



행성 볼 밀 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.

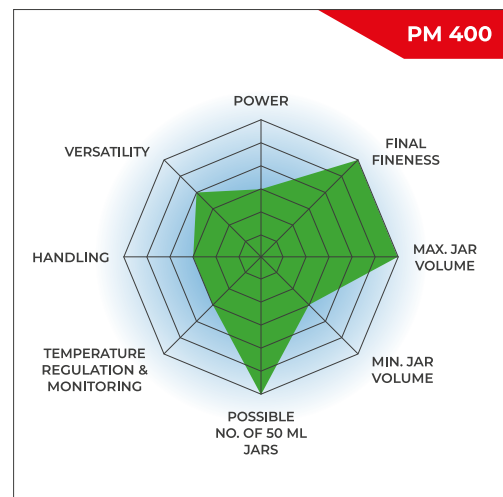
The mill is ideally suited for tasks in research like mechanochemistry (co-crystal screening, mechano-synthesis, mechanical alloying and mechanocatalysis), or ultrafine colloidal grinding on a nanometer scale, as well as for routine tasks such as mixing and homogenizing soft, hard, brittle or fibrous 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.
- | Aeration lids to control the atmosphere inside the jar
- | Floor model, storable SOPs and cycle programs, 5 different jar materials for dry and wet grinding



FAST & POWERFUL

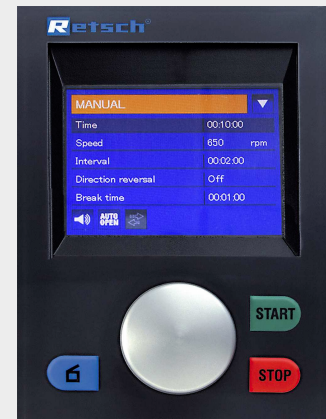
- | Loss-free size reduction down to the submicron range
- | Wet grinding yields particle sizes in the nanometer range (<100 nm)
- | Variable speed from 30 to 400 rpm, speed ratio 1:-2 | 1:-2.5 | 1:-3
- | Batch-wise processing with max. 4 x 220 ml
- | 8 x 20 ml sample per batch with stacked jars
- |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



행성 볼 밀 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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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.

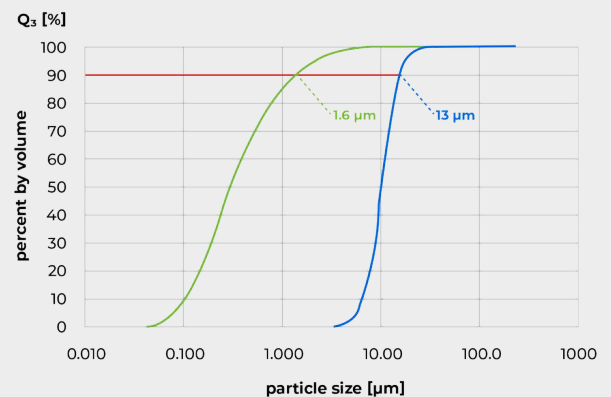
For more details on jar filling, wet grinding and sample recovery watch the video.



[비디오 시청 클릭](#)

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 .

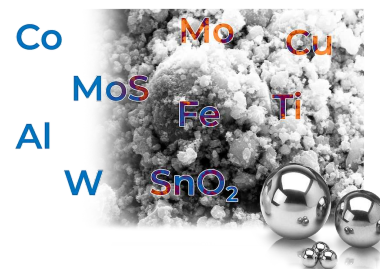


*Grinding of glass in ethanol with 1 mm grinding balls.
Blue curve: original sample; green curve: pulverized sample after 60 min.*

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.



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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 aluminium 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



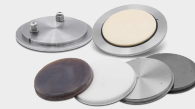
JARS & LIDS FOR SPECIAL APPLICATIONS

- | 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

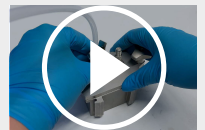
Both the aeration lid and GrindControl can now be equipped with inlays of different materials. Thus, the lid can be used for, e. g. a steel and a zirconium oxide jar by simply exchanging the inlay.



GrindControl



Aeration lid



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Video:
Aeration 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.



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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
12 ml	up to -까지 ≤5 ml	<1 mm	50	15	5	-	-	-
25 ml	up to -까지 ≤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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대표 시료

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, 취성: 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, 인성: 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: 화강암



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

샘플 준비 작업에 가장 적합한 솔루션을 찾으려면 애플리케이션 데이터베이스를 방문하십시오.

행성 볼 밀 PM 400

작동 원리

분쇄 용기는 행성 볼 밀의 sun wheel에 편심 배치됩니다. 용기의 운동 방향은 sunwheel에 대하여 1:-2 (또는 1:-2.5 또는 1:-3) 비율로 반대 운동합니다.

분쇄 용기 내 분쇄용 볼은 소위 코리올리의 힘 (Coriolis forces) 이라 불리는 중첩 회전 운동을 받습니다. 볼과 분쇄 용기간 상이한 속도는 높은 동적 에너지를 방출하며 마찰력과 충격 사이에서 상호 작용 합니다. 이러한 힘 사이의 상호 작용은 행성 볼 밀의 분쇄를 매우 효과적이며 높은 수준으로 만듭니다.



[비디오 시청 클릭](#)

행성 볼 밀 PM 400

기술 데이터

응용 분야	pulverizing, mixing, homogenizing, colloidal milling, mechanical alloying, mechanosynthesis, nano grinding, co-crystal screening
응용분야	건축 재료, 농업, 생물학, 엔지니어링 / 전자 공학, 유리 / 세라믹, 의학 / 제약, 지질학 / 야금, 화학, 환경 / 재활용
투입 시료	연질, 경질, 취성, 섬유질 - 건식 또는 습식
크기 축소 원리	충격, 마찰
최대 투입 크기*	< 10 mm
최종 분말 입도*	< 1 µm, 습식 분쇄 시 < 0.1 µm
시료 일괄 처리량*	최대. 4 x 220 ml, 최대. 8 x 20ml 장착된 분쇄조
분쇄조 수	4 / 2
속도 비율	1:-2 / 1:-2.5 / 1:-3
선 휠 속도	30 - 400 min ⁻¹
효율적인 선 휠 직경	300 mm
중력 (G-force)	26.8 g
분쇄 용기 종류	EasyFit, optional aeration covers, safety closure devices
분쇄 도구 재질	경화 스틸, 스테인레스 스틸, 탄화 텅스텐, 마노, 소결 산화 알루미늄, 질화규소, 산화 지르코늄
분쇄 용기 크기	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
분쇄 시간 설정	디지털, 00:00:01 에서 99:59:59
인터벌 작업	가능, 역방향
인터벌 작업 시간	00:00:01 에서 99:59:59
일시정지 시간	00:00:01 에서 99:59:59
표준 운영 절차 저장 가능 수	10
투입 에너지 측정 가능성	가능
인터페이스	RS 232 / RS 485
구동	주파수 변환기를 가진 3상 비동기식 모터
구동 전력	1.5 kW
전원 공급 데이터	다른 전압
전원 연결	단상

안전 보호 코드	IP 30
소비 전력	~ 2200 W (VA)
폭 x 높이 x 깊이 닫혔을 때	836 x 1220 (1900) x 780 mm
중량	~ 290 kg
표준	CE
특허 / 실용 특허	SafetySlider (DE 202008008473)

*투입 재료와 장비 환경, 설정에 따라

www.retsch.com/pm400

주문 정보

행성 볼 밀 PM 400

이동식 (분쇄 용기 및 볼 별도 주문)

20.535.0001  PM 400 분쇄 스테이션 4 개, 속도 비율 1 : -2

20.535.0007  PM 400 분쇄 스테이션 4 개, 속도 비율 1 : -2.5, 기계식 합금 용

20.535.0008  PM 400 분쇄 스테이션 4 개, 속도 비율 1 : -3, 기계식 합금 용

다른 전력 버전도 동일한 가격으로 제공

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  PM 400 IQ/OQ 문서

PRESSURE AND TEMPERATURE MEASURING SYSTEM GRINDCONTROL FOR PLANETARY BALL MILLS

incl. sensors and transmitter unit, insert 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

GRINDCONTROL LID INSERTS

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

ACCESSORIES FOR PM GRINDCONTROL WITH GRINDING JARS EASYFIT

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)
03.111.0438		Flat gasket for 50 ml, 80 ml or 125 ml
03.111.0439		Flat gasket for 250 ml - 500 ml
22.186.0007		Sintered filter with O-ring, set of 10 pieces
22.864.0001		Valve set 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
01.462.0498	500 ml

아게이트 (마노)

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

소결 알루미늄 옥사이드

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
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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

AERATION LIDS FOR GRINDING JARS EASYFIT

INCL. O-RINGS AND SINTERED FILTER (PLEASE ORDER LID INSERT AND GRINDING JAR SEPARATELY)

22.107.0636	Aeration lid for grinding jar EasyFit 50 ml - 125 ml
22.107.0637	Aeration lid for grinding jar EasyFit 250 ml - 500 ml

INSERT FOR GRINDING JAR EASYFIT

03.474.0261	Aeration lid insert for grinding jar EasyFit 50, 80 oder 125 ml, stainless steel
03.474.0262	Aeration lid insert for grinding jar EasyFit 50, 80 oder 125 ml, zirconium oxide
03.474.0263	Aeration lid insert for grinding jar EasyFit 50, 80 oder 125 ml, tungsten carbide
03.474.0268	Aeration lid insert for grinding jar EasyFit 50, 80 oder 125 ml, agate
03.474.0264	Aeration lid insert for grinding jar EasyFit 250 oder 500 ml, stainless steel
22.186.0007	Sintered filter with O-ring, set of 10 pieces
22.864.0001	Valve set M8x1 for GrindControl and aeration lids



안전 폐쇄 장치

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 링

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
03.111.0438		Flat gasket for 50 ml, 80 ml or 125 ml
03.111.0439		Flat gasket for 250 ml - 500 ml

분쇄용 볼

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 (약 110 ml)
22.455.0011		3 mm Ø, 500 g (약 120 ml)
22.455.0002		3 mm Ø, 200 개 (약 6 ml)

22.455.0001



4 mm Ø, 200 개 (약 14 ml)

22.455.0003



5 mm Ø, 200 개 (약 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 개 (약 6 ml)

22.455.0005



4 mm Ø, 200 개 (약 14 ml)

22.455.0004



5 mm Ø, 200 개 (약 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

아게이트 (마노)

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

소결 알루미늄 옥사이드

05.368.0021		10 mm Ø
05.368.0112		15 mm Ø

05.368.0054 20 mm Ø



05.368.0053 30 mm Ø



05.368.0052 40 mm Ø



ZIRCONIUM OXIDE

32.368.0005 0.1 mm Ø, 0.5 kg (약 135 ml)



32.368.0003 0.5 mm Ø, 0.5 kg (약 135 ml)



32.368.0004 1 mm Ø, 0.5 kg (약 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 개 (약 6 ml)



22.455.0009 5 mm Ø, 200 개 (약 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