PLANETARY BALL MILL PM 400

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 (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.

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, 99:59:59 h max.
- Interval operation allows for cooling breaks
- Direction reversal helps to minimize caking effects

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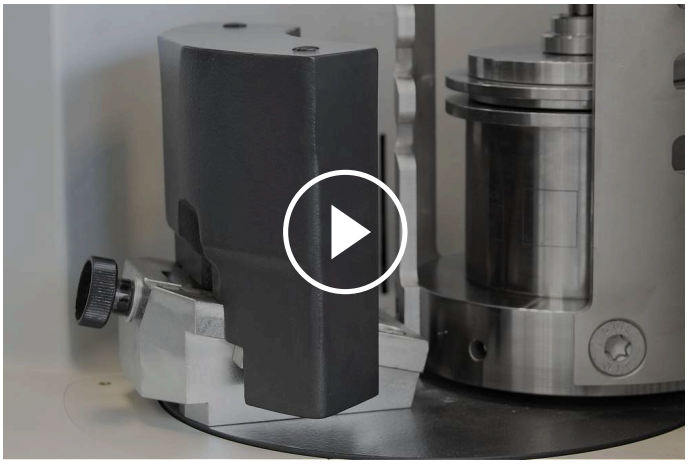
SAFETY FIRST: COUNTERWEIGHT AND JAR CLAMPING

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.

WET AND NANO-SCALE GRINDING WITH THE PM 100

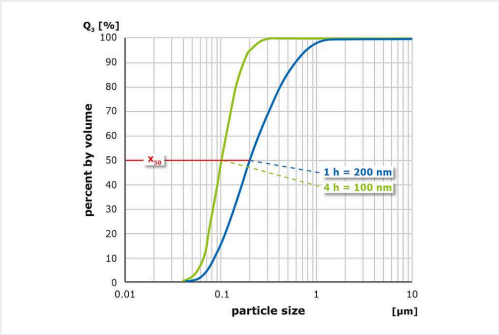
Wet grinding is used to obtain particle sizes below 5 µm, as small particles tend to get charged on their surfaces and agglomerate, which makes further grinding in dry mode difficult. By adding a liquid or dispersant the particles can be kept separated.

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.

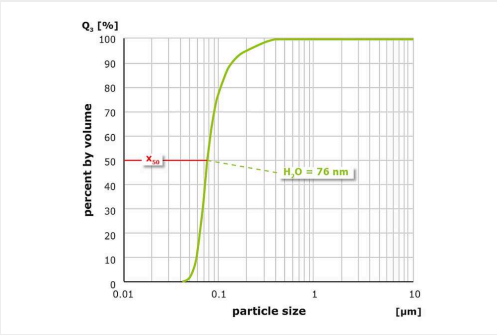
Click to view video

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 a 1 mm grinding ball (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.

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"COMFORT" 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 *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.

- Available jar sizes: 12 ml / 25 ml / 50 ml / 80 ml / 125 ml / 250 ml / 500 ml
- Pressure-tight and dust-proof O-ring sealing prevents material spillage, even after clamping is released
- Jars and balls available in 7 materials: hardened steel, stainless steel, tungsten carbide, agate, sintered aluminium oxide, silicon nitride, 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
- 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

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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	Ø 40 mm
12 ml	up to 5 ml	<1 mm	50	15	5	-	-	-	-
25 ml	up to 10 ml	<1 mm	100	25	8	-	-	-	-
50 ml	5 – 20 ml	<3 mm	200	45	10	7	3	-	-
80 ml	10 – 35 ml	<4 mm	250	70	25	10	5	-	-
125 ml	15 – 50 ml	<4 mm	500	110	30	18	7	-	-
250 ml	25 – 120 ml	<6 mm	1200	220	50	45	15	6	-
500 ml	75 – 220 ml	<10 mm	2000	440	100	70	25	8	4

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

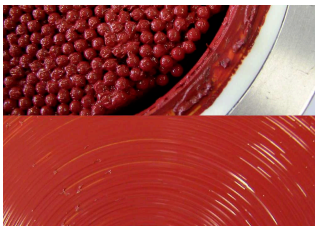
MEDIUM-HARD: LIMESTONE

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



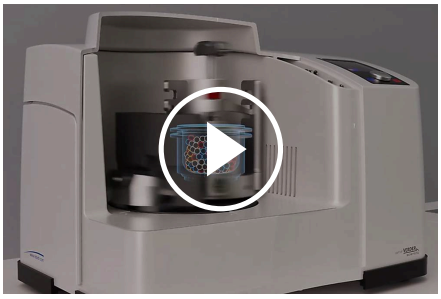
50 g sample + 70 g oil
50 ml zirconium oxide grinding jar
1100 g 3 mm zirconium oxide grinding balls
2 h at 480 rpm (interval operation with 10 min grinding / 10 min break = net grinding time 1 h)

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

PLANETARY BALL MILL PM 100

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.

www.retsch.com/pm100