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Find the *Retsch MM301* at our website: ***Click HERE***

RETSCH Product Navigator

- **Milling**
  - Jaw Crushers
  - Rotor Mills
  - Cutting Mills
  - Mortar Grinders
  - Disc Mills
  - Ball Mills
    - MM 200
    - MM 301
    - S 100
    - PM 100
    - PM 200
    - PM 400
- **Sieving**
- **Assisting**

Size reduction and homogenization with ball mills





Unlimited applications

RETSCH ball mills are suitable for universal use. Depending on the model (planetary ball mill or mixer mill), they can be used for dry, wet or cryogenic grinding. Mixing, homogenizing, cell disruption, mechanical alloying or even colloidal grinding are further possible applications. Due to their versatility they can be used in virtually all sectors concerned with the mechanical treatment of solids in industry and research.

Retsch®

Solutions in Milling & Sieving

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RETSCH ball mills are used for the pulverization of soft, fibrous, hard and brittle materials. They achieve a very high final fineness down to the submicron range. The feed size depends on the mill and can have a maximum size of 10 mm. If the sample feed size is larger than this then the sample must first undergo preliminary size reduction.

Preliminary size reduction



For the coarse and preliminary size reduction of hard, brittle or even tough materials, the RETSCH jaw crushers have proven themselves in practice. In contrast, bulky, soft, fibrous or elastic materials are best prepared in RETSCH cutting mills.

Sample dividers



For the subsequent pulverization a **representative part-sample** must first be obtained, e.g. with the sample divider PT 100 from RETSCH.

Tablet press



RETSCH offers a manual hydraulic tablet press for preparing solid samples for XRF studies.

Superiority in detail – technology from RETSCH

RETSCH offers a comprehensive range of ball mills for the preparation of soft to hard materials. The various models differ primarily from each other in their mode of operation.

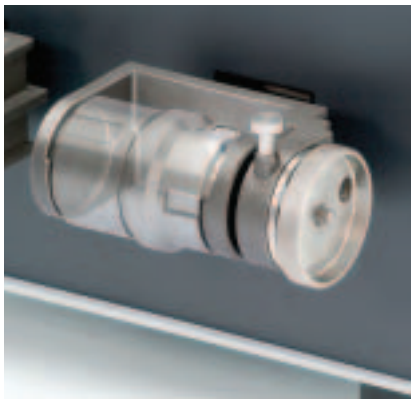
- **Mixer mills MM 200, MM 301**
- **Centrifugal ball mill S 100**
- **Planetary ball mills PM 100, PM 200, PM 400**

RETSCH ball mills are the right choice whenever efficient pulverization and homogenization of soft to hard materials are required. Unique features and innovative details prove this.

Mixer mill MM 301

Grinding jar attachment – simple and safe

The unique grinding jar attachment system of the MM 301 allows quick, simple and safe clamping of the jars. The automatic centering and exact placement of the grinding jars optimizes the reproducibility of the grinding process. The **self-locking device** prevents the grinding jars from becoming loose during the grinding process.



Cryogenic grinding – quick and efficient



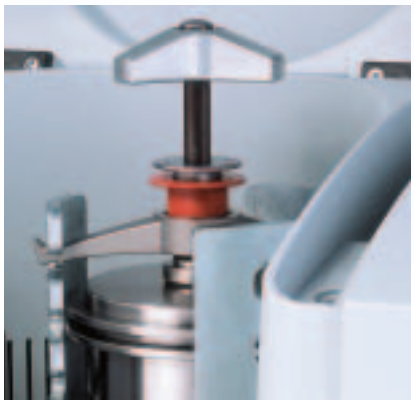
Before grinding takes place the grinding jars are immersed in liquid nitrogen (-196 °C) in the cryo box for approx. 2 - 3 minutes

The mixer mill MM 301 is ideally suitable for cryogenic grinding. The sample and grinding ball charge are placed in the screw-top stainless steel grinding jars, which are then immersed in liquid nitrogen. They are fastened in the quick-clamping device of the MM 301; this holds the grinding jars securely, even at extremely low temperatures.
After a grinding time of only 2 - 3 minutes a completely homogenized sample is obtained.
This procedure saves time and is particularly economical due to the very low consumption of liquid nitrogen.

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Planetary ball mills PM 100 / PM 200 / PM 400

Safety and versatility





“comfort” grinding jars
Thanks to their many unique details, the “comfort” grinding jars make a great contribution to the particular safety of RETSCH planetary ball mills. More information about the grinding jars can be found on page 15.

Quick-action clamping device
The patented quick-action clamping device is used in all RETSCH planetary ball mills. This allows the grinding jars to be inserted in the mills quickly and, above all, safely. The self-acting lock ensures that the grinding jars are seated correctly and securely.

Optimal safety during wet grinding with solvents
Special design measures taken with the PM 100 and the PM 200 expressly permit the use of grinding aids such as highly flammable solvents. They offer the greatest possible safety during wet grinding with solvents, e.g. with the “comfort” grinding jars, whose O-rings make them gas-tight and dust-proof and which can also be fitted with a **safety closure device**. The PM 100 and PM 200 have **a built-in extraction fan with standstill monitoring**, which directly evacuates the grinding chamber. The air exchange rate per hour is more than 20 times the grinding chamber volume.



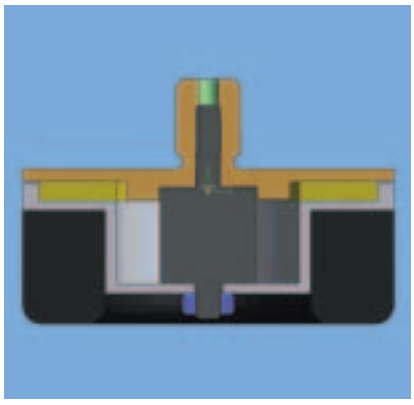
The safety closure device for “comfort” grinding jars guarantees tightness even if overpressure occurs in the grinding jar, such as during wet grinding with alcohols or hydrocarbons (benzine). It also allows gas-tight handling in glove boxes under inert atmosphere and ensures the safe transport of the grinding jars.

Controlled forces in single-station planetary ball mills

Planetary mills with only a single grinding station require a counterweight for balancing purposes. In the ball mill PM 100 this counterweight can be adjusted on an inclined guide rail. In this way the different heights of the centers of gravity of differently-sized grinding jars can be compensated in order to avoid disturbing oscillations of the machine.

Any remaining vibrations are compensated by feet with some free movement **(F**ree-**F**orce **C**ompensation **S**ockets**)**. This **innovative FFCS technology** is based on the d’Alembert principle and allows very small circular movements of the machine housing that result in an automatic mass compensation. The laboratory bench is only subjected to minimal frictional forces generated in the feet.

In this way the PM 100 ensures a quiet and safe operation with maximum compensation of vibrations even with the largest pulverization forces inside the grinding jars and therefore can be left on the bench unsupervised.



The special design of the feet effectively compensates the free forces and ensures a low-vibration operation.



For optimal balancing the counterweight of the PM 100 can slide up an inclined guide rail

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Mixer mills MM 200 and MM 301

Grinding, mixing, disrupting small amounts of sample



MM 200

RETSCH mixer mills MM 200 and MM 301 are laboratory "all-rounders". They have been developed specially for **dry, wet and cryogenic grinding of small amounts of sample**. They can mix and homogenize powders and suspensions in only a few seconds. They are also perfectly suitable for the **disruption of biological cells** as well as for DNA/RNA recovery.

The mixer mills can pulverize, mix or homogenize two samples from 0.2 to 20 ml at the same time. For cell disruption it is possible to process 20 samples simultaneously. The mixer mills MM 200 and MM 301 operate so effectively that the grinding time is very short and the sample is hardly warmed at all. **This means that most materials can be pulverized and mixed at ambient temperature, without any cooling**.

Overview

- Quick, efficient pulverization and homogenization
- Higher sample throughput due to short grinding times and two grinding stations
- Reproducible results by digital preselection of grinding time and vibrational frequency
- Large range of grinding jars
- Safe wet grinding without loss of material with screw-top grinding jars
- Simple and comfortable operation
- Memory keys for three parameter combinations
- Set parameters can be locked against accidental alteration
- 2 year warranty, CE-conforming

MM 200 and MM 301 – high-performance mixer mills for any type of material

The RETSCH mixer mills MM 200 and MM 301 are used for size reduction and pulverization of hard, medium-hard and brittle samples as well as for soft, elastic or fibrous ones. They pulverize **tissue, bones, hair, chemicals, drugs, coated and uncoated tablets, minerals, ores, alloys, glass, ceramics, soils, sludge, plant parts, cereal grains, oil seeds, plastics, waste samples, wool and textiles, to name just a few.**

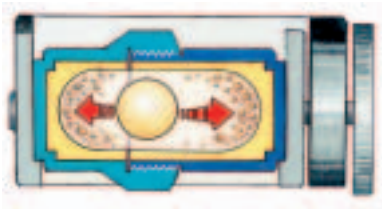
With their ability to process small sample amounts to analytical fineness quickly and in a reproducible manner, RETSCH mixer mills are the ideal device to prepare pressed tablets for subsequent **XRF analysis**.

Mixer mills are primarily used in the following sectors:

- **Agriculture**
- **Biology and Biotechnology**
- **Ceramics and Glass**
- **Chemicals and Plastics**
- **Environmental Research**
- **Foodstuffs**
- **Forensic Science**
- **Medicine and Pharmaceuticals**
- **Metallurgy and Metallurgical Engineering**
- **Mineralogy**
- **New Materials Research**

MM 200 and MM 301 technology

The grinding jars perform radial oscillations in a horizontal position. The inertia of the grinding balls causes them to impact with high energy on the sample material at the rounded ends of the grinding jars and pulverize it. Also, the movement of the grinding jars combined with the movement of the balls result in the intensive mixing of the sample. The degree of mixing can be increased even further by using several smaller balls. If several small balls are used (e.g. glass beads) then, for example, biological cells can be disrupted. The large frictional impact effects between the beads ensure effective cell disruption.



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Maximum reproducibility



Both the MM 200 and the MM 301 are particularly easy to use. The vibrational intensity can be set accurately from 3 to 30 hertz. An electronic speed control keeps this value constant during the entire grinding process. The grinding and mixing time can be preset digitally in the range from 10 seconds to 99 minutes. All instrument parameters are retained during standby operation for subsequent processes. A memory function allows storage of 3 different parameter combinations which offer ultimate convenience in routine testing of various samples. At the same time this ensures the highest degree of reproducibility for the following sample preparation processes.

Wet grinding

The screw-top grinding jars provide the ideal preconditions for wet grinding with mixer mills. An Teflon seal prevents the escape of liquids and particles even at maximum vibrational frequency.



MM 301

MM 301 – the mixer mill with unsurpassed performance, safety and comfort

Due to the increased oscillation radius of the MM 301, the **energy input is approx. 30% greater** than that of the MM 200. This results in more fineness in less time. Large grinding jars with a capacity of 35 ml and 50 ml are available for the MM 301. In these jars, up to 20 ml of sample material with a **feed size of up to 8 mm** can be ground. Clamping and removing the grinding jars is easier and safer. The special **self-centering of the grinding jars** ensures that they are always located in exactly the same position, which optimizes the reproducibility of the grinding process. The **self-locking clamping device** fixes the grinding jars with maximum security.

Advantage MM 301

The mixer mill MM 301 is a real multi-talent with nearly unlimited applications...

- reproducible **dry grinding**, e.g. for sample preparation for XRF analyses
- loss-free **wet grinding** due to screw-top, leak-proof grinding jars
- convenient **cryogenic grinding** of thermally sensitive products without long pre-cooling times and with a minimum consumption of liquid nitrogen
- efficient **disruption** of plant or animal tissues or cell suspensions in adapter racks for 5 or 10 reaction vials





Cryogenic grinding with the mixer mill MM 301

Thermally-sensitive and elastic substances can be successfully processed by external cooling of the grinding jars. However, beakers made from agate and ceramics should not be cooled with liquid nitrogen in order to avoid damage during the grinding process.
The screw-top grinding jars are particularly suitable for cryogenic grinding, as after the grinding process they remain hermetically sealed until they have regained room temperature. This prevents atmospheric humidity from condensing on the cold sample as water vapor which could penetrate the sample and falsify the analytical results.

A special cryo kit is available for precooling the grinding jars in liquid nitrogen; it consists of:
2 insulated containers (1 and 4 liter),
2 pairs of grinding jar tongs
1 pair of safety glasses.



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Selection guide for mixer mills

The **MM 200** is mainly used for the size reduction of small amounts of sample.

The **MM 301**, with 30% higher energy, can pulverize samples finer and faster, with optimum reproducibility. Its convenient self-locking clamp allows the use of large jars up to 50 ml and pre-chilled jars of stainless steel.

Performance data	MM 200	MM 301
Field of application	size reduction, mixing, homogenization, cell disruption	
Feed material	hard, medium-hard, soft, brittle, elastic, fibrous	
Feed size*	up to 6 mm	up to 8 mm
Final fineness*	approx. 10 µm	approx. 5 µm
Batch/Sample volume	max. 2 x 10 ml	max. 2 x 20 ml
Typical mean grinding time	2 minutes	2 minutes
Possible applications		
Dry grinding	yes	yes
Wet grinding	yes**	yes
Cryogenic grinding	no	yes
Cell digestion with reaction vials	max. 10 x 2.0 ml	max. 20 x 2.0 ml
Suitable grinding jars		
Grinding jar with push-fit lids	1.5 - 25 ml	no
Grinding jars with screw-top lids	1.5 - 25 ml	1.5 - 50 ml
Self-centering clamping device	no	yes
No. of grinding stations	2	2
Digital preselection of vibrational frequency	3 - 30 Hz (180 -1800 min^{-1})	3 - 30 Hz (180 - 1800 min^{-1})
Digital preselection of grinding time	10 s - 99 min	10 s - 99 min
Memory for parameter combinations	3	3
Parameter lock	yes	yes
Technical data		
Nominal power	76 W at 50 Hz / 64 W at 60 Hz	76 W at 50 Hz / 64 W at 60 Hz
W x H x D	300 x 182 x 465 mm	300 x 225 x 470 mm
Net weight	approx. 20 kg	approx. 20 kg
Noise values (noise measuring according to DIN 45635-31-01-KL3)		
Emission value with regard to workplace*	L_{pAeq} 61 dB(A)	L_{pAeq} 61 dB(A)
Sound power level	L_{WA} 71.4 dB(A)	L_{WA} 71.4 dB(A)
Measuring conditions:		
Feed material	8 ml broken quartz pebbles, approx. 4.0 – 6.0 mm	8 ml broken quartz pebbles, approx. 4.0 – 6.0 mm
Grinding jars used	2 x 25 ml steel	2 x 25 ml steel
Grinding balls used	1 steel ball 20 mm dia.	1 steel ball 20 mm dia.

*depending on feed material, grinding jars and vibrational frequency, **using screw-top grinding jars

Cell disruption with RETSCH mixer mills

Small amounts of sample, such as are normally used for the isolation of DNA and RNA, can be prepared in disposable reaction vials (e.g. Eppendorf). Adapter racks which accommodate either 5 or 10 disposable reaction vials can be used for this. In the mixer mills, efficient disruption is achieved so quickly that no additional cooling is necessary.

Stainless steel 12.5 ml jars are available for the MM 200 for the disruption of microorganisms and bacteria; these have a special opening for injection of cell suspensions.



12.5 ml grinding jar with special closure (1)
Adapter rack for:
5 reaction vials 1.5 and 2.0 ml (2)
10 reaction vials 1.5 and 2.0 ml (3)
10 reaction vials 0.2 ml (4)

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Grinding jars and grinding balls for versatile use

The grinding result is greatly influenced by the choice of grinding tools. Jar volume, ball charge and the material depend on the type and amount of sample. In order not to falsify the subsequent analytical determination, a neutral-to-analysis material should be selected.

The pulverization energy is determined by the density and weight of the ball material. The higher the ball weight and density, the higher the pulverization energy. The jar and balls should always be made of the same material. The table shown below is intended to help you to select suitable grinding tools.

In addition to the standard grinding jars with push-fit lids for the MM 200, superior screw-top grinding jars are available.



Screw-top grinding jars



Grinding jars with push-fit lids for MM 200

Advantages of the screw-top grinding jars

- **Exceptionally simple and safe handling**
- Dust-proof and air-tight (no loss of material, no escape of e.g. inert atmosphere)
- Suitable for wet and cryogenic grinding
- Ultimate reproducibility by automatic centering and uniform jar design (MM 301)
- Ergonomic gripping flanges on jar and lid
- Stainless steel protective jacket (for agate, zirconium oxide and tungsten carbide jars)

The screw-top grinding jars have been specially designed for the mixer mill MM 301. Grinding jars up to 10 ml made of all materials and the 25 ml stainless steel grinding jar can also be used in the MM 200.

In addition to the instrument settings, the filling level of the jar is also of crucial importance for the success of the grinding process in mixer mills. A jar filling should consist of about 1/3 sample and 1/3 ball charge. The remaining third is the free jar volume that is necessary for the free movement of the balls. The following table provides guidelines.

Grinding jar filling levels – guidelines for sample volume and ball charge

Grinding jar nominal volume	Sample amount	Max. feed size	Recommended ball charge Ø 5 mm	Ø 7 mm	Ø 9/10 mm	Ø 12 mm	Ø 20 mm	Ø 25 mm	Ø 30 mm
1.5 ml	0.2 – 0.5 ml	1 mm	1 to 2 pcs.	–	–	–	–	–	–
5.0 ml	0.5 – 2.0 ml	2 mm	–	1 to 2 pcs.	–	–	–	–	–
10.0 ml	2.0 – 4.0 ml	4 mm	–	–	1 to 2 pcs.	1 to 2 pcs.	–	–	–
25.0 ml	4.0 – 10.0 ml	6 mm	–	–	–	2 pcs.	1 pc.	–	–
35.0 ml	6.0 – 15.0 ml	6 mm	–	–	–	–	1 pc.	1 pc.	–
50.0 ml	8.0 – 20.0 ml	8 mm	–	–	–	–	–	1 pc.	1 pc.

Material composition guidelines

Grinding jar	Material no.	MM 200	MM 301	approx. hardness	Material analysis (in %)
Chrome steel	1.2080	■	■	62-63 HRC	Fe (84.89), Cr (12), C (2.2), Mn (0.45), Si (0.4), P (0.03), S (0.03)
Stainless steel	1.4034	■	–	48-52 HRC	Fe (82.925), Cr (14.5), C (0.5), Mn (1), Si (1), C (0.5), P (0.045), S (0.03)
	1.4112	–	■	55-57 HRC	Fe (76.5), Cr (19), Mo (1.3), Mn (1), Si (1), C (0.95), V (0.12), P (0.04), S (0.03)
Tungsten carbide		■	■	1180-1280 HV 30	WC (94), Co (6)
Agate		■	■	6.5-7 Mohs	SiO_2 (99.91), Al_2O_3 (0.02), Na_2O (0.02), Fe_2O_3 (0.01), K_2O (0.01), MnO (0.01), MgO (0.01), CaO (0.01)
Sintered corundum		■	–	1750 HV	Al_2O_3 (99.7), CaO (0.07), MgO (0.075), SiO_2 (0.075), Na_2O (0.01), Fe_2O_3 (0.01)
Zirconium oxide*		■	■	1200 HV	$Zr0_2$ (94.5), Y_2O_3 (5.2)

The above percentages are mean values. We reserve the right to make alterations.

*yttrium-stabilized

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Mixer mills order data

Mixer mill MM 200					Item No.
MM 200 (please order grinding jars and grinding balls separately)					
MM 200	for 220-240 V, 50/60 Hz				20.738.0001
MM 200	for 100-110 V, 50/60 Hz				20.738.0002
Grinding jars with lids for MM 200	1.5 ml	5 ml	10 ml	25 ml	
Chrome steel	02.462.0056	02.462.0058	02.462.0060	02.462.0052	
Stainless steel	02.462.0057	02.462.0059	02.462.0061	02.462.0119	
Tungsten carbide	01.462.0114	01.462.0115	01.462.0009	–	
Agate	01.462.0112	01.462.0113	01.462.0008	–	
Sintered corundum	01.462.0110	01.462.0111	01.462.0007	–	
Zirconium oxide	–	–	01.462.0194	01.462.0195	
Teflon	–	02.462.0183	02.462.0184	02.462.0051	
Mixing jars, polystyrene, 28 ml, 100 pcs.				22.041.0003	
The following grinding jars with screw-top lids for the MM 301 can also be used in the mixer mill MM 200: 1.5 ml, 5 ml, 10 ml: all materials; 25 ml: stainless steel and chrome steel					

Mixer mill MM 301						Item No.
MM 301 with quick-clamping device (please order grinding jars and grinding balls separately)						
MM 301	for 220-240 V, 50/60 Hz					20.741.0001
MM 301	for 100-115 V, 50/60 Hz					20.741.0002
Grinding jars with screw-top lid	1.5 ml	5 ml	10 ml	25 ml	35 ml	50 ml
Chrome steel	–	–	–	01.462.0237	–	–
Stainless steel	01.462.0230	01.462.0231	01.462.0236	02.462.0213	01.462.0214	01.462.0216
Tungsten carbide	–	–	01.462.0235	01.462.0217	–	–
Agate	–	01.462.0232	01.462.0233	–	–	–
Zirconium oxide	–	–	01.462.0234	01.462.0201	01.462.0215	–
Teflon	–	–	–	01.462.0238	–	–
Accessories						
Jar wrench for screw-top jars, 25 ml tungsten carbide, 35 ml stainless steel or zirconium oxide, 50 ml stainless steel						02.486.0001
Cryo kit for cooling grinding jars with liquid nitrogen						22.354.0001

Grinding balls for MM 200 and MM 301							Item No.
Grinding balls	5 mm Ø	7 mm Ø	9/10 mm Ø	12 mm Ø	20 mm Ø	25 mm Ø	30 mm Ø
Chrome steel	05.368.0029	05.368.0030	05.368.0031	05.368.0032	05.368.0033	–	–
Stainless steel	05.368.0034	05.368.0035	05.368.0036	05.368.0037	05.368.0062	05.368.0105	05.368.0061
Tungsten carbide	05.368.0038	05.368.0039	05.368.0040	05.368.0041	05.368.0070	–	–
Agate	05.368.0024	05.368.0025	05.368.0026	05.368.0027	–	–	–
Sintered corundum	05.368.0019*	05.368.0020*	05.368.0021	05.368.0022	–	–	–
Zirconium oxide	–	–	–	05.368.0096	05.368.0093	05.368.0106	–
Teflon with steel core	–	–	05.368.0045	05.368.0046	05.368.0047	–	–
Polyamide for mixing vessel	05.368.0042	05.368.0043	05.368.0044	05.368.0003	–	–	–
*Hard porcelain							

Accessories for cell and tissue disruption with MM 200 and MM 301					Item No.
Adapter racks, PTFE, for reaction vials for MM 200 and MM 301					
Adapter rack	for 10 reaction vials, 1.5 and 2.0 ml (for MM 301 only)				22.008.0008
Adapter rack	for 5 reaction vials, 1.5 und 2.0 ml				22.008.0005
Adapter rack	for 10 reaction vials, 0.2 ml				22.008.0006
Safe-Lock reaction vials			0.2 ml	1.5 ml	2.0 ml
Safe-Lock reaction vials, 1000 pcs.			22.749.0004	22.749.0002	22.749.0001
Grinding balls for reaction vials			3 mm Ø	4 mm Ø	5 mm Ø
Stainless steel, approx. 200 pcs.			22.455.0002	22.455.0001	22.455.0003
Tungsten carbide, approx. 200 pcs.			22.455.0006	22.455.0005	22.455.0004
Zirconium oxide, approx. 200 pcs.			22.455.0007	–	22.455.0009
Glass beads for reaction vials	0.10-0.25 mm Ø	0.25-0.50 mm Ø	0.50-0.75 mm Ø	0.75-1.00 mm Ø	1.00-1.50 mm Ø
500 g	22.222.0001	22.222.0002	22.222.0003	22.222.0004	22.222.0005
Grinding jars with special closure for disruption of microorganisms and bacteria with MM 200					
Grinding jars with special closure, 12.5 ml made from stainless steel					01.462.0117

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Centrifugal ball mill S 100



Grinding and mixing

The RETSCH centrifugal ball mill S 100 has proven itself over the years for reducing the particle size of samples for subsequent analysis. It is powerful, user-friendly and safe, which is why it has been used successfully for both experimental and routine sample preparation in a wide range of different areas. For applications without high requirements, the S 100 is a cost-efficient alternative to the high-performance planetary ball mills. It can also be used for mixing, homogenizing and emulsifying.

Overview

- High final fineness down to the micron range
- Loss-free dry and wet grinding in a very short time
- High reproducibility due to digital setting and control of time and speed
- Memory keys for three parameter combinations
- Set parameters can be locked against accidental alteration
- Automatic direction reversal
- Stable and smooth operation with adjustable balancing masses
- 2 year warranty, CE-conforming

The RETSCH centrifugal ball mill pulverizes and mixes soft, medium-hard, hard and brittle materials.
It is suitable for powders and suspensions.
The S 100 is used to prepare **chemicals, minerals, glass, ceramics, enamel, pigments, slags, soils, drugs, tablets, plant parts, cellulose, compost, sewage sludge and many other substances** simply and without loss.

Centrifugal ball mills are used in

- **Agriculture**
- **Biology**
- **Ceramics and Glass**
- **Environmental Protection**
- **Geology**
- **Mineralogy**
- **Paints and Lacquers**
- **Pharmaceuticals**

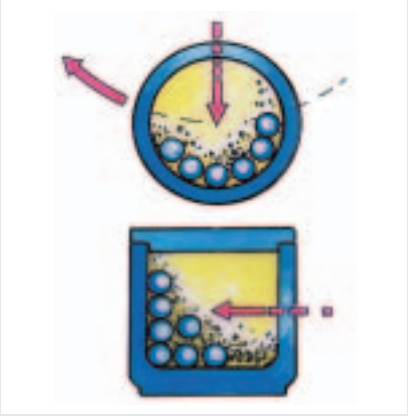
and many others areas.



The centrifugal ball mill S 100 is very easy to use. The ergonomical keypad contains the digital controls for time, speed and interval operation. When the running time has elapsed all the settings are retained for the following processes. The input keys can be locked against accidental alteration. Three parameter combinations (time, speed, interval) can be stored in the memory and called up for repetitive grinding tasks.

Centrifugal ball mill S 100 technology

The grinding jars of the centrifugal ball mill move in a circular path in a horizontal plane. This corresponds to the motion of a planetary ball mill with a speed ratio of 1:-1 (grinding jar vs. sun wheel). During the grinding process the speed is continuously compared with the set value by an electronic drive control and kept constant. The centrifugal forces produced by the rotation force the sample and the grinding balls against the inner wall of the grinding jar, where size reduction takes place primarily by pressure and friction.
The mill is equipped with an automatic direction reversal system to counter agglomeration effects and to increase the homogenization effect.



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Centrifugal ball mill S 100

Performance data	S 100
Field of application	size reduction, mixing, homogenization
Feed material	soft, medium-hard, hard, brittle – dry or wet
Feed size*	<10 mm
Final fineness*	down to 1 µm
Batch/Sample volume	max. 1 x 250 ml
Suitable grinding jars	50 / 125 / 250 / 500 ml
No. of grinding stations	1
Speed ratio	1 : -1
Sun wheel speed	100 - 580 min^{-1}
Effective sun wheel diameter	76 mm
Timer	digital, 1 - 300 min
Direction reversal system	yes, interval time: 35 s (standard) selectable between 30 and 300 s
Parameter lock	yes

Technical data	
Nominal power	100 W
W x H x D	350 x 420 x 510 mm
Net weight	approx. 42 kg

Noise values (noise measuring according to DIN 45635-31-01-KL3)	
Emission value with regard to workplace	L_{pAeq} 68.5 dB(A)
Sound power level	L_{WA} 78 dB(A)
Measuring conditions:	
Feed material	broken gypsum <2.0 mm
Sample volume	18 ml
Grinding jar used	50 ml type "S", agate
Grinding balls used	3 balls 20 mm dia.
*depending on feed material	

Compact and safe

The centrifugal ball mill has a compact housing with a hinged Plexiglas protective cover. The robust, low-maintenance drive guarantees trouble-free use for a long time. The speed can be set precisely from 100 to 580 min^{-1} and during the grinding process the actual speed is continuously compared with the set speed and kept constant. If the protective cover is opened during operation a brake motor brings the mill to an immediate standstill (<1 s).



Grinding jars and grinding balls

Various grinding jars are available for the centrifugal ball mill S 100. The "comfort" grinding jars are available in 6 different materials and offer quick, simple and safe handling. A detailed description of the "comfort" grinding jars as well as the grinding balls can be found on page 15. For particular applications in the centrifugal ball mill S 100, custom grinding jars in 3 materials are available. The comprehensive range of accessories ensures smooth adaptation to a wide range of applications, no matter whether in research, development or quality control.

Centrifugal ball mill S 100 order data

Centrifugal ball mill S 100				Item No.
Centrifugal ball mill S 100 (please order grinding jars and grinding balls separately)				
S 100 for 220–240 V, 50/60 Hz, with reversal mechanism				20.189.1001
S 100 for 100–120 V, 50/60 Hz, with reversal mechanism				20.189.1002
Special grinding jars for S 100 **(for all other grinding jars and grinding balls please see pages 15-16)**				
Tungsten carbide, 250 ml				02.462.0041
Zirconium oxide, 500 ml				01.462.0189
Hard porcelain (round-shaped), 250 ml				02.462.0020
Grinding balls	10 mm Ø	20 mm Ø	30 mm Ø	40 mm Ø
Tungsten carbide	05.368.0071	05.368.0070	05.368.0069	05.368.0068
Zirconium oxide	05.368.0094	05.368.0093	05.368.0092	05.368.0091
Hard porcelain	05.368.0051	05.368.0050	05.368.0049	05.368.0048
Accessories for S 100				
Sleeve for centering/reducing grinding jars "comfort", 50 ml				02.112.0059
Carrying handles, 1 pair				32.825.0001

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Planetary ball mills
PM 100, PM 200 and PM 400



Highest degree of fineness in the shortest time

RETSCH planetary ball mills are used wherever the highest degree of fineness is required. Apart from the classical mixing and size reduction processes, the mills also meet all the technical requirements for colloidal milling and have the energy input necessary for mechanical alloying processes.

The extremely high centrifugal forces of the planetary ball mills result in very high pulverization energy and therefore **short grinding times**.

Together with the "comfort" grinding jars these new planetary ball mills offer the highest possible degree of performance, safety and reliability.

RETSCH planetary ball mills pulverize and mix soft, medium-hard to extremely hard, brittle and fibrous materials. Dry and wet grinding can be carried out. **Minerals, ores, alloys, chemicals, glass, ceramics, plant parts, soils, sewage sludge, household and industrial waste and many other materials** can be pulverized easily, quickly and without loss. Planetary ball mills are used successfully **in virtually all industry and research sectors**, in particular wherever the highest demands are placed on purity, quickness, fineness and reproducibility.

The main fields of application for planetary ball mills are:

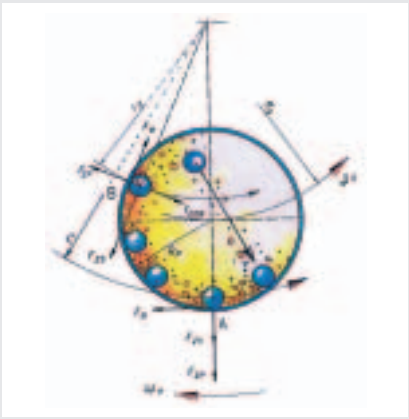
- **Agriculture**
- **Biology and Biotechnology**
- **Ceramics and Glass**
- **Chemicals**
- **Construction Materials**
- **Environmental Research**
- **Medicine**
- **Mineralogy and Metallurgy**
- **New Materials and Abrasives**

to name just a few.

Planetary ball mills are available in versions with 1 to 4 grinding stations. The universal machine settings, comprehensive range of grinding jars made from top-quality materials as well as the numerous possible ball charge combinations (number and ball size) allow **individual adaptation of the grinding parameters to the particular size reduction task.**

Planetary ball mill technology

The grinding jar rotates about its own axis and, in the opposite direction, around the common axis of the sun wheel. This produces grinding ball movements with high pulverization energies. The centrifugal forces acting on the grinding jar wall initially carry the grinding balls in the direction in which the jar is rotating. Differences occur between the speed of the grinding jar wall and the balls; this results in strong frictional forces acting on the sample. As the rotational movement increases, **Coriolis forces** act on the balls and displace them from the jar walls. The balls then fly through the interior of the grinding jar and impact against the sample on the opposite wall of the grinding jar. This releases considerable dynamic impact energy. The combination of impact forces and frictional forces results in the **high degree of pulverization** of the planetary ball mills.



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Planetary ball mills PM 100 and PM 200



Highest degree of efficiency due to optimal energy input

The planetary ball mill PM 100 with one grinding station and PM 200 with two grinding stations are used whenever high degrees of fineness down to the submicron range are to be achieved in a very short time. The extremely high centrifugal forces in the mills mean that the **energy input is up to 50% higher** than in conventional planetary ball mills.

Overview

- Extreme speeds for particularly high final fineness
- Up to 50% higher energy input
- Grinding jar volumes from 12 ml to 500 ml
- Suitable for long-term trials and continuous use
- Safe and stable operation
- Reproducible results due to energy and speed control
- 10 combinations of grinding parameters can be stored
- Graphics display and ergonomic 1-button operation
- Automatic grinding chamber ventilation for grinding with solvents
- 2 year warranty, CE-conforming

Innovative technology for superior performance

A **new type of operating concept** and, above all, the optimized safety aspects set new standards in this product segment and offer the user the possibility of carrying out size reduction tasks optimally and safely. The powerful and maintenance-free mill drive guarantees a constant controlled speed even **for continuous use** in long-term trials and under maximum load. The **low vibration rates** of these benchtop models also allow their unattended operation. Due to the built-in fan with standstill monitoring and the "comfort" grinding jars, the PM 100 and PM 200 offer the highest degree of safety for **wet grinding with solvents**.

Both mills are characterized by their versatile and innovative possibilities. For example, the energy applied to the grinding jar during the grinding process can be measured in kJ. This means that for the first time it is possible to compare the efficiency of various grinding parameters directly with one another, in order to be able to optimize them to a previously unknown extent. For different grinding parameters (time, grinding jar, ball charge, etc.) the energy input can be compared with the result in the form of the particle size distribution. The optimal parameter combination is then obtained from the required degree of fineness at the smallest possible energy input.

New technology with maximum operating comfort

The planetary ball mills PM 100 and PM 200 feature a new and very convenient operator guidance. All the relevant data can be entered or called up via a graphics display with 1-button operation:

- speed
- grinding time
- energy input
- grinding direction reversal with selection of running and pause times
- starting time
- remaining running time
- display of drive load factor
- operating hours
- clear text error messages
- service intervals.

10 combinations of speed, grinding time and interval settings can be stored for repetitive grinding tasks. **With multi-language graphical menu guidance.**



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Planetary ball mill PM 400



Powerful and safe

The planetary ball mill PM 400 is a robust, compact floor-mounted model on casters. Its sturdy drive guarantees smooth operation even at maximum speed. It has 4 grinding stations for 2, 4 or even 8 grinding jars. In this way the PM 400 achieves a particularly **high sample throughput**. Alternatively, the PM 400 can be supplied with only 2 grinding stations.

The mill is very user-friendly. All operating parameters can be entered easily via the ergonomic touch-sensitive keypad. The speed and grinding time are set digitally. This ensures reproducible grinding processes. During the grinding process the actual values are shown digitally. Direction reversal can be switched on for a better mixing effect and for loosening up the sample. The running and interval parameters can be freely programmed.



The high speed of 30 to 400 min^{-1} in combination with the very large sun wheel diameter of 300 mm guarantee **extremely high fineness in a short time**.

The easily accessible grinding chamber of the PM 400 is noise-protected and provided with a twin fan for ventilation. With its powerful, maintenance-free drive the PM 400 is particularly suitable for long-term trials or – in the special version PM 400 MA-type – for mechanical alloying.

Overview

- Extremely high degree of fineness down to the submicron range
- Grinding jar volumes from 12 ml to 500 ml
- Simultaneous processing of 2, 4 or 8 samples
- Reproducible results by digital setting and speed control
- 2 grinding chamber fans
- Universal use due to comprehensive range of accessories: grinding jars in 7 sizes and 6 materials
- Simple and safe operation
- Stable, robust, sound-insulated execution, suitable for continuous use
- Short grinding times for high sample throughput
- 2 year warranty, CE-conforming

Speed ratios

The working principle of the planetary ball mills is based on the relative rotational movement between the grinding jar and the sun wheel. In addition to the sun wheel diameter and speed of rotation this speed ratio is decisive for the energy input and therefore for the results of the size reduction process. **The higher the speed ratio, the more energy is generated.**

There are planetary ball mills with different speed ratio settings. For example, a ratio of 1:-1 means that each time that the sun wheel rotates the grinding jar also rotates exactly once in the opposite direction (indicated by the minus sign). With a speed ratio of 1:-2 the grinding jar rotates twice for each sun wheel rotation. In order to follow the rotational movement of the grinding jar you have to imagine that you are standing at the center of the sun wheel. During the sun wheel rotation you will see the red reference point exactly twice, i.e. the grinding jar has rotated twice (see illustration).

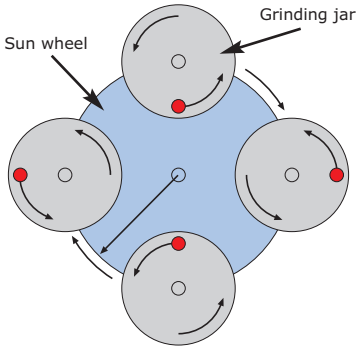


Diagram: speed ratio 1:-2

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The optimal planetary ball mill for your requirements

RETSCH planetary ball mills are available in 3 different versions

The **PM 100** – the convenient benchtop model with 1 grinding station for grinding jars with a nominal volume of 12 to 500 ml.

The benchtop model **PM 200** with 2 grinding stations for grinding jars with a nominal volume of 12 to 125 ml. The larger sun wheel diameter results in a higher energy input when compared to the PM 100.

The robust floor-mounted model **PM 400** with 4 grinding stations for grinding jars with a nominal volume of 12 to 500 ml allows a high sample throughput. The PM 400 is also available with 2 grinding stations as well as in a special version for mechanical alloying.

Performance data	PM 100	PM 200	PM 400	PM 400 MA-type
Field of application	pulverizing, mixing, homogenizing, colloidal milling, mechanical alloying			
Feed material	soft, hard, brittle, fibrous – dry or wet			
Feed size*	<10 mm	<4 mm	<10 mm	<10 mm
Final fineness*	<1 µm	<1 µm	<1 µm	<1 µm
For colloidal grinding	<0.1 µm	<0.1 µm	<0.1 µm	<0.1 µm
Batch/Sample volume	max. 1 x 300 ml	max. 2 x 70 ml	max. 4 x 300 ml	max. 4 x 300 ml
with stacked grinding jars	max. 2 x 20 ml	–	max. 8 x 20 ml	max. 8 x 20 ml
Suitable grinding jars	„comfort" 12 / 25 / 50 / 80 / 125 / 250 / 500 ml	„comfort" 12 / 25 / 50 / 80 / 125 ml	„comfort" 12 / 25 / 50 / 80 / 125 / 250 / 500 ml	„comfort" 12 / 25 / 50 / 80 / 125 / 250 / 500 ml
No. of grinding stations	1	2	4 or 2	4 or 2
Speed ratio	1 : -2	1 : -2	1 : -2	1 : -2,5 / 1 : -3
Sun wheel speed	100 - 650 min^{-1}	100 - 650 min^{-1}	30 - 400 min^{-1}	30 - 400 min^{-1}
Effective sun wheel diameter	141 mm	157 mm	300 mm	300 mm
Digital grinding time setting (hours:minutes:seconds)	00:00:01 to 99:59:59	00:00:01 to 99:59:59	00:01:-- to 99:59:--	00:01:-- to 99:59:--
Direction reversal	yes	yes	yes	yes
Interval time (minutes:seconds)	00:01 to 99:59	00:01 to 99:59	00:01 to 99:59	00:01 to 99:59
Pause time (minutes:seconds)	00:01 to 99:59	00:01 to 99:59	00:30 to 99:59	00:30 to 99:59
Serial interface	yes	yes	no	no
Technical data				
Power consumption	approx. 1250 W (VA)	approx. 1250 W (VA)	approx. 2100 W (VA)	approx. 2100 W (VA)
Nominal Power	750 W	750 W	1500 W	1500 W
W x H x D	630 x 468 x 415 mm	630 x 468 x 415 mm	820 x 1070 x 685 mm	820 x 1070 x 685 mm
Net weight	approx. 80 kg	approx. 72 kg	approx. 285 kg	approx. 285 kg
Noise values (noise measuring according to DIN 45635-31-01-KL3)				
Emission value with regard to workplace	L_{pAeq} up to 85 dB(A)	L_{pAeq} up to 80 dB(A)	L_{pAeq} up to 85 dB(A)	L_{pAeq} up to 85 dB(A)
depending on feed material, grinding jar volume, ball charge and selected speed				
*depending on feed material				

Mechanical alloying with RETSCH planetary ball mills

The mechanical alloying of materials in a grinding process to form new materials with new properties is no problem for RETSCH planetary ball mills. For ductile metals the speed ratio of the jar to the sun wheel of 1:-2 is fully adequate in most cases, as the impact energy produced by the ball charge is large enough to form an alloy.

However, greater energy is required for hard-brittle materials such as covalently bound semiconductors. The PM 400 MA-type with an increased speed ratio of 1:-2.5 or 1:-3.0 is available for such applications. The optimal speed ratio and all other grinding parameters must be determined experimentally for the specific product.



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“comfort” grinding jars for PM 100, PM 200, PM 400 and S 100

Grinding jars for excellent grinding results

The performance and the result of sample preparation are also determined by the choice of the grinding jar and its ball charge. The choice depends on the amount of sample and the final fineness and purity of the ground sample that are necessary for the subsequent analysis.

In the PM 100 and PM 400 each grinding station can accommodate 2 stacked 12 - 50 ml “comfort” grinding jars. The 50 ml grinding jars require an additional adapter, the smaller grinding jars can be stacked directly.

Special accessories for the grinding jars are available for particular applications. For example, the **aeration cover** is used to create an inert atmosphere in the grinding jar. The **safety closure device** permits the necessary filling and emptying processes to be carried out in a glovebox and can also be used for grinding with solvents.



The unique advantages of “comfort” grinding jars

- **unusually simple and safe handling**
- safe, non-slip seating with built-in anti-rotation device and conical base centering
- **O-ring for gas-tight and dust-proof seal**
- user-friendly gripping flanges on jar and lid
- gap between jar and edge of lid for easy opening
- stainless steel protective jacket (for agate, sintered corundum, zirconium oxide and tungsten carbide grinding jars)
- grinding jar identification (item number, material and volume)
- labeling field (e.g. for sample information)

The “comfort” range of grinding jars has been specially designed for extreme working conditions such as long-term trials, wet grinding, high mechanical loads and maximum speeds as well as for mechanical alloying.

Grinding jar filling levels – guidelines for sample volume and ball charge

Grinding jar nominal volume	Useful volume (sample and balls)	Max. feed size	S 100	PM 100	PM 200	PM 400	Recommended ball charge Ø 10 mm	Ø 20 mm	Ø 30 mm	Ø 40 mm
12 ml	up to 5 ml	<1 mm	–	■	■	■	5 pcs.	–	–	–
25 ml	up to 10 ml	<1 mm	–	■	■	■	8 pcs.	–	–	–
50 ml	5 - 20 ml	<3 mm	■	■	■	■	10 pcs.	3 pcs.	–	–
80 ml	10 - 50 ml	<4 mm	■	■	■	■	20 pcs.	5 pcs.	–	–
125 ml	15 - 70 ml	<4 mm	■	■	■	■	25 pcs.	6 pcs.	–	–
250 ml	25 - 150 ml	<6 mm	■[1)]	■	–	■	50 pcs.	12 pcs.	5 pcs.	–
500 ml	75 - 300 ml	<10 mm	■[2)]	■	–	■	100 pcs.	20 pcs.	8 pcs.	4 pcs.

[1)]not tungsten carbide, [2)]not zirconium oxide

Material composition guidelines

Grinding jar	Material no.	approx. hardness	Material analysis (in %)
Chrome steel	1.2080	62-63 HRC	Fe (84.89), Cr (12), C (2.2), Mn (0.45), Si (0.4), P (0.03), S (0.03)
Stainless steel	1.4034	48-52 HRC	Fe (82.925), Cr (14.5), Mn (1), Si (1), C (0.5), P (0.045), S (0.03)
Tungsten carbide		1180-1280 HV 30	WC (94), Co (6)
Agate		6.5-7 Mohs	SiO_2 (99.91), Al_2O_3 (0.02), Na_2O (0.02), Fe_2O_3 (0.01), K_2O (0.01), MnO (0.01), MgO (0.01), CaO (0.01)
Sintered corundum		1750 HV	Al_2O_3 (99.7), MgO (0.075), SiO_2 (0.075), CaO (0.07), Fe_2O_3 (0.01), Na_2O (0.01)
Zirconium oxide*		1200 HV	$Zr0_2$ (94.5), Y_2O_3 (5.2), SI_2/ MgO/ CaO/ Fe_2O_3/ Na_2O/ K_2O (< 0.3)

The above percentages are mean values. We reserve the right to make alterations.

*yttrium-stabilized

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Planetary ball mills order data

Planetary ball mills PM 100, PM 200, PM 400				Item No.
PM 100 (please order grinding jars and grinding balls separately)				
PM 100	for 230 V, 50/60 Hz	with 1 grinding station	set speed ratio 1 : -2	20.540.0001
PM 100	for 110 V, 50/60 Hz	with 1 grinding station	set speed ratio 1 : -2	20.540.0002
PM 200 (please order grinding jars and grinding balls separately)				
PM 200	for 230 V, 50/60 Hz	with 2 grinding stations	set speed ratio 1 : -2	20.640.0001
PM 200	for 110 V, 50/60 Hz	with 2 grinding stations	set speed ratio 1 : -2	20.640.0002
PM 400 mounted on casters (2 x lockable) (please order grinding jars and grinding balls separately)				
PM 400	for 1 x 220-230 V, 50-60 Hz	with 4 grinding stations	set speed ratio 1 : -2	20.532.0001
PM 400	for 1 x 240 V, 50-60 Hz	with 4 grinding stations	set speed ratio 1 : -2	20.532.0002
PM 400/2	for 1 x 220-230 V, 50-60 Hz	with 2 grinding stations	set speed ratio 1 : -2	20.532.0005
PM 400/2	for 1 x 240 V, 50-60 Hz	with 2 grinding stations	set speed ratio 1 : -2	20.532.0006
PM 400 MA-type, special version for mechanical alloying (please order grinding jars and grinding balls separately)				
PM 400 MA-type	for 220-230 V, 50/60 Hz	with 4 grinding stations	set speed ratio 1 : -2.5	20.532.0007
PM 400 MA-type	for 220-230 V, 50/60 Hz	with 4 grinding stations	set speed ratio 1 : -3	20.532.0008

"comfort" grinding jars for PM 100, PM 200, PM 400 and S 100							Item No.
"comfort" grinding jars	12 ml**	25 ml**	50 ml	80 ml	125 ml	250 ml*	500 ml*
Chrome steel	–	–	01.462.0145	–	01.462.0144	01.462.0224	01.462.0229
Stainless steel	01.462.0239	01.462.0240	01.462.0149	–	01.462.0148	01.462.0223	01.462.0228
Tungsten carbide	–	–	01.462.0156	–	01.462.0155	01.462.0222**	–
Agate	–	–	01.462.0139	01.462.0197	01.462.0136	01.462.0220	01.462.0225
Sintered corundum	–	–	01.462.0153	–	01.462.0152	01.462.0221	01.462.0226
Zirconium oxide	–	–	01.462.0188	–	01.462.0187	01.462.0219	01.462.0227**

*not for PM 200, **not suitable for S 100

Accessories for "comfort" grinding jars	Item No.
Adapter for stacking 50 ml "comfort" grinding jars in the PM 100 or PM 400	
for 50 ml "comfort" grinding jars made from stainless steel or chrome steel	03.025.0002
for 50 ml "comfort" grinding jars made from agate, sintered corundum, zirconium oxide or tungsten carbide	03.025.0003
Aeration cover	
for 250 ml "comfort" grinding jars made from stainless steel	22.107.0005
for 250 ml "comfort" grinding jars made from tungsten carbide	22.107.0006
for 500 ml "comfort" grinding jars made from stainless steel	22.107.0007
Safety closure devices	
for 50 ml "comfort" grinding jars	22.867.0002
for 125 ml "comfort" grinding jars	22.867.0003
for 250 ml "comfort" grinding jars	22.867.0004
for 500 ml "comfort" grinding jars	22.867.0005
Other accessories	
Adapter for using "comfort" grinding jars, 250 - 500 ml, versions before June 2003 in the PM 100	22.001.0004

Grinding balls	10 mm Ø	20 mm Ø	30 mm Ø	40 mm Ø	Item No.
Grinding balls	10 mm Ø	20 mm Ø	30 mm Ø	40 mm Ø	
Chrome steel	05.368.0059	05.368.0033	05.368.0057	05.368.0056	
Stainless steel	05.368.0063	05.368.0062	05.368.0061	05.368.0060	
Tungsten carbide	05.368.0071	05.368.0070	05.368.0069	05.368.0068	
Agate, polished	05.368.0067	05.368.0028	05.368.0065	05.368.0064	
Sintered corundum	05.368.0021	05.368.0054	05.368.0053	05.368.0052	
Zirconium oxide	05.368.0094	05.368.0093	05.368.0092	05.368.0091	
Grinding balls for colloidal milling			2 mm Ø	3 mm Ø	
Stainless steel, container = 500 g			22.455.0010	22.455.0011	
Zirconium oxide, yttrium-stabilized, container =500 g			05.368.0089	05.368.0090	

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