 / 2200.2 3100 / 3200
	36823	Sound proof box (noise reducing by approx 30 dB (AU)) + 115-V-US plug NEMA 5-15	3400 / 4050 4100 / 4200 4400
	36824		

The sound proof box LS 40 can be used with the stand HG 40 or alternatively a suitable laboratory stand.

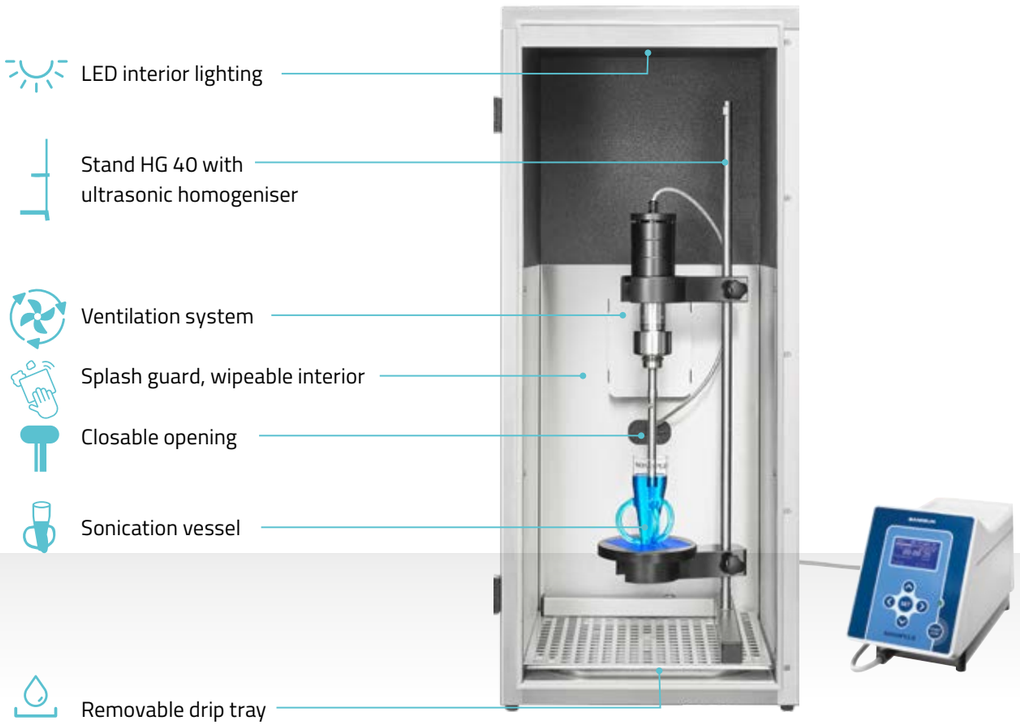
For direct and indirect sonication

The stand HG 40 can be flexibly placed in the sound proof box LS 40 to perform direct or indirect sound reinforcement.

Direct sonication
Sound proof box LS 40, stand HG 40 with holder WH 40, ultrasonic converter UW 200, standard horn SH 200 G, probe TS 113 and rosette cell RZ 3

Direct sonication
Sound proof box LS 40, stand HG 40 with two holders WH 40 and supporting table AT 40, ultrasonic converter UW 200, standard horn SH 200 G, probe TS 113 and rosette cell RZ 3

Indirect soncation
Sound proof box LS 40, stand HG 40 with two holders WH 40, ultrasonic converter UW 200 and cup horn BB 6 with reaction cup holder EH 6



Recirculating chiller *LABOCOOL* LC 200

LABOCOOL LC 200 is used for either removal of process heat or effective cooling of samples during sonication with the SONOPULS ultrasonic homogenizer. Compared to conventional laboratory coolers, LABOCOOOL LC 200 is characterised by a closed water circuit without an equalization tank. Thus, a constant water level is achieved in the processing vessel and overflowing is excluded. Due to the natural refrigerant R-290, LABOCOOL LC 200 is particularly efficient and climate-friendly.

For constant media temperature in the ultrasonic bath: ***LABOCOOL*** **LC 400**

Applications with cooling

The sonication of biological samples reduces the processing time for sample preparation for following analysis and enables reproducible results. The high ultrasonic power applied generates frictional heat, which warms-up the sonication liquid in a short time. In order to protect samples from excessive heat input, many applications require an external cooling system. LABOCOOL LC 200 provides a ready-to-connect complete solution which enables a cooling of samples at the push of a button.

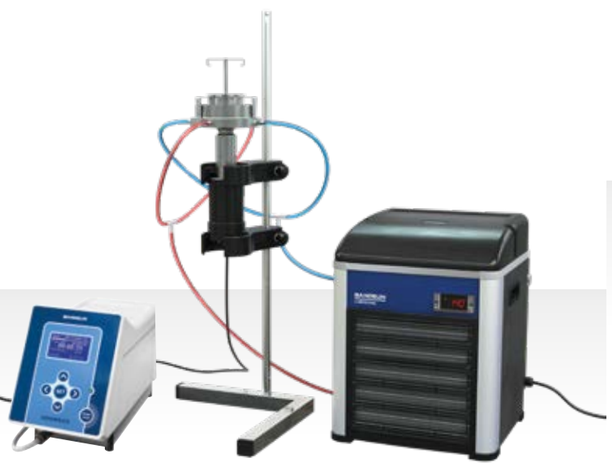
Use in applications with the cup horn BB 6

LABOCOOL LC 200 is connected to BB 6 cup horn using the supplied tubes. BB 6 can also be placed into the sound proof box.

Use in applications with the cup booster TR 110

An outstanding feature of TR 110 is the most efficient cooling system using two cooling water inlets and two outlets. These are easily connected to LABOCOOL LC 200 by supplied accessories. When using in the sound proof box, LC 200 can be placed next to the sound proof box.

LABOCOOL LC 200 with HD 4000 and BB 6



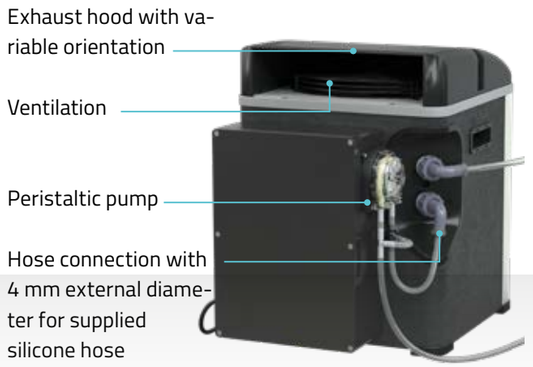
LABOCOOL LC 200 with HD 4000 and TR 110

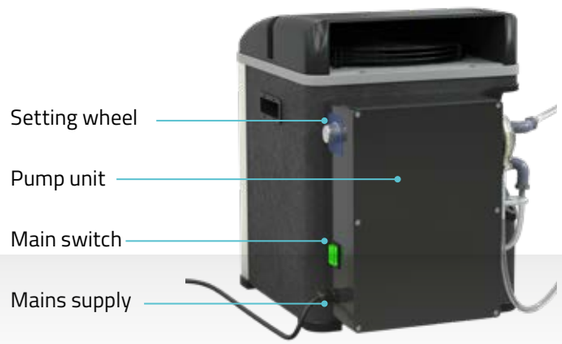
Front side

The display shows the status of the cooling function and the water temperature in the device. The side buttons can be used to set the desired water temperature within a range of 5–30 °C.

Back side

The pump unit and the main switch are located at the rear of the unit. The volume flow of the self-priming peristaltic pump can be varied by means of an adjusting knob.





Type	Code No.	For HD series	External dimensions l × w × d [mm]	Cooling power [W]	Refrige-rant	Refrigerant quantity [g]	Pump type	Pump power [W]	max. Flow-rate [l/h]
LC 200	3855	4000	415 × 320 × 420	440	R-290	90	Peristaltic pump	10	36

Use of the SONOPULS Ultrasonic homogeniser

03

Basic instructions for the application

The most important information on handling in practice.

from page 58

Setting the sonication parameters

Explanation of the relevant factors for an optimal result.

from page 62

Overview of applications

Presentation of various processes and industries for ultrasonic applications.

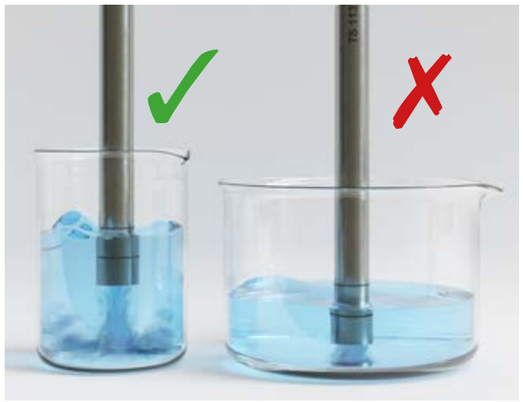
from page 64

Basic instructions for the application

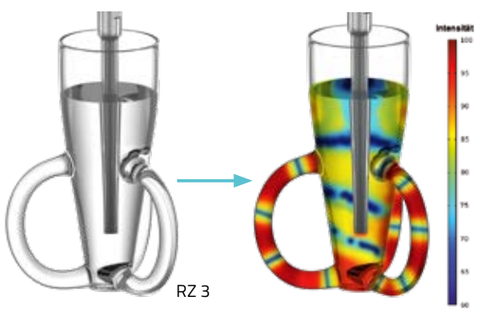
The success of sonication with the ultrasonic homogeniser is fundamentally dependent on the correct selection of the device and method parameters. On the basis of the previous versions and / or a consultation with BANDELIN employees, you have now selected the right device with the right probe and possible accessories.The following chapter explains the parameters so as to allow you to identify the suitable method for your requirements and ensure the sonication is successful. As requirements can be very specific, the approach can be selected in such a way that a basic method is chosen on the basis of similar application scenarios, but needs to be modified in a range of initial tests in order to optimise conditions, using the basic knowledge communicated here so as to suit the individual requirements.

Selection of vessels

In theory, you can use any vessels made of any material (glass, plastic, etc.). A narrow vessel is preferable to a wide vessel. The ultrasonic energy is generated from the radiating surface of the tip and is directed downward. The sample liquid is pushed down and away in all directions. If the vessel is too wide it will not mix effectively and some sample will remain untreated at the periphery. However, there is a good experience with rather narrow and conical shaped vessels. An optimal power transmission is guaranteed and splashing is prevented. With the so-called rosette cells offered as accessories, a higher degree of circulation can be achieved.
The ultrasound pressure forces the sample against the bottom of the vessel and then through the three side arms, so it is sonicated repeatedly. When placed in crushed ice, for example, the sample liquid is cooled very well and effectively thanks to the side arms and the uninterrupted circulation.



Optimal sonication distribution in narrow vessels

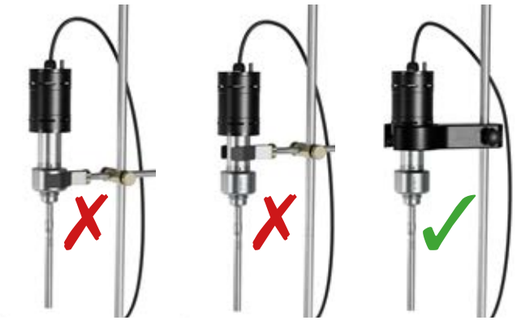


Visualisation of the intensity areas in a rosette cell
Source reference: Beuth Hochschule Berlin

Cooling of the sample in a rosette cell RZ with crushed ice

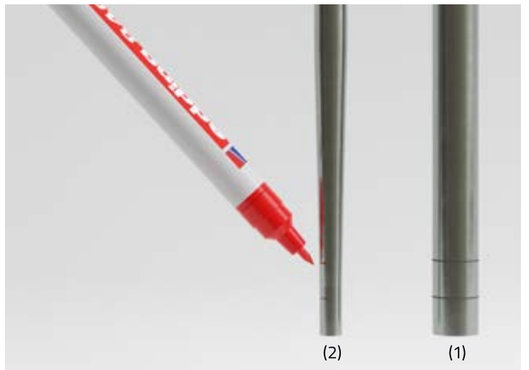
Fixation of the ultrasonic converter

The ultrasonic converters may only be held by the black housing, for example using a stand clamp. Improper clamping/fixing can lead to malfunctions or mechanical faults. For example, the preset amplitude is not reached and an error displayed.



Immersion depth of the probe

Probes must be immersed correctly, normally approx. 1 cm. If the probe is not submerged enough the sample tends to foam or splash. If the probe is immersed too deep the sample will not circulate effectively and on the other hand the probe can be damped too much laterally (especially with highly viscous media). Both will end up with poor results.



The immersion depth of the probe is often difficult to see, as either the sample liquid is too dark or the reaction vessel is placed in ice. Our cylindrical probes (1) have markings in the lower area to control the immersion depth. When working with so called micro tips (2), we recommend filling the reaction vessel with water to match the desired sample volume. The micro tip has to be inserted to the optimum depth. To indicate where to stop inserting the micro tip a horizontal line has to be drawed with a permanent marker on the micro tip. So the correct immersion depth can be ensured each time.

Sonication of a chunky sample in a liquid

In many cases, mechanical grinding of the sample is necessary in advance, as ultrasound is significantly more effective on smaller particle sizes. If chunky samples are to be sonicated, the probe should be positioned directly on the sample.

Probes with “pitted” surfaces

The probe tip wears away with use. At the same time, the efficiency of the sonication deteriorates and the reproducibility of the sample sonication becomes poorer. The smoother the sound-emitting surface, the better the power output in the medium. Sand the probe while the pitting is still minimal (see instructions for use). If the pitting is deeper than approx. 1 mm, the probe should be reprocessed by BANDELIN or replaced.

Guide values for the useful life of the samples

The values listed apply to the maximum amplitude when used in water up to a material removal ≤ 1 mm at the sample tip. Depending on the conditions of use, the actual service life may be longer or shorter. The service life is given in hours [h].

Probe	HD 4050	HD 4100	HD 4200	HD 4400
TS 102	17	9	–	–
TS 103	36	19	10	–
TS 104	64	34	17	–
TS 106	138	74	37	–
TS 109	311	166	83	–
TS 113	–	308	154	–
TT 213	–	273	136	–
TS 216	–	–	245	–
TS 219	–	–	345	–
TS 225	–	–	560	–
TS 413	–	–	–	77
TS 416	–	–	–	122
TS 419	–	–	–	173
TS 425	–	–	–	280
TS 432	–	–	–	432
TS 438	–	–	–	609

Mounting of probes

Here it is imperative to ensure that a minimal torque [Nm] is always reached so that a stable mechanical connection between the probe and horn is always guaranteed. We recommend the use of a torque spanner to ensure a reliable mechanical contact and thus correct function (please consult the corresponding product information for the tightening torques). The same applies when changing the horn on the ultrasonic converter.

Mounting of probes

and more useful videos on
youtube.com/bandelin

Further information

For minute volumes, we recommend immersing the probe as far as possible so as to avoid significant movements on the sample surface. If the sample still foams, try working with a lower amplitude, cooling the medium and / or selecting the pulse mode. If necessary, glass beads (d = 0.5 mm) can also be added. These beads sink to the bottom following sonication and can be centrifuged out. Conical vessels and vessels with irregular interior surfaces are best suited for the sonication of minute volumes in order to prevent foaming.

Setting the sonication parameters

Amplitude

The amplitude is set to control the power input level and the extent of the cavitation strength. The value is selected as a percentage of the probe's maximum amplitude. The amplitude must be high enough to achieve a good sonication result. If the amplitude and sonication time, and therefore the power application, are too high, the result may be unnecessarily heavy heating, splashing or foaming of the sample liquid or possibly a destruction of the sample components. Settings guidelines can be taken from our application examples or determined in tests.

Pulsation

In the standard setting, the power is transferred to the sample continuously during sonication. In such cases, the device works in continuous operation (non-stop mode).
There are applications in which it can be practical to apply the energy in time intervals. Indications for pulsation include undesirable, rapid heating of the sample, desired settling of the sample on the bottom of the vessel, or allowing reactions to occur during the pauses.

Sonication time

In stationary operation, the sonication time is generally between 15 s and 5 min. Similarly to what applies for the selected amplitude, since too short a sonication period may be insufficient for the desired sonication result. Prolonged sonication, in contrast, may result in an unnecessary temperature increase of the sample or even affect the properties of the sample. Last but not least, it may result in an unnecessary increase in the processing efforts required. It is thus advisable to

select a tendency for the sonication time based on the applications outlined in chap. 6, and then to analyse in a series of small tests which duration is optimal for the actual application, as there is no 100% correct answer for each type of vessel, sample volume, concentration, etc.

Cooling

Depending on the conditions, the applied power is converted to heat and can thus result in considerable temperature increases in samples with small volumes. The heating can be influenced using the parameters described above: amplitude, pulsation and sonication time. It is necessary to check whether the heating still occurring has a negative effect on the sample. If so, cooling of the samples is recommended. This can be easily done by positioning the sample vessels in an ice bath or crushed ice. Alternatively, double-walled vessels which allow water cooling can also be procured from our range.

Cooling with crushed ice

Beads in the reaction cup

Use of beads

When using particularly solid material, it may be useful to add glass beads to the solution, as these intensify the effect of the ultrasonic cavitation. Depending on the application, glass beads in different sizes (up to 0.5 mm in diameter) and different quantities may be added.
A ratio of 1/3 glass beads to 2/3 solution often delivers good results. The beads settle to the bottom of the vessel after sonication and can be centrifuged or filtered out. Higher probe wear also needs to be taken into account when using beads.

Beads greatly enlarged

Overview of applications

The number of possible applications is very high and the range of application areas especially broad, with new ones being added all the time. The most important procedures and branches in which the ultrasonic homogeniser is used in laboratories or the sonoreactor at production level, are listed below. Regard it as inspiration for your own situation, as the ultrasonic homogeniser or sonoreactor might represent a viable solution.

Basic procedures

Dispersing: Suspending, Emulsifying

Dispersing is a procedure in which substances which do not or barely dissolve in one another, are mixed together optimally. A distinction is made between different types of dispersion depending on the dispersing medium and the dispersed phases.

Emulsion – liquid in liquid (dispersed phase)
Suspension – solid in liquid

Ultrasonic homogenisers can achieve great results when emulsifying as well as suspending. Particles are disagglomerated and electrostatic attractive forces (Van der Waals forces) perturbed. The high forces (see basics of ultrasound) make it possible to achieve very finaly dispersed emulsions / suspensions with very small droplet or particle sizes in the micrometre and nanometre range, which leads to very good stabilities of the resulting emulsions / suspensions. The clumping, agglutination, sedimentation and undesirable inclusion of air experienced with other methods do not occur. Application examples include the production of ink, paints, cosmetics, technical oils, etc.

A particular explosion of applications has been observed in the area of nanoparticles in recent years. Here, it is possible to achieve particularly good dispersion results with regard to the average particle size and particle size distribution, using ultrasound.
Ultrasonic sonication is possible in all size ranges, from µl right up to production levels via upscaling.
The sonication can be performed discontinuously or in flow-through. One example is the production of pharmaceutical preparations, especially minutely dispersed emulsions such as lotions and ointments.
When mechanical homogenisers are used, excessively slow stirring often results in separation of the liquid, and excessively fast stirring leads to the undesirable inclusion of air.
The ultrasonic homogeniser produces a physically stable emulsion!The applied amplitude is decisive for the yield of the droplet comminution.

Homogenising

If ultrasound is used for homogenising, the particles (solid or liquid) are comminuted in a liquid, resulting in more intensive mixing. There is a wide range of application possibilities. See below for further information on homogenising in sample preparation for analysis.

Extraction

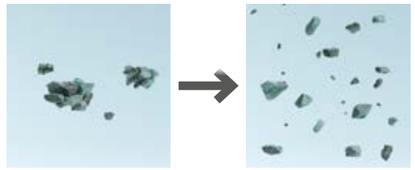
The extraction of ingredients from solid particles in the liquid phase represents yet another extremely inte-resting field of application. The possible advantages to be achieved for many applications, in comparison with other extraction methods, are:

- higher yield,
- shorter extraction times,
- lower required temperature,
- lower proportion of solvent or
- complete conversion to aqueous phases.

A combination of ultrasound and other extraction methods is also practical in some cases. The application can be customised to the requirements, and upscaling to production processes is also possible with excellent results. One example of this application is the extraction of mineral components from the soil in the scope of sample preparation for analysis. The extraction is completely finished after 10 seconds, whereas it has to be shaken for 1 hour in the conventional shaker.

Disagglomeration

Agglomerates can be very effectively destroyed with an ultrasonic homogeniser. For example, this is employed in sample preparation for particle size analysis, as preparation for cell count determination in microbiology, for the production of stable protein solutions, etc.
The high variability of the power input makes it possible to ensure that precisely the right amount of power that is required for complete disagglomeration without degrading the particles, cells, etc., is applied.



Degassing, defoaming

The removal of air or other gases from liquids is essential for further use in a variety of scenarios, for example for HPLC eluent, for the analysis of sparkling drinks, for the degassing or defoaming of emulsions, varnishes, etc. Degassing or defoaming with an ultrasonic homogeniser is very fast, simple and effective. Even large sample volumes, including chemical solutions, can be degassed with ultrasound. This is mostly carried out in a flow-through cell that can also be integrated in a production line where, for example, gas is to be expelled from a fluid (a degassing opening must be present).

Sample preparation for analysis – homogenising, extracting, disagglomerating, degassing

These procedures are widely used in the preparation of samples for analysis and are particularly efficient and simple in their use compared with the available alternatives. The sonication takes just a few seconds or minutes. The preparation, use and cleaning are exceptionally simple and uncomplicated. Dismantling of the device for cleaning is not required. An autosampler can be used.

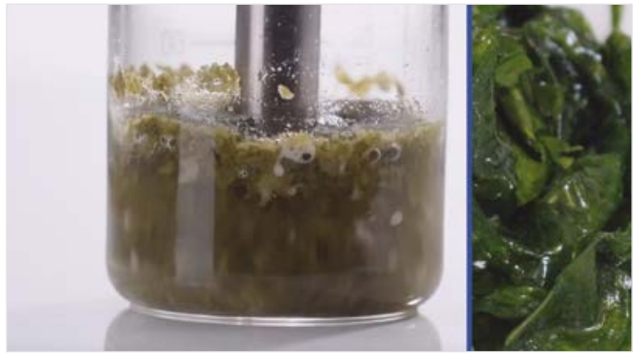
Examples of applications include:

- Disagglomeration as sample preparation for particle size analysis
- Homogenising of waste, wastewater, food samples for content analysis
- Extraction of components, for example minerals from soil, etc.
- Degassing of sparkling drinks for undisturbed analysis of the contents

It is possible to sonicate volumes from µl quantities up to 3,000 ml in stationary operation, and up to 100 l/h in a flow-through vessel made of glass or stainless steel. The solution to be treated can also be routed through the sonication vessel multiple times in a circuit.
In the case of samples consisting of large pieces, comminution in advance is often practical. If necessary, simple cooling is also possible (ice bath, flow-through cooling jacket). The pulsation mode (cyclical sonication) avoids rapid warming on the one hand, and achieves good swirling of the sample on the other.
Long probes are especially suited for the sonication of ceramic suspensions or for sample preparation for particle size analysis, for example.

Disruption of cells, microorganisms and tissue

The ultrasonic homogeniser has been established as the standard method for disruption of cells of all types, for decades. It is possible to disrupt bacteria, yeasts, fungi, eukaryotic or plant cells, tissue, algae and even microalgae. The broad range of variation of the power input is particularly relevant in this respect, as it allows control over the degree of disruption. Fragmentation of DNA, for example, is also possible if desired. An excessively high power input may lead to a high degree of disruption or to unnecessary heating of the sample. Cooling is recommended for the majority of cases, in this respect. To some extent, indirect sonication is also given preference. Even very small quantities in the µl range can be sonicated well and with ease.



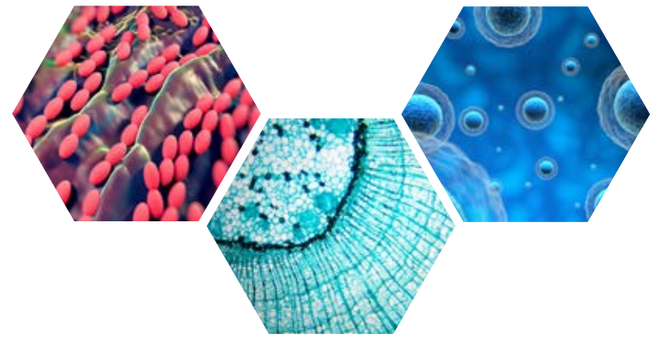
Cell disruption

Sonication with an ultrasonic homogeniser makes it possible to achieve short disruption times, especially for bacteria. 20 ml of a 20% yeast cell solution can be disrupted in 20 min (use of glass beads). In the case of animal cells, which are encased in only one outer membrane, a significantly shorter disruption time is achieved than with alternative methods. The time needed ranges from only a few seconds to 5 min.
In the case of plant cells, up to 15 min are needed since the cells possess one additional shaping membrane. Thermal damage to the cell contents can be prevented by employing pulsation, i.e., periodic interruption of the power supply. In addition, respectively suitable time intervals can be set on the device. Cooling down is possible during the pulse pause.
In addition, cooling vessels made of glass or stainless steel may be used, making temperature control through the use of liquid cooling agents possible during sonication.

The use of rosette cells, in which the sample is repeated and evenly sonicated thanks to the design of the side arms, is also suitable. Cooling is possible with ease, for example by positioning the vessel in an ice bath. Larger quantities can be sonicated in a flow-through vessel which, just like the cooling vessels, is also equipped with a cooling jacket.

Direct sonication with micro tips is helpful for particularly-resistant bacteria, fungi and spores, since this method makes a higher power density possible.
It should be mentioned again at this point that the probes are produced from a titanium alloy and are thus both thermally stable and autoclavable.

Direct sonication of µl quantities in 2 ml plastic vials with the 20-W-SONOPULS is regularly employed with success in practice. Alternatively, µl quantities can also be sonicated indirectly in the beaker resonator.
This can prove the better alternative if too intense splashing occurs in direct sonication. However, the attainable po-wer densities are lower, but cell disruption is still possible in many cases.



Tissue disruption

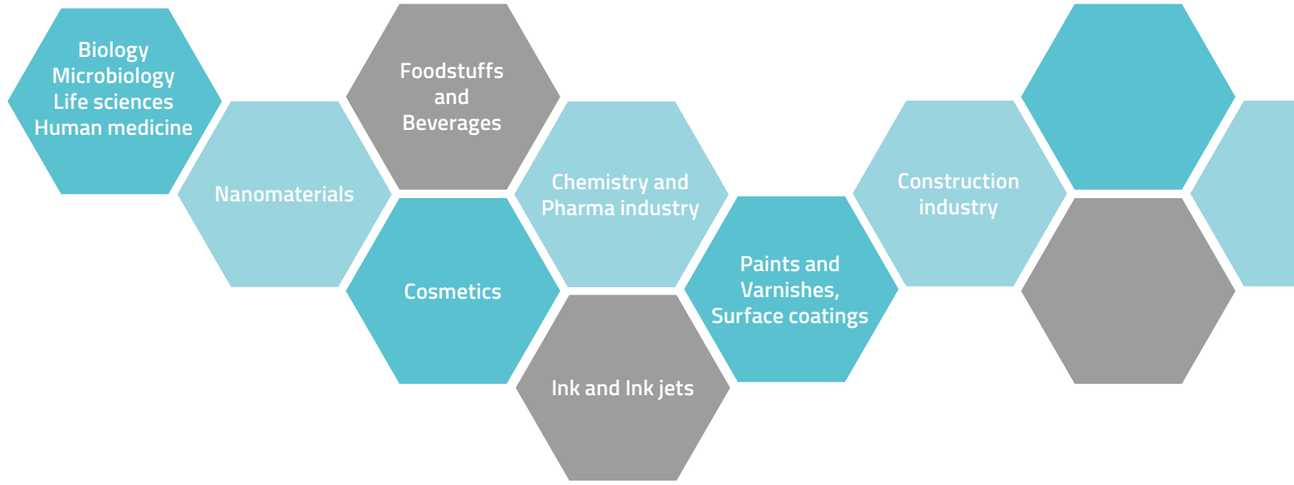
Another interesting application is the use of ultrasound for tissue disruption, particularly for difficult tissues such as the brain, liver, bladder, aorta, kidneys, lungs, skin, muscles, bone, heart muscle and fibrins.
If an intact piece of tissue is sonicated, the piece of tissue and the probe must be in contact. Possible rapid heating of the sample may render cooling necessary.
The material, shape and size of the sample vessel are also decisive. Sample vessels made of thin glass, such as Pyrex or Vycor, have a tendency to break when the probe is pressed against the walls of the vessel.
The use of stainless steel centrifuge tubes and "cold shoulder cooling cells" is recommended. These are thin stainless steel test tubes with a comb shape on the sides and a dimple on the bottom. The comb shape increases the transfer of heat and the dimple provides a "resting place" for the tissue. If the cell is placed in an ice bath, the temperature of the tissue can be kept at 5°C using a magnetic stirrer.

With skin, effective disruption is only possible if the probe is placed on the tissue and pressed against the bottom of the vessel. Even faster results are obtained if glass beads (diameter up to 0.5 mm) are added to the solution, which fall to the bottom of the vessel after sonication and can then be centrifuged or filtered out.
A good ratio is 1/3 glass beads to 2/3 solution.
With this approach, 4 minutes are required for the disruption of 1 g of skin. If it is not possible to add glass beads, enzymes such as hyaluronidase can be used to dissolve the connected tissue. The sample vessel should be filled with sufficient liquid in order to prevent foaming, although this is only a problem with minute volumes.
It is also possible to place a plastic ring or wire on the surface of the liquid, and thus prevent heavy surface or circular movements. Very small tissue pieces can be well disrupted with a micro tip in a narrow vessel.

Cutting the tissue into small pieces is not especially advantageous unless it is to "flow-through freely" beneath the probe. In such a case, the probe may not be positioned directly on the tissue.
If freezing and grinding are possible, the probe must not touch the tissue. It is also possible to sonicate larger quantities. The following is a simple method for sonicating larger quantities, for example 10 g of liver:
The tissue is liquefied for 10 s in a high-speed mixer. The probe is then immersed in the liquid and sonicated for 15 s. If subcellular elements are to remain intact, the operation should use a lower amplitude and perhaps a longer sonication time.

Sonochemistry

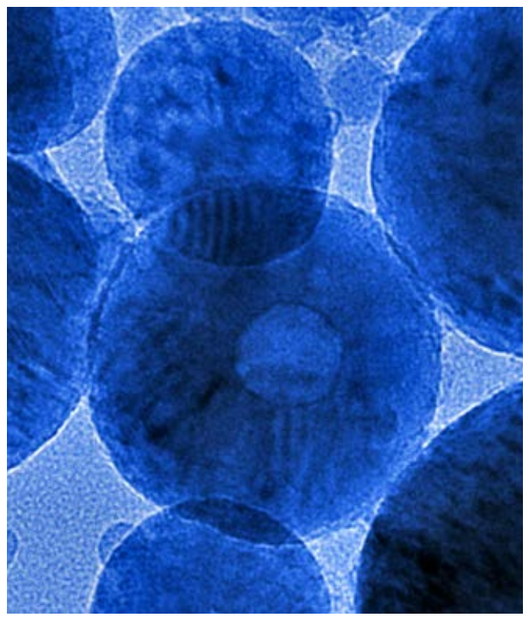
The term 'sonochemistry' refers to the use of ultrasound to influence chemical reactions or polymerisation. Effects that are desired and achieved through such use include an increase of the reaction speed and yield overall or of individual reactants / catalysts, or the influencing of the reaction pathway. In some cases, reactions only occur at all if power is applied via an ultrasonic homogeniser. The effects are understandably extremely case-specific and thus the testing and development of methods can prove very beneficial.



Branches with ultrasonic applications

Biology – Microbiology – Life sciences – Human medicine

The disruption of cells or tissue is an established method for obtaining good results with a wide range of cell and tissue types. With respect to the volumes, there are absolutely no restrictions, whether microvials in labs or applications at production level.
Fermentation processes can be activated or accelerated and cells disrupted on a grand scale. A special setup optimises the turnover in biogas plants.



Nanomaterials

Nanomaterials are in widespread use today and there is a whole spectrum of products on offer, so it is not surprising that the range of applications for ultrasonic homogenisers in this field is equally broad. Classic applications include the disagglomeration of nanoparticles in solutions for further use, particle size analysis and the suspension of nanoparticles in solutions for further processing, for toxicity tests, etc.
Ultrasonic homogenisers are also used in the production of nanomaterials, where they contribute to acceleration, controlling reactions, preserving defined particle structures, etc. Further tried and tested applications include the positive influencing of the production of surface coatings and functionalisation / phase transfers of nanoparticles. With respect to the volumes, there are absolutely no restrictions, whether of microvials in labs or applications at production level.

Foodstuffs and Beverages

Foodstuffs often need to be homogenised in a liquid phase before they can be analysed. This can be achieved very easily, rapidly and efficiently with the ultrasonic homogeniser. The high power input generates smaller particles and thus achieves a more homogeneous distribution. In many cases, the addition of solvents is no longer necessary and smaller sample quantities can be used. The main area of use for ultrasonic homogenisers is the treatment and preparation of samples, homogenising and extracting all types of substances. The variety of samples is extensive.
The sonication of hard cheese, cottage cheese, salami and ham, for example, has proven very successful in practice. In the beverage industry, degassing via ultrasonic homogenisers is a particularly widespread practice both for subsequent analysis and for further processing requirements. 0.5 l beer is degassed, for example, in 1 minute at 100% amplitude and 50% pulsation.

Puréed meat was compared with ultrasound-homogenised meat.
Using the ultrasonic homogeniser made it possible to save both time and energy, plus a smaller sample quantity was required! Furthermore, for example, 50 g of frozenfish were homogenised in less than 1 min without the addition of a solvent. Cheese, especially cream cheese, is often homogenised in practice for sample preparation for analysis (e.g., nitrate determination) with excellent application advantages, namely simple handling and very rapid cleaning. It has been documented that very reliable analysis results are obtained.

Microbial processes such as fermentation, cell disruption, enzyme activation, etc., can be supported / performed in a myriad of ways. Autosamplers can be employed for larger sample flow-throughs in sample preparation. All processes such as homogenising, dispersing, suspending, emulsifying and degassing can be performed with sonoreactors in individual setups at production level.
Different companies and investigating bodies have performed a range of reference investigations in combination with universities. At one university, for example, a process for the rapid and gentle isolation of fat was developed for determination of the intramuscular fat and fatty acid pattern in pork. To this end, 50 pork chop samples were investigated.

Cosmetics

Emulsions and suspensions are the keystones of products as well as development, analysis and production processes in the cosmetics industry. As already described, the sonication with the ultrasonic homogeniser produces emulsions and suspensions with outstanding characteristics combined with simple handling and optimal flexibility in terms of the setting of the properties (droplet / particle size, stability, etc.).
Another field of application is the extraction of contents from plants, which is possible rapidly, efficiently and with high yields. Both the extraction time and the required extraction temperature are more cost-effective for a wide range of applications than with other extraction methods. The combination of classic extraction methods with the ultrasonic homogeniser has also proven successful in some cases. These processes can be employed in a laboratory or at production level with customised technology constellations. The ultrasonic homogeniser has also established itself excellently in the sample preparation for analysis for cosmetics, be it for particle size analysis, the homogenising of hydrophobic substances with high fat contents such as make-up, lipstick and mascara for analysis of the ingredients (e.g. via HPLC), or other analysis techniques.

Chemistry and Pharma industry

The broad spectrum of products and processes in these two branches gives rise to the enormous number of possible applications for the procedures described above with the ultrasonic homogeniser, in laboratories and the sonoreactors at production level. On the one hand, there are the physical procedures of suspending and emulsifying for additives such as pigments or other supplementary components for lubricating oils, formula, etc. On the other hand, sonochemistry allows for the direct influencing of chemical reactions or polymerisations with regard to the yield, reaction speed, reaction control, etc. The overlaps between the pharma, chemical, phyto, cosmetics, life sciences and nanomaterials industries are now very high and the transitions are seamless.
As such, applications such as extraction, cell disruption and disagglomeration (for example for particular polymer structures) are also worth mentioning here. In order to avoid unnecessary repetition, these aspects are not all dealt with in detail here. For further information, please refer to the individual parts of chap. 4 for the basic application possibilities and other similar topics addressed in this section.

Ink and Ink jets

The dispersion of ink pigments is an outstandingly introduced ultrasonic homogeniser application. As particle sizes down to the low nanometre range can be achieved, it is possible to produce particularly finely dispersed inks with resulting products that have correspondingly high-qualitycharacteristics. It is possible to sonicate both water-based and solvent-based inks. An additional advantage is particularly reliable process control. It is also true that both process development at the laboratory level and up-scaling to production processes are possible with good results.

Paints and Varnishes, Surface coatings

Pigments, fillers and additives of all kinds can be effec-tively added to varnishes, paints and other surface coatings using ultrasound. Ultrasonic homogenisers are also used very successfully in the field of nanoparticles in laboratories and sonoreactors in production departments. For all tasks involving dispersing, emulsifying, suspending, disagglomeration, defoaming or degassing, ultrasound is a tried and tested means of conducting processes and optimising product features as described above. Ultrasound can also be employed outstandingly in the ever more desired changeover of solvent-based to water-based products and the reduction of VOCs, be it in product development in the laboratory or in the sonoreactor in production following upscaling. Disagglomeration or homogenising for sample preparation via an ultrasonic homogeniser can also be successfully employed in the field of analytics. There are also application possibilities in the field of synthesis, such as mini emulsion polymerisation to name but one example.

Construction industry

Ceramics and cement manufacturers, among others, employ ultrasonic homogenisers for a wide range of applications. The predispersing of slips and the suspension of substances such as aluminium oxide, silicon dioxide, etc., as well as sample preparation for particle size analysis are all examples of practical applications. Here too, the production process, such as the production of cement, can be influenced positively.

Detailed applications
Examples from the practice

04

Detailed applications
A word in advance

Short explanations of the following practical examples.

page 76

Overview of applications

Tabular classification according to processes and industries.

from page 78

Publications

Recommendations for further literature on ultrasonic homogenisers and their applications.

page 87

Detailed applications

A word in advance

The ultrasonic homogeniser's method, in other words the direct application of ultrasonic power to the sample, has proven its worth as a complement to the old, familiar, laboratory ultrasonic baths, which have proven themselves in practice for decades. Foodstuffs, soil, waste, nanoparticles, materials, cosmetics, pharmaceuticals, biotechnology, microbiology, life sciences and chemistry are just some of the fields in which the ultrasonic homogeniser, manufactured by BANDELIN since 1964, is already in use.

The application guide has been produced in response to our customers' suggestions and for the benefit of our existing and potential customers. And not only that: it has also been compiled in cooperation with our customers. Users report on their practical experiences and make available the method parameters that they have employed successfully. Last but not least, this third edition includes the experiences and knowledge collected in our ultrasound application seminars, in which we delved into the world of ultrasonics with theory and practice reports. The discussions and practical applications using the participants' samples resulted in an array of new experiences for the successful application of the devices. How can the devices be used successfully, how can they be optimally integrated into existing processes and what product features and information are important to users?

Whenever the task involves

- homogenising, suspending, emulsifying,
- sample preparation for analysis,
- disagglomerating, extracting,
- cell and tissue disruption or
- sonochemistry,

the use of the ultrasonic homogeniser is of interest as long as a liquid medium is available.

HD 4200 with TS 113

The number of applications in a certain application field is not directly related to the suitability of the ultrasonic homogeniser for these applications. It can be largely attributed to the segments in which the use of the ultrasonic homogeniser has been established in practice for many years and those where the viability was only recently "discovered", often with particular success. The detail provided for each application is another criterion. Whereas individual description of the cell disruption for many different organisms appears practical, in other areas such as that of degassing, a general application is sufficient.

Ultimately, we can adopt as many varieties of the practice examples in this collection as are provided by cooperative users.

The collection of applications is expanding all the time. We are happy to receive any feedback concerning interesting applications.

The overview shows you which applications are already written down in practice reports. We will be delighted to send you the corresponding application notes on request (info@bandelin.com). If the application you are looking for is not there, please contact us. We will surely be able to provide you with some pointers.

Classification based on process

Dispersing, suspending

Number	Working area	Branch	Title
C-104	Dispersing/ suspending	Materials	Dispersing of carbon nanoparticles in processing oil
C-105	Dispersing/ suspending	Materials	Dispersing of ceramic raw materials and glass powder
C-107	Dispersing/ suspending	Pharma	Production of ultrafine pharmaceutical emulsions
C-108	Dispersing/ suspending	Polymers	Production of microcapsules with monomers
C-109	Dispersing/ suspending	Materials	Dispersing of solids such as aluminium oxide and silicone dioxide
C-202	Dispersing/ suspending	Materials	Suspending of multi-walled carbon nanotubes (MWCNTs). GFRPs and other hard-to-dissolve materials
C-203	Dispersing/ suspending	Materials	Sample preparation of ceramic suspensions for particle measurement – particle size analysis
C-207	Dispersing/ suspending	Polymers	Production of polymer particle suspensions
L-102	Dispersing/ suspending	Foodstuffs	Production of hop emulsions
C-301	Dispersing/ suspending	Materials	Producing ceramic slurries (Al_2O_3in water)
C-302	**Sample preparation**	Cosmetics	Sample preparation of cosmetics in organic and aqueous solvents
C-303	Dispersing/ suspending	Materials	Dispersing titanium dioxide in oil or water
C-304	Sample preparation	Miscellaneous	Dispersing of ettringite, aluminium and silicon dioxide for particle size analysis
C-305	Dispersing/ suspending	Materials	Dispersing of solids such as very fine titanium dioxide or aluminium oxide

Disagglomeration

Number	Working area	Branch	Title
B-208	Disagglomeration	Microbiology	Separation of yeasts for determination of the vital cell count
C-101	Disagglomeration / particle size analysis	Materials	Disagglomeration of tungsten powder for subsequent particle size determination
C-102	Disagglomeration / particle size analysis	Materials	Dispersing of fine metal powder (Al) for subsequent particle size determination
C-106	Disagglomeration / particle size analysis	Water /waste-water	Disagglomeration of water sediment samples in preparation for particle size analysis
C-111T	Disagglomeration / particle size analysis	Materials	Disagglomeration as sample preparation for particle size analysis – Tabular overview
C-204	Disagglomeration / particle size analysis	Materials	Sample preparation for the particle size measurement of catalyst dispersions
C-208	Disagglomeration / particle size analysis	Foodstuffs	Homogenising of solid food supplements in water for sample preparation for particle size analysis
C-211	Disagglomeration	Materials	Disagglomeration of IONP produced using the coprecipitation method
C-304	Sample preparation	Miscellaneous	Dispersing of ettringite, aluminium and silicon dioxide for particle size analysis
C-305	Dispersing/ suspending	Materials	Dispersing of solids such as very fine titanium dioxide or aluminium oxide
C-306	Disagglomeration	Materials	Desagglomeration of ceramic nanoparticles

Degassing, defoaming

see „Degassing, defoaming“, page 86

Extraction

Number	Working area	Branch	Title
C-201	Extraction	Soil	Extraction of exchangeable magnesium from soil
C-206	**Extraction**	Paints / varnishes	Extraction of oily ingredients from dried varnish
U-301	Extraction	Soil	Extraction of water-soluble ions from soils
U-303	Extraction/ Sample preparation	Soil	Extraction/Homogenising of soil samples in liquids to analyse minerals like Mg, K, P, N

Sample preparation for analysis (except particle size analysis)

Number	Working area	Branch	Title
B-114	Sample preparation	Medicine	Homogenising of sperm for determination of quantity
B-212	**Sample preparation**	Molecular biology	Dissolving of peptides as sample preparation for analysis
C-110	**Sample preparation**	Water / wastewater	Sample preparation of wastewater samples
C-112T	**Sample preparation**	Miscellaneous	Sample preparation for analysis for soil and wastewater samples
C-205	**Sample preparation**	Cosmetics	Homogenising of cosmetics in solvents for sample preparation for analysis
C-210	**Sample preparation**	Water / wastewater	Sample preparation of wastewater containing particles, for TOC determination as per DIN EN 1484
L-101	**Sample preparation**	Foodstuff	Fast and gentle isolation of fat for fatty acid determination in meat – Method improvement

Number	Working area	Branch	Title
L-103	**Sample preparation**	Foodstuffs	Identification of fatty acid distribution in bovine milk
L-201	**Sample preparation**	Foodstuffs	Sample preparation for determination of nitrate content in cheese (xylenol process)
L-202	**Sample preparation**	Foodstuffs	Sample preparation for potentiometric determination of chloride content in cheese
L-203	**Sample preparation**	Foodstuffs	Sample preparation for potentiometric determination of chloride content in cheese
L-204	**Sample preparation**	Foodstuffs	Sample preparation / homogenising of cheese and other foodstuffs and extraction of relevant analytes
U-203	**Sample preparation**	Water / wastewate	Sample preparation at a sewage plant
C-302	**Sample preparation**	Cosmetics	Sample preparation of cosmetics in organic and aqueous solvents
C-304	Sample preparation	Miscellaneous	Dispersing of ettringite, aluminium and silicon dioxide for particle size analysis
L-301	**Sample preparation**	Foodstuffs	Homogenising of frozen human milk and disruption of fat globules and disruption of fat globules
U-301	Extraction	Soil	Extraction of water-soluble ions from soils
U-302	Sample preparation	Waste	Preparation of waste samples
U-303	Extraction/ Sample preparation	Soil	Extraction/Homogenising of soil samples in liquids to analyse minerals like Mg, K, P, N

Sample preparation for particle size analysis

see „Desagglomeration“, page 98

Cell and tissue disruption

Cell disruption

Number	Working area	Branch	Title
B-101	Cell disruption	Molecular biology	Cell and tissue disruption, including in µl-batches with indirect sonication in a beaker resonator
B-102	**Cell disruption**	Molecular biology	Cell disruption of yeast cells
B-108T	**Cell disruption**	Molecular biology	Cell disruption of Escherichia coli bacteria – tests with diverse parameters with the SONOPULS
B-109	**Cell disruption**	Molecular biology	Cell disruption of Pseudomonas thailandensis
B-110	**Cell disruption**	Molecular biology	Lysis and fragmentation of cell cultures via indirect sonication in the scope of cancer research
B-111	**Cell disruption**	Molecular biology	Procurement of proteins for the western blot technique, e.g., for evidence of HIV or other infections
B-112	**Cell disruption**	Molecular biology	Cell disruption of eukaryotic cells as preliminary step to protein isolation
B-113	**Cell disruption**	Molecular biology	Cell disruption of insect cells as preliminary step to protein isolation
B-115	**Cell disruption**	Molecular biology	Cell disruption of mammalian cells
B-117	**Cell disruption**	Molecular biology	Production of lysates from purchased cell cultures for antibody reactions
B-119T	**Cell disruption**	Molecular biology	Cell disruption of different organisms and cells – Tabular overview
B-201	**Cell disruption**	Molecular biology	Cell disruption of E. coli in volumes from µl to l
B-203	**Cell disruption**	Algae	Cell disruption of Haematococcus pluvialis microalgae for carotinoid analysis
B-205	**Cell disruption**	Molecular biology	Cell disruption of Escherichia coli for protein analysis
B-206	**Cell disruption**	Molecular biology/ Medicine	Cell disruption of human cells
B-207	**Cell disruption**	Algae	Cell disruption of microalgae and cyanobacteria
B-209	**Cell disruption**	Molecular biology	Production of cell lysates of eukaryotic cells in different volumes
B-211	**Cell disruption**	Molecular biology	Cell disruption for enzyme processing for E. coli or fungi cultures
B-302	**Cell disruption**	Molecular biology	Time-efficient disruption of human cells
B-305	**Cell disruption**	Materials	Disruption of Acetobacter xylinum
B-306	**Cell disruption**	Genetics	Disruption of Erythrocytes for the paternity test
B-307	**Cell disruption**	Biochemistry	Disruption of Candida albicans
B-308	**Cell disruption**	Microbiology	Disruption of Staphylococcus aureus
B-309	**Cell disruption**	Microbiology	Disruption of Streptococcus
B-310	**Cell disruption**	Microbiology	Disruption of Pseudomonas aeruginosa
B-311	**Cell disruption**	Microbiology	Disruption of Enterobacter for protein isolation

Tissue disruption

Number	Working area	Branch	Title
B-106	Tissue disruption	Tissue	Tissue disruptions, especially also for difficult tissues
B-107	Tissue disruption	Tissue	Tissue disruption of larger quantities, e.g., liver
B-116	Tissue disruption	Molecular biology	Production of protein lysates from tissue
B-118T	Tissue disruption	Tissue	Tissue disruption applications – Tabular overview
B-202	Tissue disruption	Toxicology	Tissue disruption –Homogenising of organs in forensic medicine
B-301	Tissue disruption	Molecular biology	Homogenising of mouse tissue for RNA isolation
B-304	Tissue disruption	Biochemistry	Disruption of dermal tissue

Miscellaneous

Number	Working area	Branch	Title
B-103	Miscellaneous	Medicine	Procurement of stroma-free haemolysate from EDTA blood for paternity testing
B-104	Miscellaneous	Molecular biology	Liposome production
B-105	Miscellaneous	Molecular biology	Replication of infectious prions – process acceleration via ultrasound
B-204	Miscellaneous	Molecular biology	Homogenising of peptide with Freund's adjuvant
B-210	DNA isolation	Molecular biology	Disruption of FFPE tissue for DNA isolation
C-103	Miscellaneous	Polymers	Degradation of cellulose using ultrasound
C-209	Miscellaneous	Materials	Phase transfer of iron oxide nanoparticles
B-303	**Cell disruption**	Biochemistry	Disruption of plant cells
B-305	**Cell disruption**	Materials	Disruption of Acetobacter xylinum
B-306	**Cell disruption**	Genetics	Disruption of Erythrocytes for the paternity test
B-307	**Cell disruption**	Biochemistry	Disruption of Candida albicans
B-308	**Cell disruption**	Microbiology	Disruption of Staphylococcus aureus
B-309	**Cell disruption**	Microbiology	Disruption of Streptococcus
B-310	**Cell disruption**	Microbiology	Disruption of Pseudomonas aeruginosa
B-311	**Cell disruption**	Microbiology	Disruption of Enterobacter for protein isolation
B-312	DNA-Fragmentation	Microbiology	Fragmentation of nucleic acid – synthetically degrated DNA

Classification by branches / working areas

Materials

Number	Working area	Branch	Title
C-101	**Disagglomeration / particle size analysis**	Materials	**Disagglomeration of tungsten powder for subsequent particle size determination**
C-102	**Disagglomeration / particle size analysis**	Materials	Dispersing of fine metal powder (Al) for subsequent particle size analysis
C-104	**Dispersing/ suspending**	Materials	Dispersing of carbon nanoparticles in process oils
C-105	**Dispersing/ suspending**	Materials	Dispersing of ceramic raw materials and glass powder
C-109	**Dispersing/ suspending**	Materials	Dispersing of solids such as aluminium oxide and silicone dioxide
C-111T	**Disagglomeration / particle size analysis**	Materials	**Disagglomeration as sample preparation for particle size analysis – Tabular overview**
C-202	**Dispersing/ suspending**	Materials	Suspending of multi-walled carbon nanotubes (MWCNTs). GFRPs and other hard-to-dissolve materials
C-203	**Dispersing/ suspending**	Materials	Sample preparation of ceramic suspensions for particle measurement – particle size analysis
C-204	**Disagglomeration / particle size analysis**	Materials	Sample preparation for the particle size measurement of catalyst dispersions
C-209	**Miscellaneous**	Materials	Phase transfer of iron oxide nanoparticles
C-211	**Disagglomeration**	Materials	Disagglomeration of IONP produced using the coprecipitation method

Polymers / paints and varnishes

Number	Working area	Branch	Title
C-103	Miscellaneous	Polymers	Degradation of cellulose using ultrasound
C-108	**Dispersing/ suspending**	Polymers	Production of microcapsules with monomers
C-206	**Extraction**	Paints/ varnishes	Extraction of oily ingredients from dried varnish
C-207	**Dispersing/ suspending**	Polymers	Production of polymer particle suspensions

Environment

Number	Working area	Branch	Title
C-106	**Disagglomeration / particle size analysis**	Water / waste-water	Disagglomeration of water sediment samples in preparation for particle size analysis
C-110	**Sample preparation**	Water / waste-water	Sample preparation of wastewater samples
C-201	Extraction	Soil	Extraction of exchangeable magnesium from soil
C-210	**Sample preparation**	Water / waste-water	Sample preparation of wastewater containing particles for TOC determination as per DIN EN 1484
U-203	**Sample preparation**	Water / waste-water	Sample preparation at a sewage plant

Life sciences / molecular biology

Number	Working area	Branch	Title
B-101	Cell disruption	Molecular biology	Cell and tissue disruption, including in µl-batches with indirect sonication in a beaker resonator
B-102	**Cell disruption**	Molecular biology	Cell disruption of yeast cells
B-103	Miscellaneous	Medicine	Procurement of stroma-free haemolysate from EDTA blood for paternity testing
B-104	Miscellaneous	Molecular biology	Liposome production
B-105	Miscellaneous	Molecular biology	Replication of infectious prions – process acceleration via ultrasound
B-108T	**Cell disruption**	Molecular biology	Cell disruption of Escherichia coli bacteria – tests with diverse parameters with the SONOPULS
B-109	**Cell disruption**	Molecular biology	Cell disruption of Pseudomonas thailandensis
B-110	**Cell disruption**	Molecular biology	Lysis and fragmentation of cell cultures via indirect sonication in the scope of cancer research
B-111	**Cell disruption**	Molecular biology	Procurement of proteins for the western blot technique, e.g., for evidence of HIV or other infections
B-112	**Cell disruption**	Molecular biology	Cell disruption of eukaryotic cells as preliminary step to protein isolation
B-113	**Cell disruption**	Molecular biology	Cell disruption of insect cells as preliminary step to protein isolation
B-115	**Cell disruption**	Molecular biology	Cell disruption of mammalian cells
B-116	Tissue disruption	Molecular biology	Production of protein lysates from tissue
B-117	**Cell disruption**	Molecular biology	Production of lysates from purchased cell cultures for antibody reactions
B-119T	**Cell disruption**	Molecular biology	Cell disruption of different organisms and cells – Tabular overview
B-201	**Cell disruption**	Molecular biology	Cell disruption of E. coli in volumes from µl to l
B-204	Miscellaneous	Molecular biology	Homogenising of peptide with Freund's adjuvant
B-205	**Cell disruption**	Molecular biology	Cell disruption of Escherichia coli for protein analysis
B-206	**Cell disruption**	Molecular biology/ medicine	Cell disruption of human cells
B-209	**Cell disruption**	Molecular biology	Production of cell lysates of eukaryotic cells in different volumes
B-210	DNA isolation	Molecular biology	Disruption of FFPE tissue for DNA isolation
B-211	**Cell disruption**	Molecular biology	Cell disruption for enzyme processing for E. coli or fungi cultures
B-212	**Sample preparation**	Molecular biology	Dissolving of peptides as sample preparation for analysis
B-301	Tissue disruption	Molecular biology	Homogenising of mouse tissue for RNA isolation
B-302	**Cell disruption**	Molecular biology	Time-efficient disruption of human cells
B-306	**Cell disruption**	Genetics	Disruption of Erythrocytes for the paternity test
B-308	**Cell disruption**	Microbiology	Disruption of Staphylococcus aureus
B-309	**Cell disruption**	Microbiology	Disruption of Streptococcus
B-310	**Cell disruption**	Microbiology	Disruption of Pseudomonas aeruginosa
B-311	**Cell disruption**	Microbiology	Disruption of Enterobacter for protein isolation
B-312	DNA-Fragmentation	Microbiology	Fragmentation of nucleic acid – synthetically degrated DNA

Medicine / toxicology / microbiology / algae

Number	Working area	Branch	Title
B-103	Miscellaneous	Medicine	Procurement of stroma-free haemolysate from EDTA blood for paternity testing
B-114	**Sample preparation**	Medicine	Homogenising of sperm for determination of quantity
B-202	Tissue disruption	Toxicology	Tissue disruption –homogenising of organs in forensic medicine
B-203	**Cell disruption**	Algae	Cell disruption of Haematococcus pluvialis microalgae for carotinoid analysis
B-207	**Cell disruption**	Algae	Cell disruption of microalgae and cyanobacteria
B-208	Disagglomeration	Microbiology	Separation of yeasts for determination of the vital cell count

Foodstuffs

Number	Working area	Branch	Title
C-208	**Disagglomeration/ particle size analysis**	Foodstuffs	Homogenising of solid food supplements in water for sample preparation for particle size analysis
L-101	**Sample preparation**	Foodstuffs	Fast and gentle isolation of fat for fatty acid determination in meat – Method improvement
L-102	**Dispersing/ suspending**	Foodstuffs	Production of hop emulsions
L-103	**Sample preparation**	Foodstuffs	Identification of fatty acid distribution in bovine milk
L-201	**Sample preparation**	Foodstuffs	Sample preparation for determination of nitrate content in cheese (xylenol process)
L-202	**Sample preparation**	Foodstuffs	Sample preparation for potentiometric determination of chloride content in cheese
L-203	**Sample preparation**	Foodstuffs	Sample preparation for potentiometric determination of chloride content in cheese
L-204	**Sample preparation**	Foodstuffs	Sample preparation / homogenising of cheese and other foodstuffs and extraction of relevant analytes

Pharma / Cosmetics

Number	Working area	Branch	Title
C-107	**Dispersing/ suspending**	Pharma	Production of ultrafine pharmaceutical emulsions
C-205	**Sample preparation**	Cosmetics	Homogenising of cosmetics in solvents for sample preparation for analysis
C-302	**Sample preparation**	Cosmetics	Sample preparation of cosmetics in organic and aqueous solvents

Publications

You can find articles in which a wide variety (a few hundred) of our SONOPULS applications are explained, in select publications and on the internet using the keywords SONOPULS and BANDELIN.

Probenvorbereitung zur Bestimmung von Partikelgrößen – Desagglomeration mit Ultraschall-Homogenisatoren

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Published in GIT Labor-Fachzeitschrift, No. 01 / 2018, page 24 – 26

Probenvorbereitung mit dem Ultraschall-Homogenisator – Einsatz im Analytiklabor nach Vergleich mit herkömmlicher Methode

(Einsatz des Ultraschall-Homogenisators für die Probenvorbereitung Lebensmittel (Käse))
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Lecture VDLUFA Annual Congress 2016 in Rostock, published in VDLUFA series of publications 73 (2016), 598

Moderne Probenvorbereitung mit Ultraschall-Homogenisatoren – Praxistest für Lebensmittel und Gewebe

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Published in GIT Labor-Fachzeitschrift, No. 11/2014, page 44 – 46

Ultraschallanwendungen in Technik und Produktion

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Published in LABO, No. 09/2016, page 40 – 42

Effiziente Probenvorbereitung für die Partikelanalyse

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Published in Chemie Extra, No. 06/2018

Preparing a Sample for Determining the Size of Particles

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Published in GIT Journal:
www.laboratory-journal.com/science/material-science/preparing-sample-determining-size-particles
November 30th, 2018

Viel Energie, wenig Aufwand

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Published in LABO, No. 02/2019, page 43 – 44

Service
We are the specialists for ultrasound in laboratory

05

SONOPULS Ultrasonic homogenisers and accessories for rent

Rent one of our ultrasonic homogenisers for a specific period only.

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FAQ

The most important questions, shortly answered.

from page 92

Your contact person for the laboratory area

Let yourself be competently and personal advice from our expert.

page 94

SONOPULS Ultrasonic homogenisers and accessories for rent

Do you need an ultrasonic homogeniser to test your application? We will provide you with a device free of charge for 3 weeks. A rental fee will be charged starting the 4th week.

Rentals are only available within Germany and are only offered to commercial customers.

A few steps to the rental unit

1 Download the questionnaire on our web-site or request it by phone or mail. Fill out part A here and return it to us by may.

For more Information:
bandelin.com/en/service/

2 We select the appropriate SONOPULS and accessories based on your planned application. You will receive the rental agreement, sign it and return it to us.

3 Let's get started: The ultrasonic homogeniser will be delivered at the agreed place and time.

4 After use, you return the device to us together with a completed Certificate of Decontamination.

Download the decontamination certificate:
bandelin.com/fragebogen/Dekontamination_GB_BANDELIN.pdf

FAQ

FAQ concerning practical application

Selection of the working frequency: 20 or 40 kHz?
40 kHz is generally used for homogenising or mixing because the cavitation bubbles formed are smaller than at 20 kHz. Thus, these bubbles have less force during the implosion phase.

Are there technical limits to the use of ultrasound?
A) Viscosity - the higher the sample viscosity, the lower the ability to transmit the sound waves into the sample. Maximum viscosity approx. 1500 mPa s - own tests are recommended for higher viscosities.
B) Temperature – max. 80°C in continuous operation

Sample liquid splashes out of the vessel.
What do I need to change? Possible solutions:
- Set a lower amplitude and test whether the result is still satisfactory
- Use conical vessels
- Increase the immersion depth

My sample fluid foams a lot. How can I prevent that?
- Increase the immersion depth
- Add glass beads
- Use a conical vessel
- Place wire on the surface of the sample

How deep should I insert the probe?
Normally min. 0.5 and max. 2 cm. Immersion that is too deep results in dampening of the probe that is too severe. This results in insufficient application of power to the sample. In Eppendorf cups, as far as possible – ensure that the sample does not foam!

Can the probe touch the vessel during sonication?
No. This can result in damage to the probe and the vessel (melting, breakage).

Can I touch the probe with my hands during the sonication process?
No. This can result in bone damage.

I want to separate / disagglomerate cells without destroying them. What do I need to change?
Reduce the amplitude or use a probe with a larger diameter.

How is the power for SONOPULS ultrasonic homogenisers measured?
During the measurement of power, the sonication vessel should be used for the standard trials.
This vessel is filled with water. The temperature increase can be measured for a set period of time and the power density calculated from the volume, temperature increase and elapsed time, using the familiar formula.
This is done using the following formula[1]:

$$P = \frac{\Delta Q}{\Delta t} = \frac{c \cdot m \cdot \Delta T}{\Delta t}$$

The following applies:

P	power [W]
ΔQ	supplied energy, in this case the amount of heat [Ws]
Δt	time [s]
ΔT	temperature difference [K]
m	test water mass [kg]
c	specific heat capacity $[\frac{J}{kg\,K}]$

Taking the volume of water into account, the volumetric power density can be calculated.
Further information can be requested from www.bandelin.com (power determination of SONOPULS ultrasonic homogenisers – 5169).

Can solvents be sonicated?
Yes, but safe extraction of vapours must be guaranteed!
Only small amounts!
Observe the flashpoint; cooling may be required!

1 The formula is only applicable for small volumes.

FAQ on equipment, samples, safety aspects

What should be done if the probe displays mild pitting?
At depths of up to approx. 1 mm, the probes should be carefully polished manually in your facility. For further information, refer to the instructions for use.

Are probes available in different lengths?
No. The probes are always calibrated to the resonance frequency and dictated by the design. They vary in the millimetre range depending on the acoustic properties of the titanium cast used (batch).

Do I need to take anything into consideration when Do I need to take anything into consideration when disposing of probes? disposing of probes?
Probes can be disposed of without any problems. They pose no hazards. They do not contain heavy metal and are thus environmentally friendly. Scrap dealers offer minor remuneration (titanium weighs very little but is valuable)

Can probes also be produced from another material?
Yes, but with the respective restrictions:
- **Quartz glass** – only low amplitudes are possible, as the material cannot withstand high amplitudes.
- **Ceramics** – permit higher amplitudes than quartz glass, but is liable to break.
- **Stainless steel** – very brittle. Breaks quickly and more likely to heat.
- **Aluminium** – too soft. A certain hardness is essential for prolonging cavitation erosion. Limited chemical resistance.

Is hearing protection necessary?
The ultrasonic homogeniser can be operated in a soundproof box, available for purchase from BANDELIN, please enquire for more information. Alternatively, hearing protection should be worn: capsule hearing protection with an HM value of 25 – 30 dB or similar ear plugs or coverings if capsule hearing protection is unsuitable for the respective application.

FAQ on standards and guidelines

Do ultrasonic homogenisers comply with the ROHS directives?
Yes, the devices comply with the ROHS directives.

A final word

We hope to have been able to provide you with a good overview of the options for the practical use of SONOPULS ultrasonic homogenisers. If you have any unanswered questions, please do not hesitate to contact us for a personal consultation. Feel free to send us your ideas for new contents in the application guide. We will also be delighted to adopt your customised methods as an application in our collection for community use.

Our individual applications can be requested in accordance with chap. 4 “Detailed applications” from:
Marina.Herrmann@bandelin.com

Your contact person for the laboratory field

We will pleased to advice you.

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