



# SONOPULS

## Ultrasonic homogenisers

SONOPULS Ultrasonic homogenisers are mainly used for homogenising, desagglomerating, emulsifying, suspending, acceleration of chemical reactions as well as for disruption of cells, bacteria, fungi or spores. Significantly reduced processing times and quickly available results make the ultrasonic homogenisers indispensable for modern processes and in analysis. Using ultrasonic homogenisers certain substances can

be selectively destroyed, tedious preparation processes can be shortened and results of many reactions are improved. When sonicating samples not only  $\mu\text{m}$  particles can be achieved but also particles in nm range!

With many years of experience in the field of ultrasonic homogenisers we assist you in your specific application.



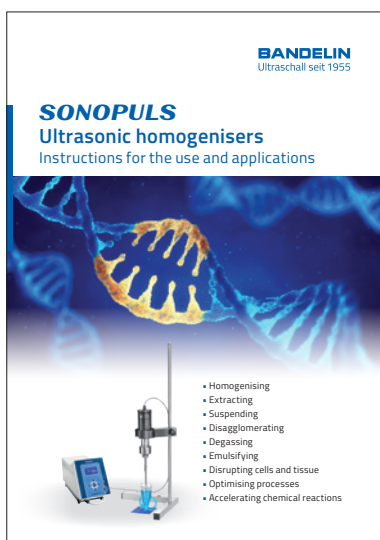
**1964**

Manufacture of the first ultrasonic homogeniser with tube generator  
**SONOREX HE 1**



**2020**

**SONOPULS** series 4000  
ultrasonic homogenisers



Our application guide can be requested:  
[info@bandelin.com](mailto:info@bandelin.com)

Take a look at our application video:  
[www.sonopuls.info](http://www.sonopuls.info)



# SONOPULS

## Applications

### Typical areas of application

- Disruption of cells without destroying the cell content
- Disruption of tissue, also mixed tissue
- Emulsifying of hardly mixable liquids, e. g. oil and water, particle size in nm range
- Deagglomeration of nanoparticles in material research (nanostructured material) in medicine, biotechnology, automobile industry
- Acceleration of chemical reactions
- Dispersing

### Analysis

- Preparing samples for grain size determination or environmental analysis
- Homogenising of cheese samples for determination of nitrates

### Biochemistry – Biology – Medicine

- Sonication of small high-quality samples for analysis like EIA or RIA
- Due to high amplitudes, disruption of either high-resistant bacteria, cells or tissues is possible. Indirect processing of samples in cup booster BR 30 or in cup horn BB 6 are recommended to avoid crosscontamination
- Detection of prions by cyclic amplification of protein misfolding

### Chemistry – Sonochemistry

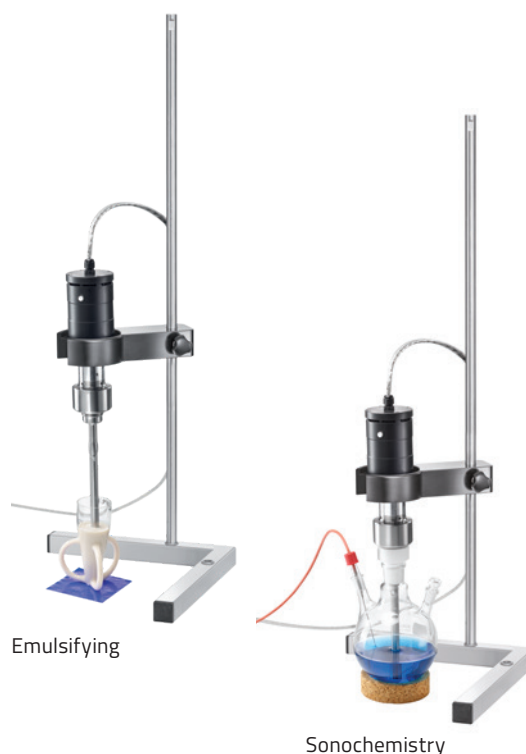
- Acceleration of chemical reactions or destroying of highly-molecular compounds

### Pharmacy – Cosmetics

- Production of larger volumes of long lasting emulsions, e.g. lotions and production of antigens, vaccines or liposomes

### General information (extract)

- 5119 General information on ultrasonic homogenisers
- 5169 Power determination
- 5159 Life span of probes
- 5972 Application guide



### Professional hints (extract)

### Molecular Biology – Microbiology – Pharmacy – Medicine

- B-101 Protein extraction by indirect sonication
- B-102 Disruption of yeasts cells
- B-103 Procurement of stroma-free haemolysate / paternity test
- B-106 Tissue disruption, especially „difficult“ tissues – overview
- B-108T Escherichia coli
- B-109 Disruption of pseudomonas thailandensis
- B-111 Protein isolation for Westernblot
- B-207 Cell disruption of micro algae and cyano bacteria
- B-209 Producing of lysates of eucaryontic cells

### Materials

- C-104 Dispersing of carbon nanotubes (CNT) in processing oil
- C-203 Sample preparation of ceramic suspensions for measuring the particle size
- C-209 Phase transfer of ferric oxides nanoparticles

### Environment

- C-106 Desagglomeration of water and sediment samples
- C-110 Preparation of sewage samples
- C-201 Extraction of magnesium out of soils
- C-210 Sample preparation of sewage water for determining of TOC according to DIN EN 1484

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## Typical applications

### Producing an oil / water emulsion

Small production of pharmaceutical formulations, e.g. very fine emulsions like lotions  
> no agglomerates, no sedimentation  
Volume: 500 ml

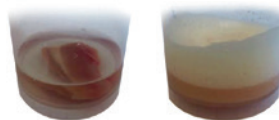
Our recommendation:  
HD 2200.2 with KE 76  
HD 4200 with TS 106



### Homogenising of brain

Volume: 50 ml

Our recommendation:  
HD 2070.2 with MS 73  
HD 4100 with TS 103



### Homogenising of Pangasius fish

Volume: 20 g in 90 ml water

Our recommendation:  
HD 2200.2 with VS 70 T  
HD 4200 with TS 113



### Homogenising of cheese for subsequent determining of nitrate

Volume: 10 g cheese in 25 ml water

Our recommendation:  
HD 2200.2 with KE 76  
HD 4200 with TS 106



## Essential aspects for choosing the appropriate ultrasonic homogeniser

### What is the difference between ultrasonic homogenisers and ultrasonic baths?

The power [W] of ultrasonic baths is fixed. The power density [W/l] is relatively low.  
Ultrasonic homogenisers have an adjustable power [W] and produce very high power densities [W/l].  
Probes with a defined radiating surface guarantee reproducible results.

### What is more important when choosing the appropriate device – power rating or amplitude?

Power output [W] is not the sole criterion for selecting the ultrasonic homogeniser. This value only indicates the power of the ultrasonic generator but not the energy delivered into the sample. The amplitude at the radiating surface of the probe is the determining factor while considering the sample volume. SONOPULS homogenisers provide higher amplitudes than comparable devices in the market due to an optimal matching of all components.

### Which information are necessary for an offer?

#### Application field

e.g.: homogenising, dispersing, extraction, cell disruption

#### Target of sonication

e.g.: isolation of cell content

#### Volume

batch operation of flow-through operation (quantity per time unit)

#### Viscosity

in [mPas]

#### Solids content

suspensions in [%]

#### Temperature range

e.g.: temperature sensitive, cooling necessary

#### Components

e.g.: alcoholic or acidic

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## Construction and principle of operating



### Ultrasonic generator (control unit)

Transforming of low-frequency voltage of 50 or 60 Hz into high frequency voltage of 20 kHz.  
Controlling and displaying of process parameters and sequences.

### Ultrasonic converter

Transforming electrical voltage delivered from the generator into mechanical vibrations of 20 kHz

### Standard and booster horns

**titanium alloy TiAl6V4 (3.7165)**

Increasing amplitudes delivered from the ultrasonic converter. The amplification depends on the their shape.

### Probes

**titanium alloy TiAl6V4 (3.7165)**

Transmitting the mechanical vibrations into the sample. The radiating surface is located on the tip of the probe, but not on the sides. The higher the amplitude the more intense the sonication and the more erosion at the radiating surface of the tip. Due to their shapes probes multiply the amplitudes. This is followed by highest power densities in the sample.

## Features

The AMPLICHRON-system guarantees a constant amplitude and thus reproducible results independently from changing conditions within the sample. Settings within a range of 10 to 100 % are possible. Verification of actual value at the display. Permanent control of ultrasound irradiation as well as indication of wear of the probe.

### Pulsation

Limits temperature increase when processing heat-sensitive samples. The adjustable pulsation allows cooling during rest intervals.

### Continuous operation

Constant sound radiation – extremely effective

### Integrated timer

Duration of sonication storable; indication of elapsed time during continuous operation or of remaining time in countdown mode.

### Switching ON / OFF – easy to handle

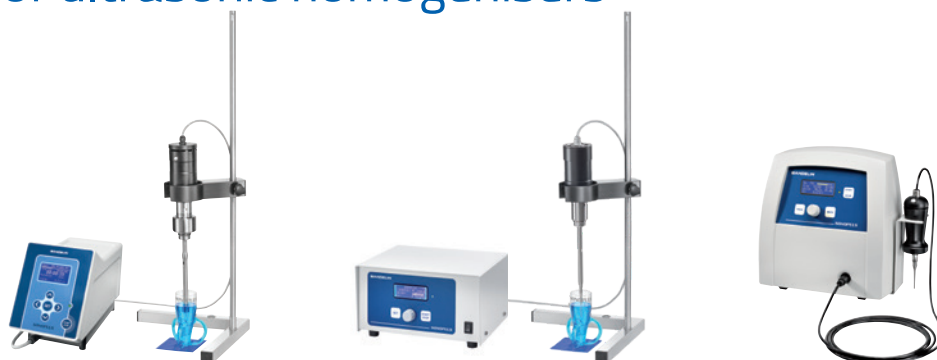
Either at the generator or directly at the ultrasonic converter via button or foot switch.

### Foil keypad – easy-care and user-friendly.

Fail-safe during continuous operation and idling.

SONOPULS-homogenisers and their special accessories are „In vitro diagnostic medical devices class 5“ (according to 98/79/EG).

# SONOPULS series 4000, mini20 and 2000.2 – Comparison of ultrasonic homogenisers



	Serie 4000	Serie 2000.2	mini20
	ADVANCED	BASIC	SPECIAL
<b>Sample volumes</b> - Batch - Flow-through	0.5 to 1000 ml up to 30 l/h	1 to 1000 ml up to 30 l/h	0.1 to 25 ml –
<b>Ultrasonic converter</b>	possible configurations: GM 4200 with UW 50 or UW 100 or UW 200 or GM 4400 with UW 400 or UW 200	possible configurations: GM 2070.2 with UW 2070 or GM 2200.2 with UW 2200	GM mini20 with UW mini20
<b>Amplitude setting</b>	10 to 100 %	10 to 100 %	10 to 100 %
<b>Automatic amplitude limiting</b>	after input of the assembled probe	after input of the assembled probe	after input of the assembled probe
<b>Pulsation</b>	ON cycles 0.2 – 600 s OFF cycles 0.3 – 600 s	ON cycles 1 – 60 s OFF cycles 1 – 60 s	ON cycles 0.1 – 60 s OFF cycles 0.2 – 60 s
<b>Time setting</b>	0:00:01 – 9:59:59 [h:mm:ss] or continuous operation	00:01 – 59:59 [mm:ss] or continuous operation	00:01 – 59:59 [mm:ss] or continuous operation
<b>Safety shut-down</b>	9 h: 59 min: 59 s	9 h: 59 min: 59 s	59 min: 59 s
<b>Indicators</b>	alphanumeric LC display of amplitude, pulse level, time, energy input, temperature (optional)	alphanumeric LC display of ampli- tude, pulse level, time	alphanumeric LC display of ampli- tude, pulse level, time, energy input
<b>Energy display</b>	in kJ	–	in kJ
<b>Temperature display and measurement</b>	optional, -10 to 120 °C, temperature sensor required, alternatively beep or switch off	–	–
<b>Batch operation Sequencing</b>	✓ several batches one after the other	–	–
<b>Remote control with PC</b>	RS 232 (Sub-D)	–	RS 232 (infrared)
<b>Fault diagnosis</b>	✓	✓	✓
<b>Operating frequency</b>	20 kHz	20 kHz	30 kHz
<b>Program memory</b>	✓, 9	–	✓, 9
<b>Functional test</b>	✓	–	✓
<b>Mains connection</b>	230 V~ (±10 %), alternatively 115 V~ (±10 %), 50/60 Hz	230 V~ (±10 %), alternatively 115 V~ (±10 %), 50/60 Hz	100-240 V~, 50/60 Hz

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## Ultrasonic homogenisers series HD 4000

### ADVANCED

#### SONOPULS HD 4050

for volumes from 0.5 to 100 ml



##### Ready-to-use set:

for volumes from 0.5 to 20 ml  
ultrasonic nominal power max. 50 W

- Ultrasonic generator GM 4200
- Ultrasonic converter UW 50
- Probe TS 102, dia. 2 mm

Code no. 4050

#### SONOPULS HD 4100

for volumes from 2 to 200 ml



##### Ready-to-use set:

for volumes from 3 to 50 ml  
ultrasonic nominal power max. 100 W

- Ultrasonic generator GM 4200
- Ultrasonic converter UW 100
- Standard horn SH 100 G
- Probe TS 103, dia. 3 mm

Code no. 4100

#### SONOPULS HD 4200

for volumes from 5 to 1000 ml



##### Ready-to-use set:

for volumes from 20 to 900 ml  
ultrasonic nominal power max. 200 W

- Ultrasonic generator GM 4200
- Ultrasonic converter UW 200
- Booster horn SH 200 G
- Titanium flat tip TT 213, dia. 13 mm

Code no. 4200

#### SONOPULS HD 4400

for volumes from 100 to 3000 ml



##### Ready-to-use set:

for volumes from 500 to 2000 ml  
ultrasonic nominal power max. 400 W

- Ultrasonic generator GM 4400
- Ultrasonic converter UW 400
- Booster horn SH 400 G
- Probe TS 425, dia. 25 mm

Code no. 4400



	HD 4050	HD 4100	HD 4200	HD 4400
Ultrasonic generator	GM 4200	GM 4200	GM 4200	GM 4400
l × w × h [mm]	150 × 220 × 335	150 × 220 × 335	150 × 220 × 335	150 × 220 × 335
Ultrasonic converter	UW 50	UW 100	UW 200	UW 400
Dia. × l [mm]	45 × 175	70 × 150	70 × 150	86 × 180
Available probes dia. [mm]	2/3/4,5/6/9	2/3/4,5/6/9/13	3/4,5/6/9/13/16/19/25	13/16/19/25/32/38

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## Probes for series HD 4000



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* approx. [mm]	157	147	133	128	126	–	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 4050/4100/4200 (peak to peak) [µm]	125/260/–	118/245/280	90/195/235	70/155/210	58/130/185	–/80/128	–/82/132	–/–/90	–/–/68	–/–/50
Volume HD4050 [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 432	TS 438
Code no.	3752	3753	3754	3755	3756	3757
Diameter [mm]	13	16	19	25	32	38
Length* ca. [mm]	139	132	129	130	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
Amplitude HD 4400 (peak to peak) [µm]	242	196	142	82	59	42
Volume HD 4400 [ml]	100 – 750	250 – 1000	250 – 1500	500 – 2000	500 – 2500	500 – 3000

\* Probes are tuned to their working frequency. Lengths may vary slightly due to variations in the titanium alloy.



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## Ultrasonic homogenisers series HD 2000.2

### BASIC

#### SONOPULS HD 2070.2

for volumes from 1 to 200 ml



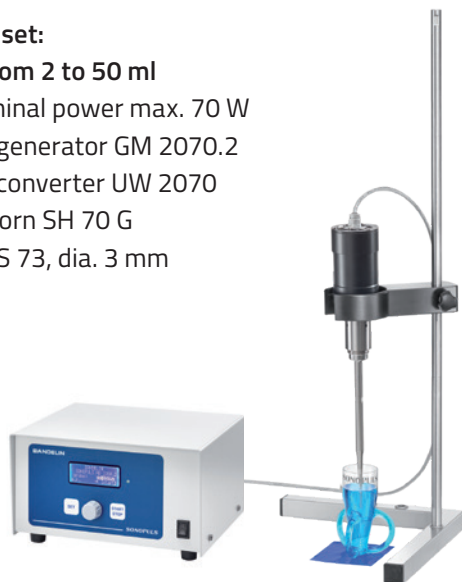
#### Ready-to-use set:

for volumes from 2 to 50 ml

ultrasonic nominal power max. 70 W

- Ultrasonic generator GM 2070.2
- Ultrasonic converter UW 2070
- Standard horn SH 70 G
- Microtip MS 73, dia. 3 mm

Code no. 2451



HD 2070.2 with RZ 3 and HG 40

#### SONOPULS HD 2200.2

for volumes from 2 to 1000 ml



#### Ready-to-use set:

for volumes from 20 to 900 ml

ultrasonic nominal power max. 200 W

- Ultrasonic generator GM 2200.2
- Ultrasonic converter UW 2200
- Booster horn SH 213 G
- Titanium flat tip TT 13, dia. 13 mm

Code no. 2531



HD 2200.2 with RZ 4 and HG 40

	HD 2070.2	HD 2200.2
Ultrasonic generator	GM 2070.2	GM 2200.2
I x w x h [mm]	240 x 210 x 140	240 x 210 x 140
Ultrasonic converter	UW 2070	UW 2200
Dia. x l [mm]	70 x 150	70 x 150
Available probes dia. [mm]	2/ 3/ 6/ 13	2/ 3/ 6/ 13/19 /25 (for 19 and 25 mm, special horns necessary)

### Probe extensions

They are used for enlarging the length of the probe to operate in deep vessels and are mounted between standard or booster horn and titanium flat tip.

**VS 70 between SH 70 G / 213 G and TT 13**

**VS 200 between SH 225 G and TT 25**



Type	VS 70	VS 200
for HD	2070.2 / 2200.2	2200.2
Code no.	500	415

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## Probes for series HD 2000.2



Type	MS 72	MS 73	KE 76	TT 13	VS 70 T	VS 190 T	TT 25	VS 200 T
Code no.	492	529	530	497	494	3638	532	478
Diameter [mm]	2	3	6	13	13	19	25	25
Length* approx. [mm]	195	179	137	5	130	130	6	130
Standard horn for HD 2070.2	SH 70 G	SH 70 G	SH 70 G	SH 70 G	SH 70 G	–	–	–
Booster horn for HD 2200.2	SH 213 G	SH 213 G	SH 213 G	SH 213 G	SH 213 G	SH 219 G	SH 225 G	SH 225 G
Amplitude HD 2070.2 (peak to peak) [μm]	285	245	191	93	97	–	–	–
Amplitude HD 2200.2 (peak to peak) [μm]	286	308	255	165	170	81	53	51
Volume HD 2070.2 [ml]	1–25	2–50	5–100	10–200	10–200	–	–	–
Volume HD 2200.2 [ml]	2–30	5–90	10–350	20–900	20–900	25–900	30–1000	30–1000

\* Probes are tuned to their working frequency. Lengths may vary slightly due to variations in the titanium alloy.

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## Ultrasonic homogenisers mini20

### SPECIAL

#### SONOPULS mini20

for volumes from 0.1 to 25 ml



#### Ready-to-use set:

for volumes from 0.5 to 25 ml  
ultrasonic nominal power max. 20 W

- Ultrasonic generator mini20
- Ultrasonic converter mini20
- Microtip MS 2.5, dia. 2.5 mm



#### Code no. 3665

Ultrasonic generator	GM mini20
l × w × h [mm]	250 × 256 × 154
Ultrasonic converter	UW mini20
Dia. × l [mm]	50 × 160
Available probes dia. [mm]	1.5 / 2.0 / 2.5

Type	MS 1.5	MS 2.0	MS 2.5
Code no.	3639	3654	3652
Diameter [mm]	1.5	2.0	2.5
Length* approx. [mm]	64	59	55
Amplitude [μm]	65	70	72
Volume [ml]	0.1 to 10	0.25 to 20	0.5 to 25

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## Accessories

### Standard and booster horns SH and TH

They amplify and transmit the vibrations to the probe. The suitable horn will be tightened to the ultrasonic converter.

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.



	for replaceable probes							with fix peak		
	Standard horns		Booster horns					Standard horn	Booster horns	
Type	SH 70 G	SH 100 G	SH 213 G	SH 219 G	SH 225 G	SH 200 G	SH 400 G	TH 100 G	TH 200 G	TH 400 G
for UW	2070	100	2200			200	400	100	200	400
Code no.	486	3731	527	3647	3634	3732	3734	3968	3969	3970



### Flow-through horns FZ

They are used to produce stable mixtures of non mixable or hardly mixable liquids (oil / water). Different vessels with standard ground can be connected via adapters NA to the external thread of the horn. In combination with two different media flow-through cell DG 4 G can be sonicated directly in the cavitation field. A cooling is also possible.

	for replaceable titanium flat tips	
	Flow-through standard horn	Flow-through booster horn
Type	FZ 5 G	FZ 7 G
for UW	2070 / 100	2200 / 200
Code no.	490	452



### Sleeve adapters

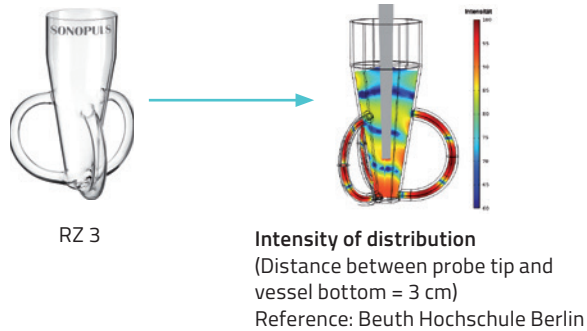
made of PTFE are for tight mounting of standard ground glass vessels to standard or booster horns with external threads.

Type	NA 29 G	NA 45 G
for	<ul style="list-style-type: none"> <li>NS 29 / 32</li> <li>SH 70 G / 100 G / SH 200 G / 213 G</li> <li>TH 100 G / 200 G</li> <li>FZ 5 G / FZ 7 G with probe diameters max. 13 mm</li> </ul>	<ul style="list-style-type: none"> <li>NS 45 / 40</li> <li>SH 70 G / 100 G / 200 G / SH 213 G / 219 G / SH 225 G / 400 G</li> <li>TH 100 G / 200 G / 400 G</li> <li>FZ 5 G / FZ 7 G with probe diameters max. 25 mm</li> </ul>
Code no.	540	487

## Processing vessels made of glass for direct sonication

### Rosette cells RZ

Caused by the sound pressure the sample will be pushed against the vessel bottom and can circulate well through the side arms. When placing the rosette cell into crushed ice, the sample will be effectively cooled because of an enlarged glass surface and improved circulation.



### Cooling vessels KG

They are used for processing temperature-sensitive samples. Their cooling jackets allow a circulation of the cooling liquid during the sonication.

### Flow-through vessels DG

They are equipped with cooling jackets. A continuous sonication of sample up to 30 l/h is possible in flow-through. The cooling jackets allow a circulation of the cooling liquid during the sonication.



	Rosette cells					Cooling vessels		Flow-through vessels			
Type	RZ 1	RZ 2	RZ 3	RZ 4	RZ 5	KG 3	KG 5	DG 3	DG 5	DG 6	DG 7
for probe dia. [mm]	2 – 3	2 – 6	3 – 13	13 – 25	19 – 25	2 – 13	13 – 25	2 – 13	13 – 25	25 – 38	13 – 38
max. volume [ml]	25	50	100	410	660	20	90	–	–	–	–
max. flow-through rate [l/h]	–	–	–	–	–	–	–	5.6	30	30	200
Internal dia. [mm]	27	40	50	75	90	20	35	20	35	71	60
Depth [mm]	80	95	130	200	240	55	95	55	100	120	170
Cooling jacket	–	–	–	–	–	✓	✓	✓	✓	✓	–
Sleeve adapters	–	–	–	–	–	–	–	–	–	–	✓
Code no.	3606	3607	522	3256	483	536	481	538	482	3819	3821

## Flow-trough processing vessels made of stainless steel for direct sonication

They will both directly mounted to the external thread of the standard or booster horn. They are especially used for emulsifying, mixing and homogenising. The liquid will be pumped from below against the radiating surface of the probe, passes directly the cavitation field and leaves the processing chamber via the outlet. A multiple circulation is possible. The sonication level depends on the set amplitude and the flow-through rate.



Typ	DG 4 G	DZ 300 E*
for HD	2070.2 / 2200.2 4100 / 4200	4400
max. flow-through rate [l/h]	50	130
max. pressure [bar]	2	4
Cooling jacket	✓	–
Code no.	3608	3822

\*not suitable for use with TS 438



## Processing vessels for indirect sonication

An indirect sonication prevents the direct contact between probe and sample. These processing vessels can be compared with very small high-intense ultrasonic baths. The ultrasound is transmitted via the contact liquid into the sample vessels. The intrusion of titanium particles of the probe is excluded. An indirect sonication is especially recommended when processing smallest sample quantities: Foaming or sample lost do not take place. This method is suggested for treating pathogenic samples – crosscontamination is excluded.

To use cup horn BB 6 or cup booster BR 30 horn an probe must be replaced. Reaction vessels containing the samples are placed together with the suitable holder EH into BB 6 or BR 30. They are sonicated from below. The cavitation is produced in the contact liquid and transferred into the samples.

### Microtube holder EH 3.1

For simultaneous sonication of up to 8 samples.  
Three changeable discs for:  
3 × 1 ml or 2 ml reaction cups  
3 × 0.5 ml reaction cups  
8 × 0.2 ml PCR cups

### Microtube holder EH 6

For simultaneous sonication of up to 6 samples.



Type	BB 6	EH 6	BR 30	EH 3.1
for	HD 2200.2 4200	BB 6	HD 2070.2 / 2200.2 4100 / 4200	BR 30
Code no.	3605	7503	7510	7527



Configuration example of a LS 40 and HG 40  
(WH 40 are a necessary accessories for an indirect sonication)



Configuration example UW 200 with BB 6, EH 6 and HG 40 with WH 40

## Stand HG, holder WH, support AT

- Stand HG 40: foot and rod: stainless steel
  - Holder WH 40 und support AT 40: POM
- The support is used for vessel positioning.  
*Option: additional holder WH 40 for indirect sonication*

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



## Foot switch TS

It is applicable for hand-free switching ON/OFF of the device. Delivered with 3 m connecting cable.

Type	TS 8
for HD	2070.2 / 2200.2 3100 / 3200 / 3400 4050 / 4100 / 4200 / 4400
Code no.	513



## Temperature sensors TM

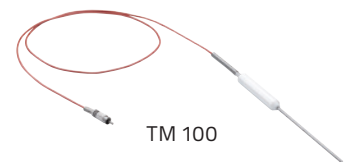
When connecting the temperature sensor to the ultrasonic generator the temperature module is activated.

Type	TM 50	TM 100
for HD	3100 / 3200 / 3400 4050 / 4100 / 4200 / 4400	
Code no.	3733	3622

Temperatures in a range from 0 to 100 °C can be measured.



TM 50



TM 100

## Sound proof boxes LS

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

### Features LS 4:

- Noise reducing by approx. 10 dB-AU
- Openings at the rear side for hoses and temperatur sensor
- Full-sized plexiglass door enables process observation; with locking hinges at 0° and 150°



LS 4



LS 40

### Features LS 40:

- Noise reducing by approx. 30 dB-AU
- LED interior lighting and acrylic glass for process viewing
- removeable drip tray  
made of stainless steel, easy cleaning
- Stainless steel insert easy to clean
- Closeable bushing at the rear side to accomodate lines and hoses for cooling or circulation systems or to connect a temperature sensor
- Ventilating system for reducing a process-related formation of moisture
- Door opening angle 180° for easy sample handling
- Sufficient space for either direct or indirect application by using stand HG 40 and other optional accessories

Type	LS 4	LS 40
for HD	2070.2 / 2200.2 3100 / 3200 4050 / 4100 / 4200	2070.2 / 2200.2 / 4050 / 4100 / 4200 / 4400
Damping in dB-AU	10	30
Code no.	416	3682