



## MIXER MILL MM 400

A true multipurpose mill

**The Mixer Mill MM 400 is a true multipurpose mill designed for dry, wet and cryogenic grinding of small volumes up to 2 x 20 ml. It mixes and homogenizes powders and suspensions with a frequency of 30 Hz within seconds – unbeatably fast and easy to operate.**

The compact benchtop unit is suitable for classic homogenization processes, as well as for biological cell disruption for DNA/RNA and protein extraction. Long processing times up to 99 hours make the MM 400 ideally suited for research applications, for example in mechanochemistry.

With regard to performance and flexibility of this mill, there is no equivalent technology available in the market.

You may also be interested in the mixer mill models MM 500 nano and MM 500 vario which operate with the same functional principle at a frequency of 35 Hz but provide substantially higher performance. For applications which require cooling or heating the sample, the Mixer Mill MM 500 control is the perfect choice. Each RETSCH mixer mill has a specific application focus.

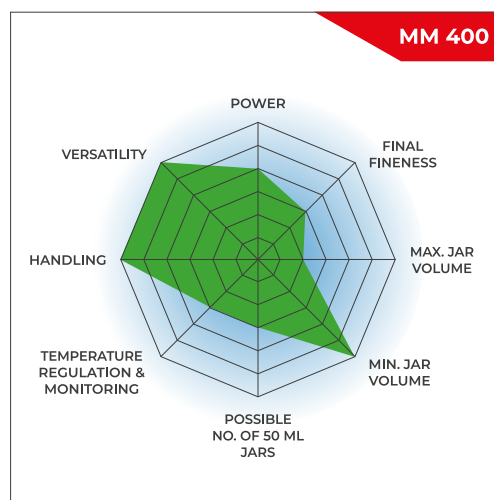


[Click to view video](#)

### Product Video

### THE MOST VERSATILE ALL-ROUNDER OF BALL MILLS

- | Max. speed 30 Hz
- | Horizontal oscillation causes strong impact effects for effective sample processing
- | Up to 8 mm feed size and 5 µm final fineness
- | 2 grinding stations for jars of min 2 ml and max 50 ml, adapter for 10 x 2 ml single use vials and 4 x 50 ml conical centrifugation tubes
- | Steel jars can be precooled manually in liquid nitrogen
- | Calibrated speed and time, small benchtop model, storable SOPs and cycle programs, 7 different jar materials

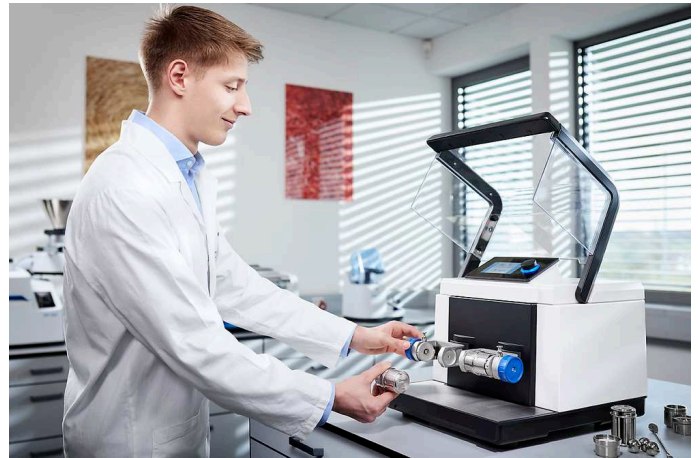


## PERFORMANCE AND DESIGN

- | Powerful size reduction and homogenization by impact and friction with up to 30 Hz
- | Equipped with 2 grinding stations for up to 20 samples per run
- | Memory for 12 Standard Operating Procedures (SOP) and 6 program cycles
- | Convenient touch display, significant noise reduction

## UNMATCHED VERSATILITY

- | 3 different grinding modes: dry, wet or cryogenic
- | Mixes powdered sample and binder in plastic vessels prior to pelletizing, e. g. for XRF analysis
- | Suitable for research applications such as mechanochemistry or for biological cell disruption by bead beating
- | Extraction of pesticides (QuEChERS) and herbal ingredients



## MIXER MILL MM 400

# CALIBRATION ENSURES REPRODUCIBLE RESULTS

Reproducibility is paramount in the process chain from sampling to analysis. Lab equipment which can be calibrated guarantees reproducible results with minimum standard deviation every time. This is particularly useful when comparing results produced at different locations.

The MM 400 is the first laboratory mill which can be calibrated. RETSCH initially calibrates time and frequency of the mill and offers a regular calibration service to ensure reproducible milling processes.

This functionality is particularly suitable for

- | Testing labs with different locations
- | Accredited labs applying ISO/IEC 17025 or ISO 9000ff
- | Pharmaceutical products



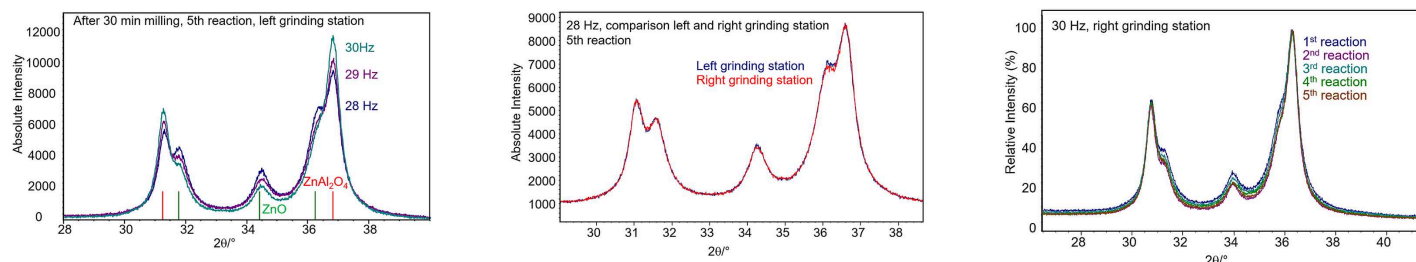
## MIXER MILL MM 400

# REPRODUCIBILITY OF MECHANOCHEMICAL REACTIONS IN THE MIXER MILL MM 400

Reproducibility is a fundamental principle of scientific research and is essential for ensuring the credibility and reliability of scientific findings. The Mixer Mill MM 400 was tested regarding the reproducibility within a mechanochemical reaction, and it could be proven that it provides excellent reproducibility during several repetitions, for both clamping positions, and also between different devices. [1]

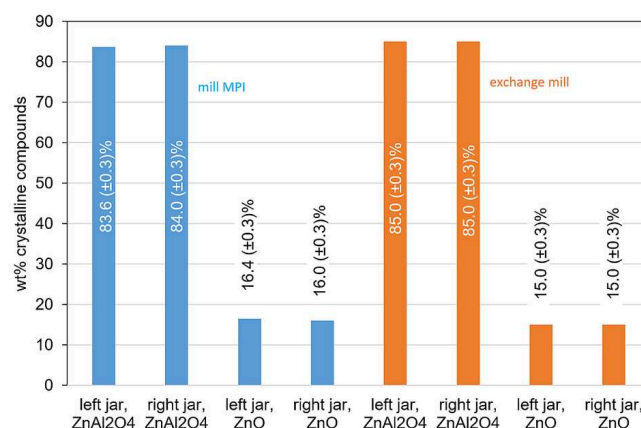
Minor variations of the frequency from 30 Hz to 29 Hz or 28 Hz have an influence on the yield of the reaction. It is of fundamental interest that the mixer mill maintains a set value, e.g. 30 Hz, and does not deviate from it. A premise which is fulfilled by the MM 400 which comes with a calibration certificate.

The mechanochemical reaction  $\gamma\text{-Al}_2\text{O}_3 + \text{ZnO} \rightarrow \text{ZnAl}_2\text{O}_4$  was conducted for 30 min using 25 ml grinding jars, 2 x 15 mm grinding balls, 1 g educts, at 28 Hz, 29 Hz and 30 Hz five times in a row. The comparison between left and right clamping station showed highly reproducible results, also the comparison between the 5 trials.



XRD patterns after the mechanochemical reaction  $\gamma\text{-Al}_2\text{O}_3 + \text{ZnO} \rightarrow \text{ZnAl}_2\text{O}_4$ : Left: Grinding at 28 Hz, 29 Hz and 30 Hz, results after 5th reaction. Middle: Comparison left and right grinding station at 28 Hz 5th reaction each. Right: Reaction 1 to 5 at 30 Hz, right grinding station. Results presented by the group of Claudia Weidenthaler. [8]

The experiments were repeated using another MM 400 device to compare the results between the two mills. Again, the excellent reproducibility was verified for the 5 tests conducted at 30 Hz, for both, left and right grinding station.



Almost identical results (weight % of educts and product) and reproducibility are obtained with a different MM 400 device. Results presented by the group of Claudia Weidenthaler. [1]

## MIXER MILL MM 400

# SOLUTIONS FOR BIOLOGICAL APPLICATIONS AND CELL DISRUPTION

Mixer mills are frequently used for homogenizing biological samples. The so-called bead beating with small glass beads is an established method for cell disruption of yeasts, microalgae or bacteria. The sample is only moderately warmed in the process which can be reduced to a minimum by pre-cooling.

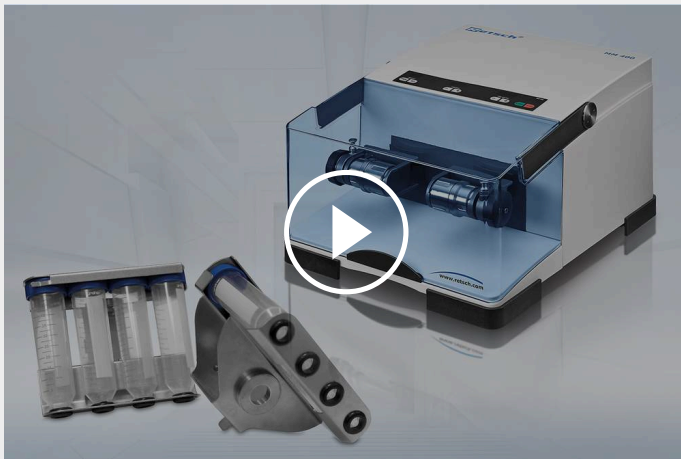
The MM 400 allows for efficient cell disruption of up to 240 ml cell suspension for DNA/RNA and protein

extraction. For accurate diagnosis of infections, it is possible to isolate intact bacteria from tissue in 8 x 30 ml bottles or 10 x 5 ml vials by using adapters.

The MM 400 can be operated with a range of adapters for single-use vials with the following capacities:

20 x 0.2 ml / 20 x 1.5 or 2 ml / 10 x 5 ml / 8 x 30 ml / 8 x 50 ml

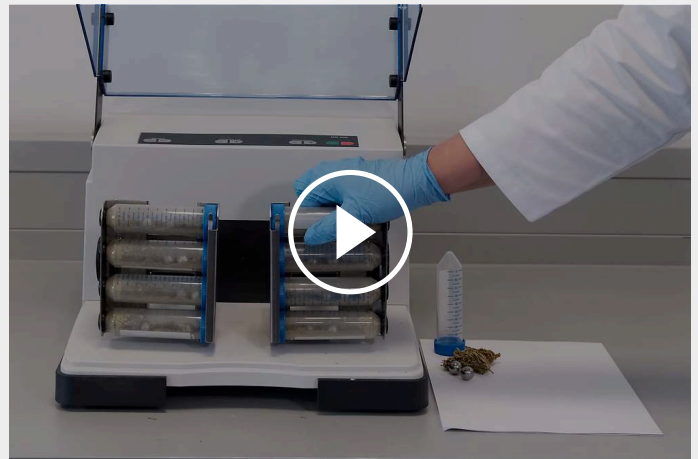
For the pulverization of 25 to 30 g plant material, such as cannabis flower, conical centrifuge tubes are best suited. Up to 8 tissue samples, like fresh liver in buffer solution, can also be homogenized in these 50 ml tubes using steel or zirconium oxide balls. To keep the mechanical stress on the vials as low as possible, a reduced frequency and a high filling level, e. g. with buffer and sample, are recommended.



[Click to view video](#)

Mixer Mill MM 400 - Yeast Cell Disruption\*

\*The video shows the previous model with identical functional principle.



[Click to view video](#)

Mixer Mill MM 400 - Homogenization of cannabis\*

MIXER MILL MM 400

## SOLUTIONS FOR CRYOGENIC GRINDING

The CryoKit is a cost-effective solution for cryogenic sample processing with the Mixer Mill MM 400. The set consists of two insulated containers, two tongs and safety glasses.

The sample to be embrittled and the grinding ball are filled into the stainless-steel grinding jar which is tightly screwed. Indirect embrittlement is effected by pre-cooling the jar in a liquid nitrogen bath. After approximately 2 minutes, the sample is sufficiently cooled for cryogenic processing.

If direct contact with liquid nitrogen is to be avoided, the CryoMill or Mixer Mill MM 500 control are suitable options. Both mills can be operated with jars made of other materials than steel for cryogenic grinding.



[Click to view video](#)

Mixer Mill MM 400 - Cryogenic Grinding\*



## MIXER MILL MM 400

# APPLICATIONS IN MECHANOCHEMISTRY

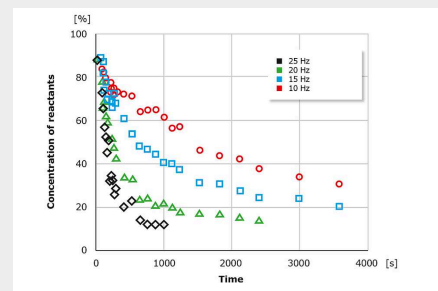
Mechanochemistry enables fast reactions of substances in a solvent-free environment. Some chemical reactions require the frictional forces of a planetary ball mill, while other reaction types need energy input through impact – that is where the Mixer Mill MM 400 comes into play.

The sample volumes available for research applications are often very low. This makes small grinding jar sizes of up to 50 ml, like they are available for the MM 400, beneficial. Due to the frequently long reaction times, the possibility to program process times of several hours is another important aspect.

Mixer mills offer a unique advantage over planetary ball mills in mechanochemical applications: the use of transparent jars in combination with the typical horizontal jar movement enables in-situ RAMAN spectroscopy. This permits real-time monitoring of the reaction process to identify the optimal time for maximum yield and avoid prolonged processing.

The MM 400 offers many advantages for mechanochemical applications:

- | Process times of up to 99 h
- | Various grinding jar sizes and materials
- | Transparent PMMA grinding jars enable in-situ RAMAN spectroscopy
- | Programmable frequency and break times
- | Adapter for 4 x 5 ml stainless-steel grinding jars permits up to 8 simultaneous reactions



Time course of the Knoevenagel reaction between vanillin and barbituric acid under mechanochemical conditions using 2x10mm zirconium oxide grinding balls in 19 ml PMMA grinding jar at 30 Hz. Reaction running over 30 minutes with visible progress indicated by color change.

Courtesy of Dr. Sven Grätz, Ruhr-University  
Bochum, Faculty of Chemistry and Biochemistry,  
AG Prof. Borchardt.

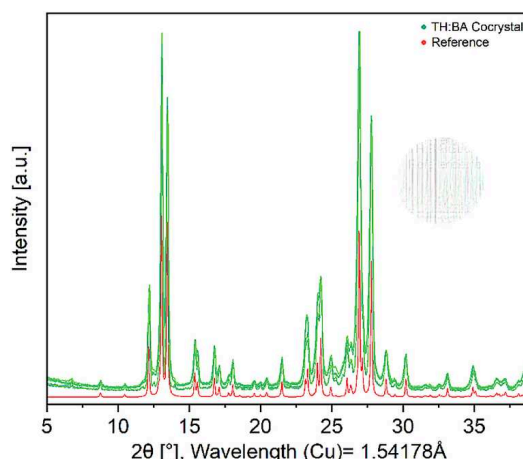


## CO-CRYSTAL SCREENING WITH THE MM 400

Co-crystal screening can be effectively performed in Mixer Mills. In a study [9] using the MM 400, 2 ml steel tubes and the corresponding PTFE adapter were employed to co-crystallize theophylline and benzamide in a 1:1 ratio under the following conditions:

- | 60 min milling time
- | 30 Hz frequency
- | One 6 mm steel ball per tube
- | Four experiments without solvent and four with 20  $\mu$ L ethanol

X-ray powder diffraction patterns of the eight resulting samples (shown in green) align closely with the simulated reference pattern of the target co-crystal. All observed signals correspond to the desired product, with no significant additional signals, indicating successful and reproducible co-crystal formation. The MM 400 with 2 ml steel tubes delivers consistent results, and this compatibility extends to the MM 500 series, which can also accommodate 2 ml steel tubes.



XRD patterns after the co-crystal formation of theophylline and benzamide after 60 min milling time in the MM 400 against a simulated reference. Results presented by experiments of Dominik Al-Sabbagh. [2]

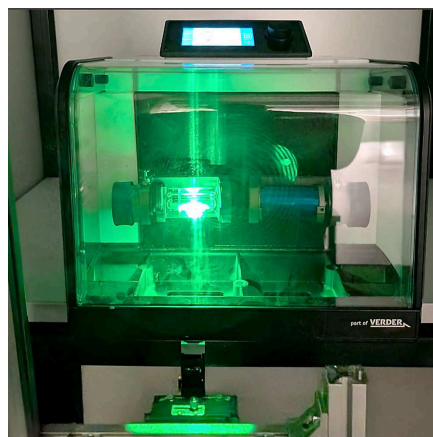
### MIXER MILL MM 400

## IN-SITU RAMAN SPECTROSCOPY

*In-situ Raman* spectroscopy is a powerful analytical technique that allows for the monitoring and analysis of materials in their natural or process environment. This method utilizes Raman scattering, a phenomenon where light interacts with molecular vibrations, leading to shifts in the wavelength of the scattered light. These shifts provide a unique spectral fingerprint for the material being analyzed, offering insights into its chemical composition or

molecular structure.

The "*in-situ*" aspect refers to the ability to observe and measure these characteristics directly during an ongoing process. This can include observing changes in the presence of various chemical reactions, also the so called mechanochemistry. Mechanochemistry involves the use of impact, shearing, or friction actions to induce chemical changes in solids. This approach is increasingly popular for its ability to bypass the need for solvents, potentially offering a more environmentally friendly and energy-efficient pathway for chemical synthesis. The Raman spectroscopy can provide invaluable insights into the reaction mechanism, phase transformations, reaction kinetics or for optimization of reaction conditions.



The MM 400 is "Raman-ready", allowing easy removal of the bottom plate inlay. The bottom plate has openings for the Raman probe to consistently measure at the bottom of the jars by placing the Raman probe underneath the mill and thus underneath the jars, where particle interaction is most intense, ensuring accurate data. The Retsch PMMA grinding jars, with their transparency and chemical resistance, enhance spectral data without contamination. The plane outer shapes of the jars further enhance the spectroscopic data. These design adjustments streamline the experimental workflow. Researchers can now perform *in-situ* Raman spectroscopy with greater ease and precision, opening new possibilities for in-depth material analysis.

FOR SAFE AND EFFECTIVE GRINDING PROCESSES

## ACCESSORIES FOR THE MIXER MILL MM 400



### GRINDING JARS IN 7 DIFFERENT MATERIALS

The nominal volume of the screw-top grinding jars ranges from 1.5 ml to 50 ml; available materials include hardened steel, stainless steel, agate, tungsten carbide, zirconium oxide and PTFE, ensuring contamination-free sample preparation.

Transparent PMMA grinding jars are used for in-situ RAMAN spectroscopy but also enable applications with photochemical reactions. Moreover, these are resistant to a variety of chemicals. The jars can be used with the predecessor of the MM 400 just like older jar models are compatible with the latest mixer mill model.



### 2 ML TUBES FOR CRYOGENIC GRINDING

Small 2 ml steel tubes are used for cryogenic applications. Up to 20 of these tubes can be clamped into the MM 400 using an adapter. The advantage: they can withstand low temperatures and mechanical stress and do not break like disposable vessels. Ideal for the smallest sample quantities in the cryogenic range.



### ADAPTERS FOR SINGLE-USE VIALS

Adapters for 0.5 / 1.5 / 2 / 5 ml single-use vials can be used in the MM 400. For larger sample amounts, e. g. for protein extraction, adapters for 50 ml conical centrifugation tubes or 30 ml wide-mouth bottles are available.



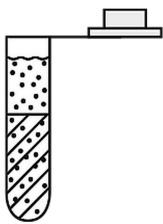
### ADAPTERS FOR INCREASED SAMPLE THROUGHPUT

The MM 400 can be equipped with adapters that accommodate four 5 ml stainless-steel grinding jars, allowing for simultaneous pulverization of a maximum of 8 samples. This increased throughput is particularly beneficial for mechanochemical applications.

## VIALS, BOTTLES AND TUBES AVAILABLE FOR MM 400

### 1.5 or 2 ml

Safe-lock  
single-use vials  
2 x 10 vials max.



- | Cell disruption for DNA/RNA proteins/metabolites
- | Cryogenic grinding of soft sample (tissue, plants, cell pellets, insects)
- | Dry or wet homogenization of soft samples (tissue, insects)

### 5 ml

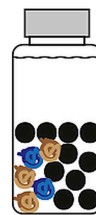
Safe-lock  
single-use vials  
2 x 5 vials max.



- | Cell disruption for DNA/RNA proteins/metabolites
- | Cryogenic grinding of soft sample (tissue, plants, cell pellets, insects)
- | Dry or wet homogenization of soft samples (tissue, insects)

### 30 ml

disposable wide  
mouth bottles  
2 x 4 bottles max.



- | Cell disruption for DNA/RNA proteins/metabolites
- | Dry or wet homogenization of soft samples (tissue, insects)
- | Dry milling of hard samples (quartz sand)

### 50 ml

disposable conical  
centrifugation tubes  
2 x 4 tubes max.



- | Cell disruption for DNA/RNA proteins/metabolites
- | Dry or wet homogenization of soft samples (tissue, insects)
- | Extraction of pesticides from food/plants (QuEChERS)
- | Mixing of powder and wax to press pellets for XRF

## MIXER MILL MM 400

### RECOMMENDED JAR FILLINGS

The jar size should be adapted to the sample volume to ensure optimum results. Ideally, the grinding balls are 3 times the size of the largest sample piece. The numbers and sizes of balls given in the table below follow this rule of thumb. To pulverize, for example, 20 ml of a sample consisting of 8-mm sized particles, the use of a 50 ml jar and 25 mm balls is recommended. According to the table, one grinding ball is required. 20 ml of a sample with 5-mm particles, however, can be homogenized with four 15 mm balls.

MIXER MILL MM 400

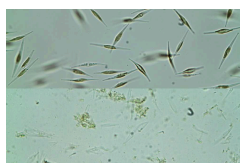
## TYPICAL SAMPLE MATERIALS

RETSCH mixer mills are true allrounders. They homogenize, for example, alloys, animal feed, bones, ceramics, cereals, chemical products, coal, coke, drugs, electronic scrap, glass, grains, hair, minerals, oil seeds, ores, paper, plant materials, plastics, sewage sludge, soils, straw, tablets, textiles, tissue, tobacco, waste samples, wood, wool, etc.



### FIBROUS: HAIR

30 ml sample  
50 ml stainless  
steel jar  
1 x 25 mm  
stainless steel ball  
2 min at 30 Hz



### CELL DISRUPTION: MICROALGAE

30 ml cell  
suspension  
8 x 50 ml conical  
centrifuge tubes  
(adapter)  
with 25 ml glass  
beads each;  
0,5-0,75 mm  
30 s at 30 Hz



### ELASTIC-LIQUID: CAPSULES WITH LIQUID

15 ml sample  
50 ml stainless  
steel jar  
1 x 25 mm  
stainless steel ball  
embrittlement in  
LN<sub>2</sub> for 3 min  
4 x 2 min at 30 Hz  
with intermediate  
cooling



### MEDIUM-HARD/ FIBROUS: SOIL

20 ml sample  
50 ml stainless  
steel jar  
1 x 25 mm  
stainless steel ball  
1 min at 30 Hz



[Click to view video](#)

### PARSLEY



### TOUGH-FIBROUS: WOOD

5 ml sample  
10 ml zirconium  
oxide jar



### ELASTIC-TOUGH: POLYURETHANE PELLETS

20 ml sample  
50 ml stainless  
steel jar



### FIBROUS: CANNABIS

3 g sample  
50 ml stainless  
steel jar



### HARD-BRITTLE: CONCRETE

10 ml sample  
25 ml zirconium  
oxide jar

2 x 12 mm  
zirconium oxide  
balls  
3 min at 30 Hz

1 x 25 mm  
stainless steel ball  
embrittlement in  
LN<sub>2</sub> for 3 min  
4 x 2 min at 30 Hz  
with intermediate  
cooling

1 x 25 mm  
stainless steel ball  
embrittlement  
with LN<sub>2</sub> for 2 min  
90 s at 30 Hz

2 x 15 mm  
zirconium oxide  
balls  
2 min at 30 Hz

## MIXER MILL MM 400

### FUNCTIONAL PRINCIPLE

The grinding jars of the mixer mill MM 400 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 jars and pulverize it. Also, the movement of the 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.



[Click to view video](#)



MIXER MILL MM 400

## TECHNICAL DATA

<b>Applications</b>	size reduction, mixing, homogenization, cell disruption, cryogenic grinding, mechanochemistry
<b>Field of application</b>	agriculture, biology, chemistry / plastics, construction materials, engineering / electronics, environment / recycling, food, geology / metallurgy, glass / ceramics, medicine / pharmaceuticals
<b>Feed material</b>	hard, medium-hard, soft, brittle, elastic, fibrous
<b>Size reduction principle</b>	impact, friction
<b>Material feed size*</b>	<= 8 mm
<b>Final fineness*</b>	~ 5 µm
<b>Batch size / feed quantity*</b>	max. 2 x 20 ml
<b>No. of grinding stations</b>	2
<b>Vibrational frequency</b>	3 - 30 Hz (180 - 1800 min <sup>-1</sup> )
<b>Typical mean grinding time</b>	30 s - 2 min
<b>Max. grindig time</b>	99 h
<b>Dry grinding</b>	Yes
<b>Wet grinding</b>	Yes
<b>Cryogenic grinding</b>	Yes
<b>Cell disruption with reaction vials</b>	yes, up to 20 x 2.0 ml
<b>Self-centering clamping device</b>	Yes
<b>Type of grinding jars</b>	screw top design
<b>Material of grinding tools</b>	hardened steel, stainless steel, tungsten carbide, agate, zirconium oxide, PTFE, PMMA
<b>Grinding jar sizes</b>	1.5 ml / 5 ml / 10 ml / 25 ml / 35 ml / 50ml
<b>Setting of grinding time</b>	digital, 10 s - 8 h
<b>Storable SOPs</b>	12
<b>Storable cycle programs</b>	6
<b>Electrical supply data</b>	100-240 V, 50/60 Hz
<b>Power connection</b>	1-phase
<b>Protection code</b>	IP 30
<b>Power consumption</b>	165W
<b>W x H x D closed</b>	385 x 350 x 470 mm

<b>Net weight</b>	~ 27,5 kg
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<b>Standards</b>	CE
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\*depending on feed material and instrument configuration/settings

## REFERENCES

[1] Reaction scheme and performance of the experiments: Prof. Dr. Claudia Weidenthaler, Research Group Leader Heterogeneous Catalysis Powder Diffraction and Surface Spectroscopy, Max-Planck Institut für Kohlenforschung, Mülheim an der Ruhr.

[2] Reaction scheme and performance of the experiments: Dominik Al-Sabbagh, Chemistry Laboratory Technician, Division 6.3 – Structure Analysis, Federal Institute for Materials Research and Testing (BAM), Berlin.

[www.retsch.com/mm400](http://www.retsch.com/mm400)

## ORDER DATA

### MIXER MILL MM 400

**Mixer Mill MM 400 with quick release clamp**  
**(please order grinding jars and balls separately)**

20.715.0001        MM 400    100–240 V, 50/60 Hz

### GRINDING JARS MM 400, SCREW TOP DESIGN


#### HARDENED STEEL

01.462.0237        25 ml

#### STAINLESS STEEL

01.462.0230        1.5 ml

01.462.0231        5 ml

01.462.0290        5 ml (for use with adapter 02.706.0351)

01.462.0236        10 ml

01.462.0213        25 ml

01.462.0214        35 ml

01.462.0216        50 ml

#### TUNGSTEN CARBIDE

01.462.0235



10 ml

01.462.0217



25 ml

#### AGATE

01.462.0232



5 ml

01.462.0233



10 ml

#### ZIRCONIUM OXIDE

01.462.0234



10 ml

01.462.0201



25 ml

01.462.0215



35 ml

#### PTFE

01.462.0238



25 ml

01.462.0244



35 ml

05.068.0004      Mixing beakers of polystyrene, 28 ml, 1 piece (please order amount multiple of 100 pcs.)

05.068.0006



Mixing beakers of polystyrene, 56 ml, 1 piece (please order amount multiple of 100 pcs.)

#### PMMA, TRANSPARENT JARS FOR MECHANOSYNTHESSES

01.462.0539



10 ml, 10 pieces

02.462.0539



10 ml, 2 pieces

## ACCESSORIES FOR GRINDING JARS MM 400

02.486.0005



Jar wrench for grinding jars

02.706.0351



Adapter for use of 2/4 grinding jars 5 ml (01.462.0290) (Only for MM 400 with item no. 20.715.0001)

03.111.0229

Gasket for grinding jar 1.5 ml, 1 piece (please order amount multiple of 10 pcs.)

03.111.0231



Gasket for grinding jar 5 ml, 1 piece (for grinding jar 01.462.0231) (please order amount multiple of 10 pcs.)

03.111.0262



Gasket for grinding jar 5 ml, 1 piece (for grinding jar 01.462.0290) (please order amount multiple of 10 pcs.)

03.111.0232

Gasket for grinding jar 10 ml, 1 piece (please order amount multiple of 10 pcs.)

03.111.0228



Gasket for grinding jar 25 ml hardened steel and stainless steel, 1 piece (please order amount multiple of 10 pcs.)

03.111.0212



Gasket for grinding jar 25 ml zirconium oxide and tungsten carbide, 1 piece (please order amount multiple of 10 pcs.)

03.111.0224



Gasket for grinding jar 35 ml stainless steel, 1 piece (please order amount multiple of 10 pcs.)

03.111.0222



Gasket for grinding jar 35 ml zirconium oxide, 1 piece (please order amount multiple of 10 pcs.)

03.111.0209



Gasket for grinding jar 50 ml stainless steel, 1 piece (please order amount multiple of 10 pcs.)

## ACCESSORIES FOR MIXING AND CELL DISRUPTION MM 400

22.001.0020

Adapter for 4 conical centrifuge tubes (e.g. Falcon® Tubes), 2 pieces, incl. 20 tubes

05.026.0001



Conical centrifuge tubes, 50 ml, 20 pieces

22.001.0021



Adapter for 4 wide mouth bottles, 2 pieces, incl. 12 wide mouth bottles, 30 ml

## ACCESSORIES FOR COLD GRINDING MM 400

22.354.0001



Cryo kit for cooling the grinding jars with liquid nitrogen (incl. 2 insulated containers (1 and 4 liter), 2 pairs of grinding jar tongs, 1 pair of safety glasses)

## ACCESSORIES MM 400

99.200.0043

IQ/OQ Documentation for MM 400

## ACCESSORIES FOR CELL AND TISSUE DISRUPTION

22.008.0010



Adapter for 5 reaction vials 5.0 ml, made of PTFE

22.008.0014

Adapter for 10 reaction vials 1.5 and 2.0 ml, made of PTFE or stainless steel

22.008.0005



Adapter for 5 reaction vials 1.5 and 2.0 ml, made of PTFE or stainless steel

22.008.0006



Adapter for 10 reaction vials 0.2 ml, made of PTFE

22.749.0006

Safe-lock reaction vials 5.0 ml, 200 pcs.

22.749.0001



Safe-lock reaction vials 2.0 ml, 1000 pcs.

22.749.0002



Safe-lock reaction vials 1.5 ml, 1000 pcs.

22.749.0004



Safe-lock reaction vials 0.2 ml, 1000 pcs.

22.749.0008



Reaction vials made of stainless steel 316L, 2.0 ml, 10 pcs.  
(for use with adapter 22.008.0014)


## 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

#### 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



#### 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



#### 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




#### ZIRCONIUM OXIDE


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

#### PTFE WITH STEEL CORE


05.368.0045  10 mm Ø




05.368.0046  12 mm Ø

05.368.0114  15 mm Ø

05.368.0047  20 mm Ø

#### POLYAMIDE FOR MIXING BEAKERS

05.368.0042  5 mm Ø

05.368.0043		7 mm Ø
05.368.0044		9 mm Ø
05.368.0003		12 mm Ø

#### GLASS BEADS

22.222.0001		0.10 – 0.25 mm Ø, 500 g (approx. 320 ml)
22.222.0002		0.25 – 0.50 mm Ø, 500 g (approx. 320 ml)
22.222.0003		0.50 – 0.75 mm Ø, 500 g (approx. 320 ml)
22.222.0004		0.75 – 1.00 mm Ø, 500 g (approx. 320 ml)
22.222.0005		1.00 – 1.50 mm Ø, 500 g (approx. 320 ml)