PLANETARY BALL MILL PM 400

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The PM 400 is a robust floor model with 4 grinding stations and accepts grinding jars with a nominal volume from 12 ml to 500 ml. It processes up to 8 samples simultaneously which results in a high sample throughput.

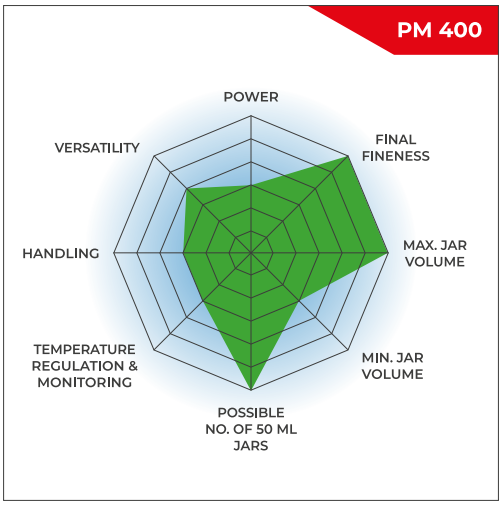
The extremely high centrifugal forces of Planetary Ball Mills result in very high pulverization energy and therefore short grinding times.

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.

For mechanical alloying of hard-brittle materials, the PM 400 is available in a special “MA” version.

THE HIGH-VOLUME BALL MILL FOR HIGH THROUGHPUT APPLICATIONS

- Max. speed 400 rpm, large sun wheel
- Up to 10 mm feed size and 0.1 µm final fineness
- 4 grinding stations 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
- Floor model, storable SOPs and cycle programs, 5 different jar materials for dry and wet grinding



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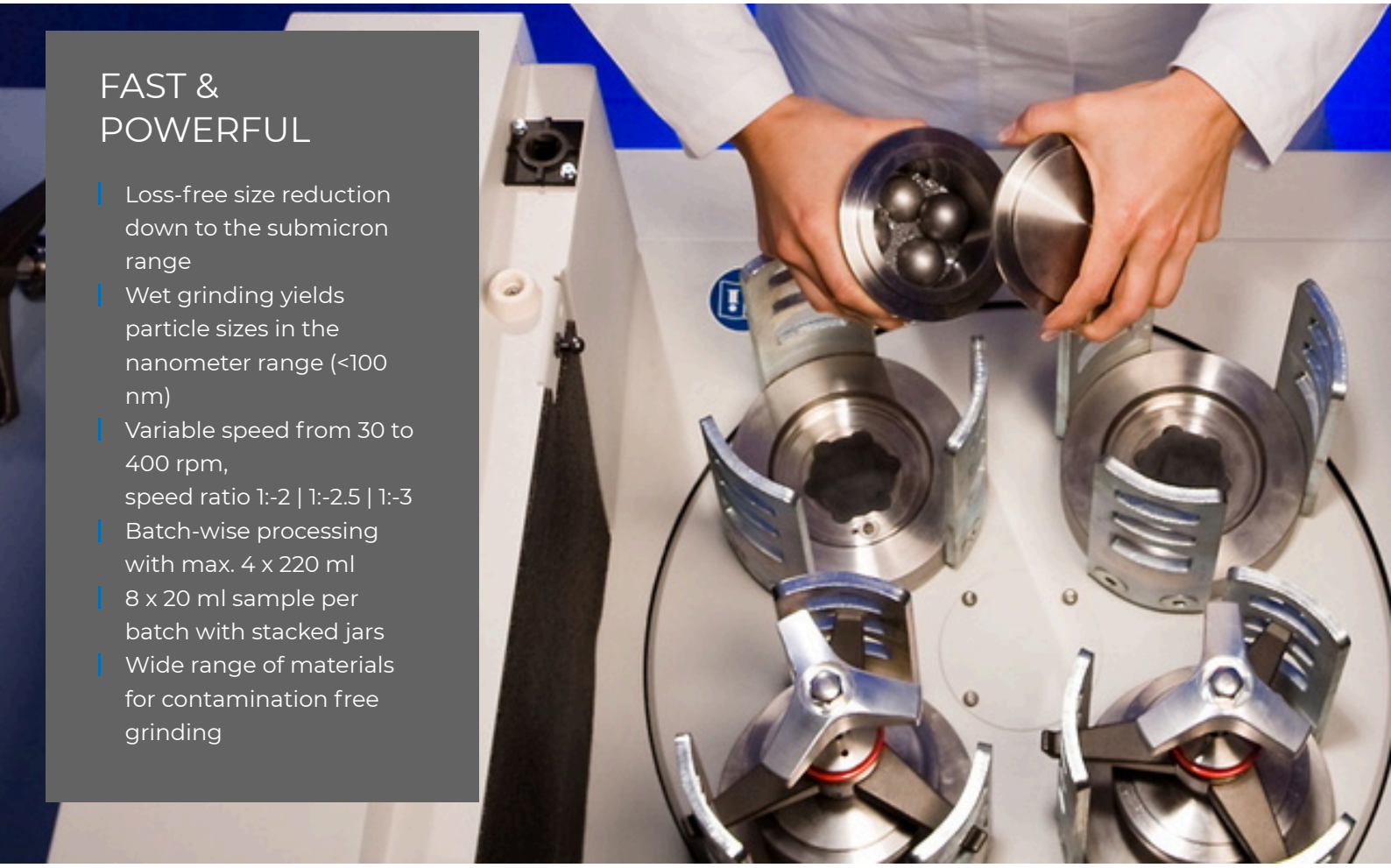

FAST & POWERFUL

- Loss-free size reduction down to the submicron range
- Wet grinding yields particle sizes in the nanometer range (<100 nm)
- Variable speed from 30 to 400 rpm,
  speed ratio 1:-2 | 1:-2.5 | 1:-3
- Batch-wise processing with max. 4 x 220 ml
- 8 x 20 ml sample per batch with stacked jars
- Wide range of materials for contamination free grinding

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PLANETARY BALL MILL PM 400

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
- 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.

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PLANETARY BALL MILL PM 400

SAFETY FIRST: JAR CLAMPING

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.

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WET AND NANO-SCALE GRINDING WITH THE PM 400

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.

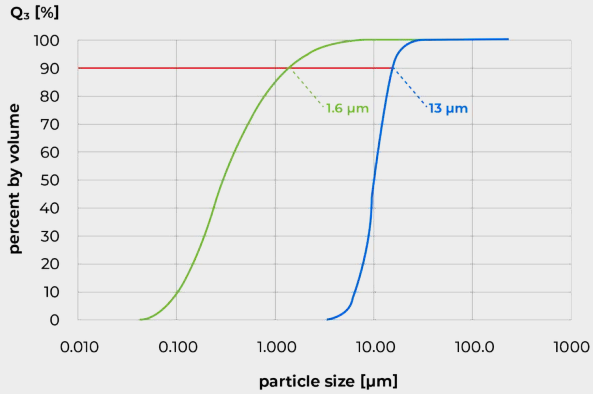
To produce very fine particles of 100 nm or less (nano-scale grinding) by wet grinding, friction rather than impact is required. This is achieved by using a large number of small grinding balls which have a large surface and many friction points. The ideal filling level of the jar should consist of 60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

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

Click to view video

The video shows wet grinding in the Planetary Ball Mill PM 100.

The graphic shows the result of grinding glass at 360 rpm in the PM 400. After 1 h of pulverization in ethanol with 1 mm grinding balls, the D90 value of the original sample was reduced from 13 µm to 1.6 µm.



Grinding of glass in ethanol with 1 mm grinding balls. Blue curve: original sample; green curve: pulverized sample after 60 min.

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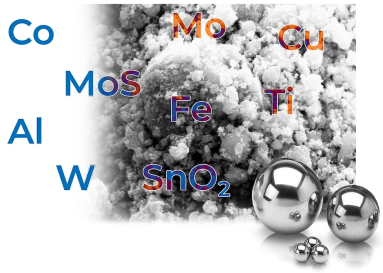
PM 400 MA FOR MECHANOCHEMICAL APPLICATIONS



RETSCH Planetary Ball Mills are perfectly suited for processes like mechanical alloying or mechanosynthesis. For most reactions, the 1:-2 speed ratio of jar to sun wheel of the models PM 100 and PM 200 is fully adequate, as the ball charge produces enough impact energy. However, greater energy is required for some reactions. Here the PM 400 MA can be used with the increased speed ratio of 1:-2.5 or 1:-3.

The PM 400 MA with an increased speed ratio of 1:-2.5 or 1:-3.0 is designed specifically for these applications. The optimum speed ratio and all other grinding parameters need be determined by trial and error for a specific product.

PLANETARY BALL MILL PM 400

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

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- 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

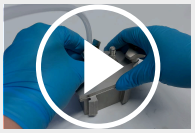
JARS & LIDS FOR SPECIAL APPLICATIONS

- 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

Aeration lid



Click to view video

Video: Aeration lid

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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.

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PLANETARY BALL MILL PM 400

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.

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PLANETARY BALL MILL PM 400

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.

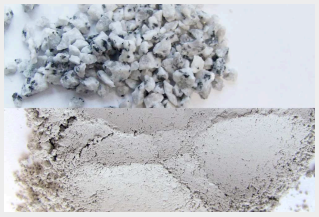
Medium-hard, brittle: coal

4 x 150 g sample
500 ml stainless steel grinding jar
25 x 20 mm stainless steel grinding balls
2 min at 350 rpm

Medium-hard, tough: PMMA

4 x 130 g sample
500 ml zirconium oxide grinding jar
15 x 25 mm zirconium oxide grinding balls
30 min pre-grinding at 400 rpm
150 x 10 mm zirconium oxide grinding balls
16 h fine-grinding at 300 rpm

Hard-brittle: granite



4 x 80 g sample
250 ml agate grinding jar
6 x 30 mm agate grinding balls
15 min at 400 rpm

Hard: silicon carbide

4 x 400 g sample
500 ml zirconium oxide grinding jar
60 x 15 mm zirconium oxide grinding balls
25 min at 400 rpm

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

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FUNCTIONAL PRINCIPLE

The grinding jars are 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 (or 1:-2.5 or 1:-3).

The grinding balls in the grinding jars are subjected to superimposed rotational movements, the so-called Coriolis forces. The difference in speeds between the balls and grinding 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.

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PLANETARY BALL MILL PM 400

TECHNICAL DATA

Applications	pulverizing, mixing, homogenizing, colloidal milling, mechanical alloying, mechanosynthesis, nano grinding, co-crystal screening
Field of application	agriculture, biology, chemistry, construction materials, engineering / electronics, environment / recycling, geology / metallurgy, glass / ceramics, medicine / pharmaceuticals
Feed material	soft, hard, brittle, fibrous - dry or wet
Size reduction principle	impact, friction
Material feed size*	< 10 mm
Final fineness*	< 1 µm, for colloidal grinding < 0.1 µm
Batch size / feed quantity*	max. 4 x 220 ml, max. 8 x 20ml with stacked grinding jars
No. of grinding stations	4 / 2
Speed ratio	1:-2 / 1:-2.5 / 1:-3
Sun wheel speed	30 - 400 min-1
Effective sun wheel diameter	300 mm
G-force	26.8 g
Type of grinding jars	EasyFit, optional areation covers, safety closure devices
Material of grinding tools	hardened steel, stainless steel, tungsten carbide, agate, sintered aluminum oxide, silicon nitride, zirconium oxide
Grinding jar sizes	12 ml / 25 ml / 50 ml / 80 ml / 125 ml / 250 ml / 500 ml
Stackable grinding jars	12 ml / 25 ml / 50 ml / 80 ml
Adapter for single-use glas vials	24 x 1.5 ml / 7 x 20 ml
Setting of grinding time	digital, 00:00:01 to 99:59:59
Interval operation	yes, with direction reversal
Interval time	00:00:01 to 99:59:59
Pause time	00:00:01 to 99:59:59
Storable SOPs	10
Measurement of input energy possible	yes
Interface	RS 232 / RS 485
Drive	3-phase asynchronous motor with frequency converter
Drive power	1.5 kW
Electrical supply data	different voltages

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Power connection	1-phase
Protection code	IP 30
Power consumption	~ 2200 W (VA)
W x H x D closed	836 x 1220 (1900) x 780 mm
Net weight	~ 290 kg
Standards	CE
Patent / Utility patent	SafetySlider (DE 202008008473)

*depending on feed material and instrument configuration/settings

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ORDER DATA

PLANETARY BALL MILL PM 400

on wheels (please order grinding jars and balls separately)

20.535.0001		PM 400 with 4 grinding stations, speed ratio 1 : -2
20.535.0007		PM 400 MA with 4 grinding stations, speed ratio 1 : -2.5, for mechanical alloying
20.535.0008		PM 400 MA with 4 grinding stations, speed ratio 1 : -3, for mechanical alloying

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
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
99.200.0009		IQ/OQ Documentation for PM 400

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)

22.782.0033	GrindControl for PM grinding jar EasyFit 50 - 125 ml
22.782.0034	GrindControl for PM grinding jar EasyFit 250 - 500 ml

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ACCESSORIES

05.114.0056		O-ring for 50, 80 or 125 ml
05.114.0054		O-ring for 250 ml - 500 ml grinding jars EasyFit (PM)
22.864.0001		Spare set valves M8X1 for GrindControl and aeration lids
03.474.0243		GrindControl lid insert for 50, 80, 125 ml, stainless steel
03.474.0246		GrindControl lid insert for 50, 80, 125 ml, zirconium oxide
03.474.0244		GrindControl lid insert for 250 or 500 ml, stainless steel
03.474.0247		GrindControl lid insert for 250 or 500 ml, zirconium oxide

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

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01.462.0497	250 ml
01.462.0498	500 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

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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

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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

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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

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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

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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)

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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

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