PLANETARY BALL MILL PM 100

The Planetary Ball Mill PM 100 is a powerful benchtop model with a single grinding station and an easy-to-use counterweight which compensates masses up to 8 kg. It allows for grinding up to 220 ml sample material per batch.

The extremely high centrifugal forces of Planetary Ball Mills result in very high pulverization energy and therefore short grinding times.

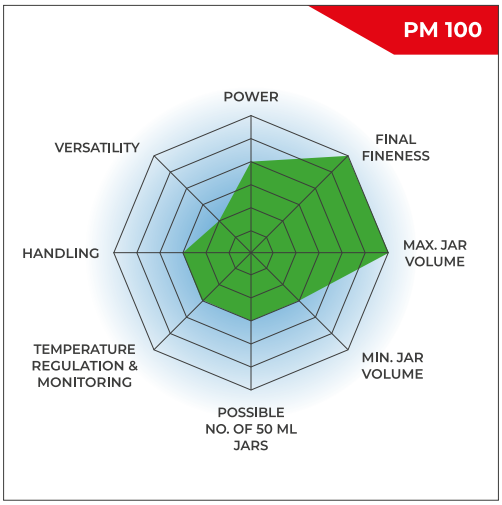
The PM 100 can be found in virtually all industries where the quality control process places the highest demands on purity, speed, fineness and reproducibility.

The mill is ideally suited for tasks in research like mechanochemistry (co-crystal screening, mechano-synthesis, mechanical alloying and mechanocatalysis), or ultrafine colloidal grinding on a nanometer scale, as well as for routine tasks such as mixing and homogenizing soft, hard, brittle or fibrous materials.

Click to view video

THE IDEAL BALL MILL FOR STANDARD APPLICATIONS

- Max. speed 650 rpm
- Up to 10 mm feed size and 0.1 µm final fineness
- 1 grinding station for jars from 12 ml up to 500 ml
- Jars of 12 – 80 ml can be stacked (two jars each)
- GrindControl to measure temperature and pressure inside the jar.
- Aeriation lids to control the atmosphere inside the jar
- Storable SOPs and cycle programs, 5 different jar materials for dry and wet grinding



FAST & POWERFUL

- Loss-free size reduction down to the submicron range
- Wet grinding yields particle sizes in the nanometer range (<100 nm)
- Variable speed from 100 to 650 rpm, speed ratio 1:-2
- Grinding with up to 33.3 x acceleration of gravity
- Batch-wise processing with max. 1 x 220 ml sample
- 2 x 20 ml sample per batch with stacked jars

PLANETARY BALL MILL PM 100

REPRODUCIBILITY, SAFETY AND EASY HANDLING

- Reproducible results due to speed control
- Easy and safe clamping of grinding jars
- The Safety Slider prevents starting the machine without securely clamped jars
- Perfect stability on the lab bench thanks to FFCS technology
- Innovative counterweight and imbalance sensor for unsupervised operation
- Comfortable parameter setting via display and ergonomic 1-button operation
- Automatic grinding chamber ventilation
- 10 SOPs can be stored, programmable starting time
- Power failure backup ensures storage of remaining processing time

SETTINGS & OPTIONS

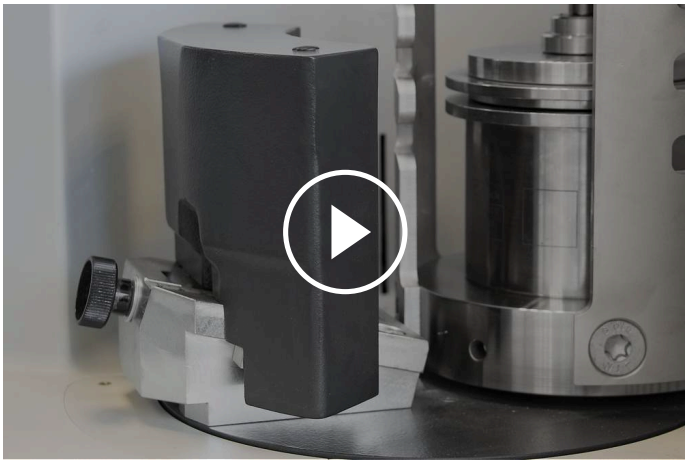
- Dry and wet grinding possible
- Suitable for long-term trials, 99 h max.
- Interval operation allows for cooling breaks
- Direction reversal helps to minimize caking effects

THE BEST ALTERNATIVE TO A RETSCH PLANETARY BALL MILL? A RETSCH MIXER MILL.

Benefit from particularly ergonomic handling while achieving the same finenesses down to the nanometer range.

SAFETY FIRST: COUNTERWEIGHT AND JAR CLAMPING

COUNTERWEIGHT



Click to view video

Planetary mills with a single grinding station require a counterweight for balancing purposes. In the planetary ball mill PM 100 this counterweight can be adjusted on an inclined guide rail to compensate for the different heights of the centers of gravity of differently-sized grinding jars and thus avoid undesired oscillations of the machine.

SAFETY SLIDER

Click to view video

Operation of the RETSCH planetary ball mills is particularly safe. They feature a robust Safety Slider which ensures that the mill can only be started after the grinding jar has been securely fixed with a clamping device. The self-acting lock ensures that the jar is seated correctly and securely. This proven solid mechanical system is less failure-prone than electronic solutions - the user has full access to the sample at any time. When the electronic system fails, it is not possible to unlock the jars, for example.

PLANETARY BALL MILL PM 100

WET AND NANO-SCALE GRINDING WITH THE PM 100

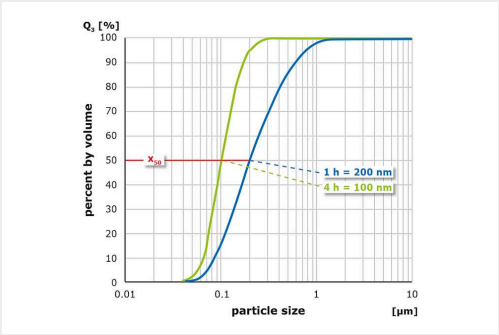
Wet grinding is used to obtain particle sizes below 5 µm, as small particles tend to get charged on their surfaces and agglomerate, which makes further grinding in dry mode difficult. By adding a liquid or dispersant the particles can be kept separated.

To produce very fine particles of 100 nm or less (nano-scale grinding) by wet grinding, friction rather than impact is required. This is achieved by using a large number of small grinding balls which have a large surface and many friction points. The ideal filling level of the jar should consist of 60 % small grinding balls.

For more details on jar filling, wet grinding and sample recovery watch the video.

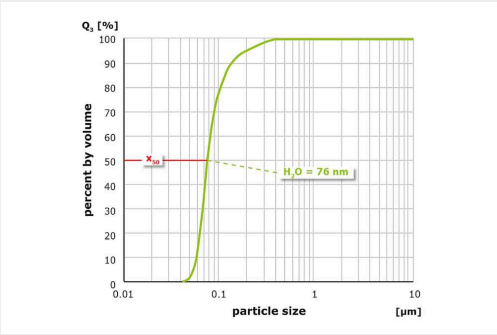
Click to view video

The graphic shows the result of grinding alumina (Al_2O_3) at 650 rpm in the PM 100. After 1 h of size reduction in water with 1 mm grinding balls, the mean value of the particle size distribution is 200 nm; after 4 h it is 100 nm.



Grinding of alumina in water with 1 mm grinding balls (left) after 1 hour (blue) and after 4 hours (green)

In another trial, the material was first pulverized for 1 hour with 1 mm grinding balls and then for 3 hours with 0.1 mm grinding balls. In this case, an average size of 76 nm was achieved.



Grinding of alumina with 1 mm grinding balls (1 hour) and then with 0.1 mm balls (3 hours) in water

The results show that planetary ball mills can produce particle sizes in the nanometer range. The choice of the right ball size, the type of liquid and the liquid/solid ratio (viscosity level) play a crucial role in this process.

EASYFIT GRINDING JARS FOR EXCELLENT RESULTS

The performance and the result of sample preparation are also determined by the choice of the grinding jar and its ball charge. The EasyFit range of jars has been specially designed for extreme working conditions such as long-term trials, even at maximum speed of 800 rpm, wet grinding, high mechanical loads and maximum speeds as well as for mechanical alloying. This line of jars is suitable for all RETSCH planetary ball mills.

The new EasyFit grinding jar series features a structure on the bottom of the 50-500 ml jars called Advanced Anti-Twist (AAT). This ensures that the jars are tightly fixed without the risk of twisting, even at high speed, and that wear and tear is drastically reduced. Secure clamping of the jars is made much easier: to find the correct clamping position, a maximum twist of 60° is required.

The geometry of the EasyFit jars in the 50 ml and 250 ml sizes has been enlarged in diameter and reduced in height compared to the previous "comfort" models. This offers two advantages: better grinding results and interchangeable lids, as there are only three diameter dimensions for the entire grinding jar range.

Diameter categories

- Diameter 1: 12 ml and 25 ml grinding jars
- Diameter 2: 50 ml, 80 ml and 125 ml grinding jars
- Diameter 3: 250 ml and 500 ml grinding jars

- Available jar sizes: 12 ml / 25 ml / 50 ml / 80 ml / 125 ml / 250 ml / 500 ml
- Innovative Advanced Anti-Twist (AAT) function ensures secure fit of grinding jars
- High flexibility thanks to suitability of three lid sizes for all seven jar sizes
- Pressure-tight and dust-proof O-ring sealing prevents material spillage
- Jars and balls available in 5 materials: hardened stainless steel, tungsten carbide, agate, sintered aluminium oxide, zirconium oxide
- Stainless steel protective jacket for agate, sintered aluminum oxide, zirconium oxide and tungsten carbide grinding jars
- A groove between jar body and lid allows for easy opening of the lid, e. g. with the help of a spatula, if there are underpressure effects inside the jar

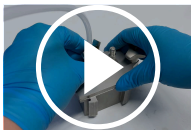
JARS & LIDS FOR SPECIAL APPLICATIONS

- For colloidal or wet grinding, the use of a grinding jar with a special closure device is recommended
- The special closure device is designed for ergonomic handling
- Aeration lids are designed for working under inert atmosphere, for example if oxygen can influence the grinding process or the mechanosynthesis. The lids allow the introduction of gases like argon or nitrogen into the grinding jar.
- Optional pressure and temperature measuring system PM GrindControl

Both the aeration lid and GrindControl can now be equipped with inlays of different materials. Thus, the lid can be used for, e. g. a steel and a zirconium oxide jar by simply exchanging the inlay.

GrindControl

Aeriation lid



Click to view video

Video: Aeriation lid

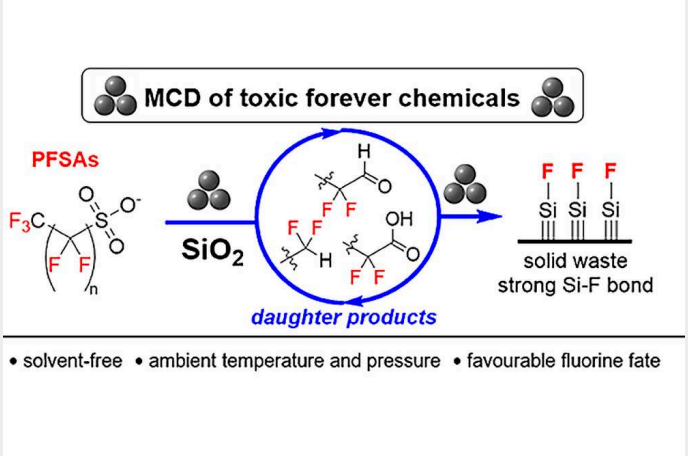
ADAPTER FOR SPECIAL APPLICATIONS

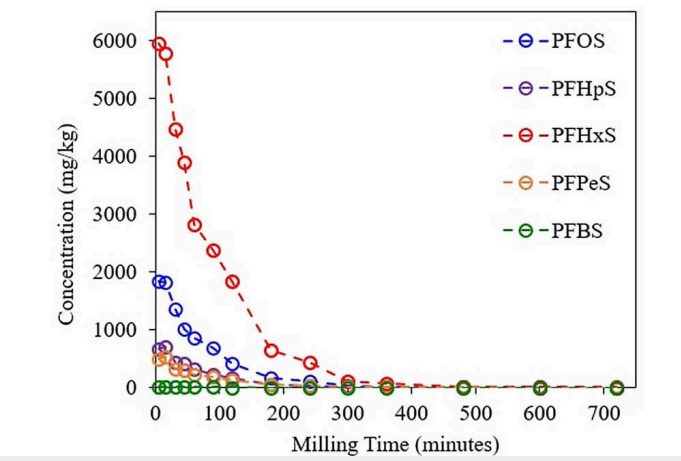
With a special adapter, co-crystal screening can be carried out in a planetary ball mill, using disposable vials such as 1.5 ml GC glass vials. The adapter features 24 positions arranged in an outer ring with 16 positions and an inner ring with 8 positions. The outer ring accepts up to 16 vials, allowing for screening up to 64 samples simultaneously when using the Planetary Ball Mill PM 400. The 8 positions of the inner ring are suitable to perform trials with different energy input, e.g. for mechanosynthesis research.

MECHANOCHEMICAL DESTRUCTION OF FOREVER CHEMICALS IN PM 100

In a detailed study, Gobindlal et al. (2022) [10] investigated the mechanochemical destruction (MCD) of perfluorosulfonic acids (PFSAs), a subclass of persistent per- and polyfluoroalkyl substances (PFASs), using the PM 100.

- Milling Setup: 0.05 g of PFAS standards were mixed with 5 g of quartz sand in a 50 ml stainless steel jar with ten 10 mm stainless steel balls.
- Milling was performed at ambient temperature and pressure, without solvents or chemical additives. Samples were milled for up to 720 minutes, under relatively mild conditions, to assess degradation kinetics and establish the underlying degradation mechanisms.
- The PM 100 achieved 99.99% degradation of total PFSA content after 720 minutes. Individual compounds like PFOS, PFHpS, PFHxS, PFPeS, and PFBS showed rapid degradation, with PFBS reaching complete destruction by 180 minutes.





Decreasing concentration of different Perflourosulfonic acids (PFAs) while grinding in the PM100 over a period of 700 min; Results presented by the group of Kapish Gobindlal [1]

MECHANISM OF ACTION:

Quartz sand, when ground in the PM 100, generates reactive surface radicals that initiate PFAS breakdown. These radicals facilitate C–F bond cleavage, one of the strongest in organic chemistry, leading to the mineralization of fluorine into stable Si–F bonds. Another study by the same group highlights the scalability and effectiveness of MCD using the Retsch PM 100 planetary ball mill for the remediation of PFAS-contaminated land and the destruction of stockpiled AFFFs.

RECOMMENDED JAR FILLINGS

To produce optimum grinding results, the jar size should be adapted to the sample amount to be processed. The grinding balls are ideally sized 3 times bigger than the largest sample piece. Following this rule of thumb, the number of grinding balls for each ball size and jar volume is indicated in the table below. To pulverize, for example, 200 ml of a sample consisting of 7 mm particles, a 500 ml jar and grinding balls sized at least 20 mm or larger are recommended. According to the table, 25 grinding balls are required.

Grinding jar nominal volume	Sample amount	Max. feed size	Recommended ball charge (pieces)					
			Ø 5 mm	Ø 7 mm	Ø 10 mm	Ø 15 mm	Ø 20 mm	Ø 30 mm
12 ml	up to ≤5 ml	<1 mm	50	15	5	-	-	-
25 ml	up to ≤10 ml	<1 mm	95 – 100	25 – 30	10	-	-	-
50 ml	5 – 20 ml	<3 mm	200	50 – 70	20	7	3 – 4	-
80 ml	10 – 35 ml	<4 mm	250 – 330	70 – 120	30 - 40	12	5	-
125 ml	15 – 50 ml	<4 mm	500	110 – 180	50 – 60	18	7	-
250 ml	25 – 120 ml	<6 mm	1100 – 1200	220 – 350	100 – 120	35 – 45	15	5
500 ml	75 – 220 ml	<10 mm	2000	440 – 700	200 – 230	70	25	8

The table shows the recommended charges (in pieces) of differently sized grinding balls in relation to the grinding jar volume, sample amount and maximum feed size.

TYPICAL SAMPLE MATERIALS

RETSCH planetary ball mills are perfectly suitable for size reduction of, for example, alloys, bentonite, bones, carbon fibres, catalysts, cellulose, cement clinker, ceramics, charcoal, chemical products, clay minerals, coal, coke, compost, concrete, electronic scrap, fibres, glass, gypsum, hair, hydroxyapatite, iron ore, kaolin, limestone, metal oxides, minerals, ores, paints and lacquers, paper, pigments, plant materials, polymers, quartz, seeds, semi-precious stones, sewage sludge, slag, soils, tissue, tobacco, waste samples, wood, etc.

TOUGH-FIBROUS: WOOD

40 g sample
500 ml stainless steel grinding jar
8 x 30 mm stainless steel grinding balls
5 min at 380 rpm

HARD-BRITTLE: MAGNETITE

315 g sample
250 ml tungsten carbide grinding jar
15 x 20 mm tungsten carbide grinding balls
5 min at 500 rpm

MEDIUM-HARD: SOIL

45 ml sample
125 ml stainless steel grinding jar
7 x 20 mm stainless steel grinding balls
2 min at 400 rpm

FIBROUS: DRIED GRASS

200 ml sample
250 ml zirconium oxide grinding jar
15 x 20 mm zirconium oxide grinding balls
30 min at 480 rpm

MEDIUM-HARD/ FIBROUS: SEWAGE SLUDGE

20 g sample
125 ml zirconium oxide grinding jar
50 x 10 mm zirconium oxide grinding balls
30 min at 380 rpm with direction reversal

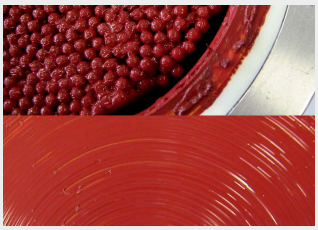
MEDIUM-HARD: LIMESTONE

170 ml sample
500 ml zirconium oxide grinding jar
8 x 30 mm zirconium oxide grinding balls
3 min at 450 rpm

HARD-BRITTLE: LAPIS LAZULI

4 sample pieces
50 ml zirconium oxide grinding jar
3 x 20 mm zirconium oxide grinding balls
2 min at 420 rpm

SOFT - WET GRINDING: CAROTENE

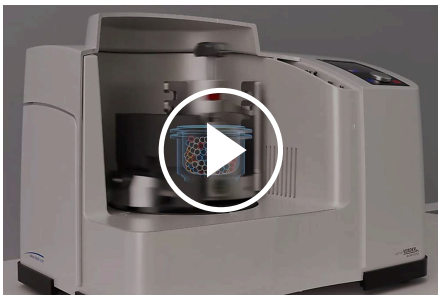


50 g sample + 70 g oil
50 ml zirconium oxide grinding jar
1100 g 3 mm zirconium oxide grinding balls
2 h at 480 rpm (interval operation with 10 min grinding / 10 min break = net grinding time 1 h)

To find the best solution for your sample preparation task, visit our application database.

FUNCTIONAL PRINCIPLE

The grinding jar is arranged eccentrically on the sun wheel of the planetary ball mill. The direction of movement of the sun wheel is opposite to that of the grinding jars in the ratio 1:-2. The grinding balls in the jars are subjected to superimposed rotational movements, the so-called Coriolis forces. The difference in speeds between balls and jars produces an interaction between frictional and impact forces, which releases high dynamic energies. The interplay between these forces produces the high and very effective degree of size reduction of the planetary ball mill, both, in ball to ball and ball to wall interactions.



Click to view video

Planetary mills with 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 jars can be compensated in order to avoid disturbing oscillations of the machine.

Any remaining vibrations are compensated by feet with some free movement (Free-Force Compensation Sockets). This innovative 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 planetary ball mill 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.

REFERENCES

[1] Kapish Gobindlal, Zoran Zujovic, Jacob Jaine, Cameron C. Weber, Jonathan Sperry; Solvent-free ambient temperature and pressure destruction-of PFSAs under MCD presents a detailed study on the mechanochemical destruction (MCD) of perfluorosulfonic acids (PFSAs), Environmental Science & Technology 2023, DOI: 10.1021/acs.est.2c06673.

ORDER DATA

PLANETARY BALL MILL PM 100

(please order grinding jars and balls separately)

20.540.0001		PM 100	with 1 grinding station, speed ratio 1 : -2

other electrical versions available for the same price

ACCESSORIES PLANETARY BALL MILLS

22.661.0002		Clamping unit for PM 100 / PM 400
03.025.0178		Adapter for stacking grinding jars 50 ml - 80 ml
22.221.0002		Add-on weight for PM 100
02.728.0048		Counter aid for sun wheel PM 100, PM 200 and PM 400
03.486.0062		Opening aid for clamping unit of planetary ball mills
99.200.0006		IQ/OQ Documentation for PM 100

PRESSURE AND TEMPERATURE MEASURING SYSTEM GRINDCONTROL

incl. sensors and transmitter unit, inseert of lid, software, case, opening aid and cleaning accessories for PM (please order grinding jars separately)

22.782.0021	GrindControl for PM grinding jar EasyFit 250 or 500 ml, stainless, hardened steel
22.782.0031	GrindControl for PM grinding jar EasyFit 250 or 500 ml, zirconium oxide
22.782.0020	GrindControl for PM grinding jar EasyFit 50, 80 or 125 ml, stainless, hardened steel
22.782.0026	GrindControl with PM grinding jar EasyFit 50, 80 or 125 ml, zirconium oxide

ACCESSORIES

05.114.0054		O-ring for 250 ml - 500 ml grinding jars EasyFit (PM)
22.186.0006		Sintered filter with O-ring, set à three pieces
03.474.0228		GrindControl insert of lid for PM grinding jar EasyFit 250 and 500 ml, stainless, hardened steel
03.474.0239		GrindControl insert of lid for PM grinding jar EasyFit 250 and 500 ml, zirconium oxide
03.474.0240		GrindControl insert of lid for 50, 80 or 125 ml, stainless, hardened steel
03.474.0241		GrindControl insert of lid for 50, 80 or 125 ml, zirconium oxide
22.864.0001		Spare set valves M8X1 for GrindControl and aeration lids

GRINDING JARS EASYFIT

(grinding jars EasyFit are suitable for all planetary ball mills)

HARDENED STAINLESS STEEL		
01.462.0239		12 ml
01.462.0240		25 ml
01.462.0516		50 ml
01.462.0517		80 ml
01.462.0518		125 ml
01.462.0519		250 ml
01.462.0520		500 ml

TUNGSTEN CARBIDE	
01.462.0494	50 ml
01.462.0495	80 ml
01.462.0527	125 ml
01.462.0497	250 ml

AGATE	
01.462.0509	50 ml
01.462.0511	80 ml
01.462.0515	125 ml
01.462.0502	250 ml
01.462.0506	500 ml

SINTERED ALUMINUM OXIDE	
01.462.0507	50 ml
01.462.0512	125 ml
01.462.0499	250 ml
01.462.0503	500 ml

ZIRCONIUM OXIDE	
01.462.0508	50 ml
01.462.0510	80 ml
01.462.0513	125 ml
01.462.0500	250 ml
01.462.0504	500 ml

ADAPTER FOR GLASS VIALS		
01.462.0540		Adapter for 24 x 1.5 ml glass vials, stainless, hardened steel
22.749.0009		Glass vial 1.5 ml incl. septum cap, 100 pieces
05.181.0112		Replacement pressure spring for adapter for 24 x 1.5 ml glass vials, 1 piece
01.462.0541		Adapter for 7 x 20 ml glass vials, stainless, hardened steel
22.749.0010		Glass vial 20 ml incl. septum cap, 100 pieces
05.181.0044		Replacement pressure spring for adapter for 7 x 20 ml glass vials, 1 piece

ACCESSORIES FOR GRINDING JARS EASYFIT FOR WET GRINDING, GRINDING WITH INERT ATMOSPHERE AND MECHANICAL ALLOYING (MA)

AERATION LIDS (INCL. INLAY)

22.107.0613		for grinding jars EasyFit 50 ml - 125 ml, hardened stainless steel
22.107.0616		for grinding jars EasyFit 50 ml - 125 ml, tungsten carbide
22.107.0617		for grinding jars EasyFit 50 ml - 125 ml, agate
22.107.0615		for grinding jars EasyFit 50 ml - 125 ml, zirconium oxide
22.107.0618		for grinding jars EasyFit 250 ml - 500 ml, hardened stainless steel
22.107.0621		for grinding jars EasyFit 250 ml - 500 ml, tungsten carbide
22.107.0622		for grinding jars EasyFit 250 ml - 500 ml, agate
22.107.0620		for grinding jars EasyFit 250 ml - 500 ml, zirconium oxide
22.107.0619		for grinding jars EasyFit 250 ml - 500 ml, aluminum oxide
22.864.0001		Spare valve set for aeration lids M8x1

INLAY FOR AERATION LID

03.474.0225		for grinding jars EasyFit 50 ml - 125 ml, hardened stainless steel
03.474.0207		for grinding jars EasyFit 50 ml - 125 ml, tungsten carbide
03.474.0208		for grinding jars EasyFit 50 ml - 125 ml, agate
03.474.0206		for grinding jars EasyFit 50 ml - 125 ml, zirconium oxide

03.474.0226		for grinding jars EasyFit 250 ml - 500 ml, hardened stainless steel
03.474.0210		for grinding jars EasyFit 250 ml - 500 ml, tungsten carbide
03.474.0211		for grinding jars EasyFit 250 ml - 500 ml, agate
03.474.0209		for grinding jars EasyFit 250 ml - 500 ml, zirconium oxide
03.474.0215		for grinding jars EasyFit 250 ml - 500 ml, aluminum oxide

SAFETY CLOSURE DEVICES

22.867.0011	for grinding jars EasyFit 50 ml - 125 ml
22.867.0012	for grinding jars EasyFit 250 ml - 500 ml
02.486.0055	Opening aid for safety closure device

GASKETS FOR GRINDING JARS EASYFIT

O-RINGS

05.114.0086		O-ring for 12 ml grinding jar EasyFit
05.114.0085		O-ring for 25 ml grinding jar EasyFit
05.114.0054		O-ring for 250 ml - 500 ml grinding jars EasyFit
05.114.0056		O-ring for 50 ml - 125 ml grinding jars EasyFit
05.114.0063		O-ring for 250 ml - 500 ml grinding jars EasyFit, agate

GRINDING BALLS

HARDENED STEEL

05.368.0029		5 mm Ø
05.368.0030		7 mm Ø
05.368.0059		10 mm Ø
05.368.0032		12 mm Ø
05.368.0108		15 mm Ø
05.368.0033		20 mm Ø
05.368.0057		30 mm Ø

STAINLESS STEEL		
22.455.0010		2 mm Ø, 500 g (approx. 110 ml)
22.455.0011		3 mm Ø, 500 g (approx. 120 ml)
22.455.0002		3 mm Ø, 200 pieces (approx. 6 ml)
22.455.0001		4 mm Ø, 200 pieces (approx. 14 ml)
22.455.0003		5 mm Ø, 200 pieces (approx. 25 ml)
05.368.0034		5 mm Ø
05.368.0035		7 mm Ø
05.368.0063		10 mm Ø

05.368.0037		12 mm Ø
05.368.0109		15 mm Ø
05.368.0062		20 mm Ø
05.368.0105		25 mm Ø
05.368.0061		30 mm Ø

TUNGSTEN CARBIDE		
22.455.0006		3 mm Ø, 200 pieces (approx. 6 ml)
22.455.0005		4 mm Ø, 200 pieces (approx. 14 ml)
22.455.0004		5 mm Ø, 200 pieces (approx. 25 ml)
05.368.0038		5 mm Ø
05.368.0039		7 mm Ø
05.368.0071		10 mm Ø
05.368.0041		12 mm Ø
05.368.0110		15 mm Ø
05.368.0070		20 mm Ø
05.368.0069		30 mm Ø

AGATE

05.368.0024		5 mm Ø
05.368.0025		7 mm Ø
05.368.0067		10 mm Ø
05.368.0027		12 mm Ø
05.368.0111		15 mm Ø
05.368.0028		20 mm Ø
05.368.0065		30 mm Ø

SINTERED ALUMINUM OXIDE

05.368.0019		5 mm Ø
05.368.0021		10 mm Ø
05.368.0112		15 mm Ø
05.368.0054		20 mm Ø
05.368.0053		30 mm Ø

ZIRCONIUM OXIDE

32.368.0005		0.1 mm Ø, 0.5 kg (approx. 135 ml)
32.368.0003		0.5 mm Ø, 0.5 kg (approx. 135 ml)

32.368.0004		1 mm Ø, 0.5 kg (approx. 135 ml)
05.368.0089		2 mm Ø, 0.5 kg (approx. 135 ml)
05.368.0090		3 mm Ø, 0.5 kg (approx. 140 ml)
22.455.0007		3 mm Ø, 200 pieces (approx. 6 ml)
22.455.0009		5 mm Ø, 200 pieces (approx. 25 ml)
05.368.0146		7 mm Ø
05.368.0094		10 mm Ø
05.368.0096		12 mm Ø
05.368.0113		15 mm Ø
05.368.0093		20 mm Ø
05.368.0106		25 mm Ø
05.368.0092		30 mm Ø