



## MIKSERLİ ÖĞÜTÜCÜ MM 400

Gerçek bir çok amaçlı değirmen

**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.

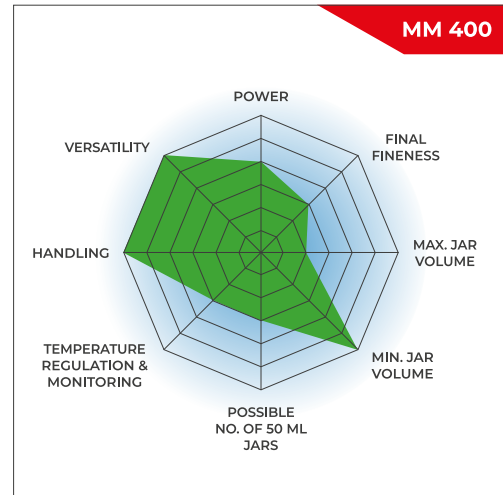


[Videoyu izlemek için tıklayın](#)

### Ürün Videosu

### 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



## PERFORMANS VE TASARIM

- | 30 Hz'e kadar darbe ve sürtünme ile güçlü boyut küçültme ve homojenizasyon
- | Çalışma başına 20 numuneye kadar 2 öğütme istasyonu ile donatılmıştır
- | Memory for 12 Standard Operating Procedures (SOP) and 6 program cycles
- | Convenient touch display, significant noise reduction

## BENZERSİZ ÇOK YÖNLÜLÜK

- | 3 farklı öğütme modu: kuru, ıslak veya kriyojenik
- | Toz haline getirilmiş numuneyi ve bağlayıcıyı peletleme öncesinde plastik kaplarda karıştırır, e. g. XRF analizi için
- | Mekanokimya gibi araştırma uygulamaları veya boncuk dövülerek biyolojik hücre bozulması için uygundur
- | Extraction of pesticides (QuEChERS) and herbal ingredients



MIKSERLI ÖĞÜTÜCÜ 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



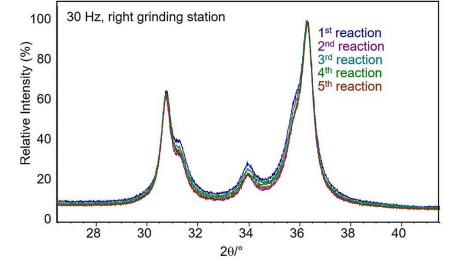
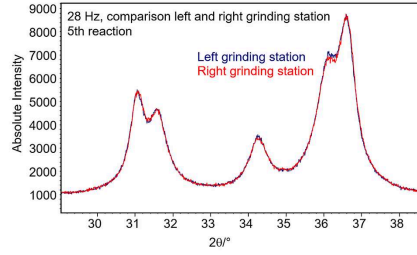
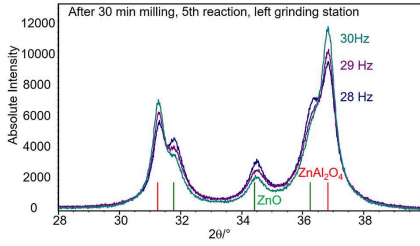
MIKSERLI ÖĞÜTÜCÜ MM 400

## 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]

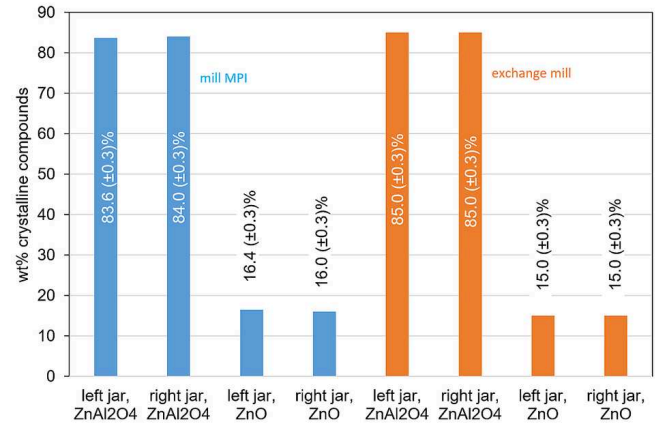
Minor variations of the frequency from 30 Hz to 29 Hz or 28 Hz have an influence on the yield of the reaction. It is of fundamental interest that the mixer mill maintains a set value, e.g. 30 Hz, and does not deviate from it. A premise which is fulfilled by the MM 400 which comes with a calibration certificate.

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]

## MIKSERLİ ÖĞÜTÜCÜ MM 400

# BIYOLOJİK UYGULAMALAR VE HÜCRE BOZULMASI İÇİN ÇÖZÜMLER

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 right sample is only moderately warmed in the process which can be reduced to a minimum by pre-cooling.

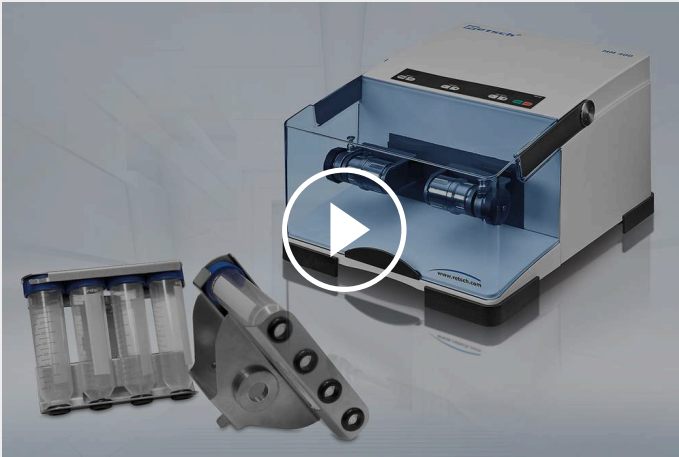
The MM 400 allows for efficient cell disruption of up to 240 ml cell suspension for DNA/RNA and protein extraction. For accurate diagnosis of infections, it is possible to isolate intact bacteria from tissue in 8 x 30 ml

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

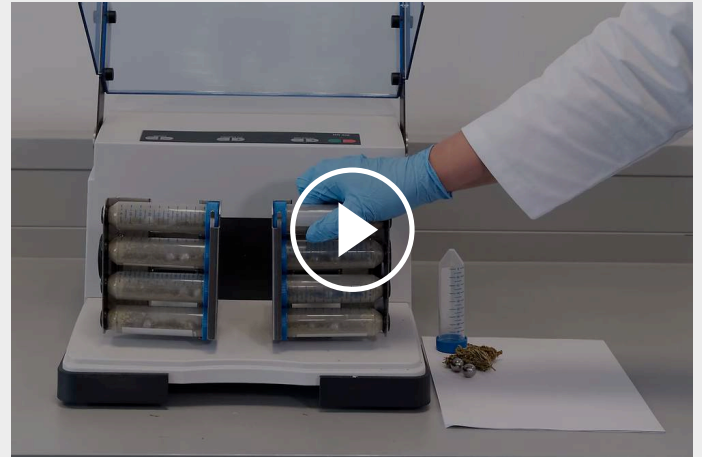
For the pulverization of 25 to 30 g plant material, such as cannabis flower, conical centrifuge tubes are best suited. Up to 8 tissue samples, like fresh liver in buffer solution, can also be homogenized in these 50 ml tubes using steel or zirconium oxide balls. To keep the mechanical stress on the vials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



[Videoyu izlemek için tıklayın](#)

Mikser Öğütücü 400 - Maya Hücresi Bozulması\*

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



[Videoyu izlemek için tıklayın](#)

Mikserli Öğütücü MM 400 - Homogenization of cannabis\*

MIKSERLİ ÖĞÜTÜCÜ 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.



[Videoyu izlemek için tıklayın](#)

Mikser Öğütücü MM 400 - Kriyojenik Öğütme\*

MIKSERLİ ÖĞÜTÜCÜ MM 400

## APPLICATIONS IN MECHANOCHEMISTRY

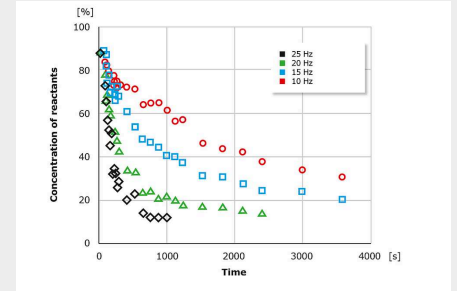
Mechanochemistry enables fast reactions of substances in a solvent-free environment. Some chemical reactions require the frictional forces of a planetary ball mill, while other reaction types need energy input through impact – that is where the Mixer Mill MM 400 comes into play.

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.

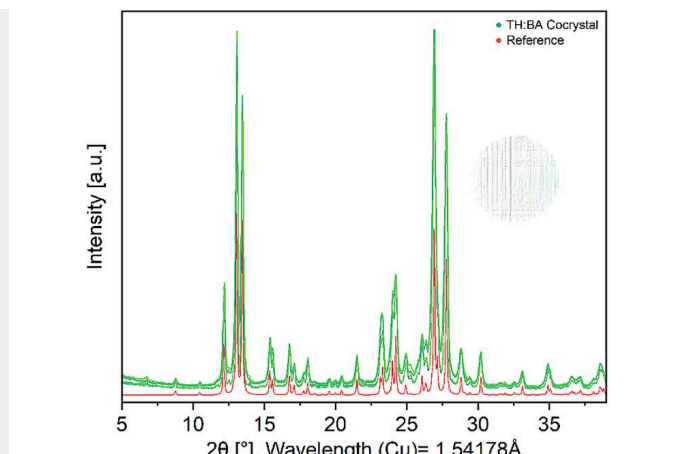
Courtesy of Dr. Sven Grätz, Ruhr-University Bochum, Faculty of Chemistry and Biochemistry, AG Prof. Borchardt.

## 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]

## CHEMISTRY IN THE MILL: TEFLON RECYCLING (PTFE) USING MECHANICAL ENERGY

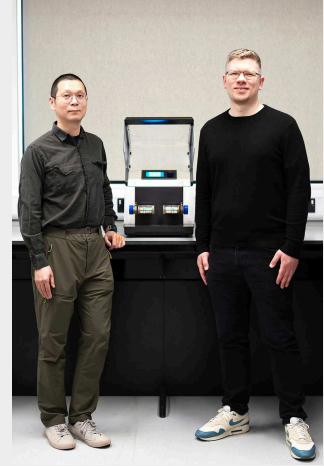
### MECHANOCHEMICAL RECYCLING OF PTFE (TEFLON)

Mechanochemical reactions can also be carried out particularly efficiently using the MM 400. Recent research shows how PTFE (Teflon) can be broken down in the MM 400 through a reaction with sodium, using mechanical energy. The intense movement of the grinding balls provides the energy needed to break the stable carbon-fluorine bonds – without any additional heat or pressure. In this way, large portions of the material can be converted into sodium fluoride and carbon – a promising approach for future recycling processes.

Image on the right: Dr. Erli Lu and Dr. Dominik Kubicki with the Mixer Mill MM 400, which was used to decompose PFAs. [4]

The process using MM 400 was part of the renowned science program “Forschung aktuell” on Deutschlandfunk. Give it a listen!

**The radio segment is available only in German.**



## FUNCTIONALIZING BIOMASS FOR PHARMA APPLICATIONS VIA MECHANOCHEMISTRY

Mechanochemistry is transforming how functional biomaterials are made, and cationic cellulose is a prime example. Using a solvent-free process, cotton fibers are combined with a catalytic base and a minimal additive, then milled together with the cationic reagent to activate the reaction using the Mixer Mill MM 400. This solid-state approach eliminates water and bulk solvents, dramatically reducing chemical use and waste compared to conventional methods. After milling, a short aging step completes the reaction, delivering highly charged cellulose fibers with exceptional performance. [3]

Optimal reaction conditions: Cotton fibers were milled in a 50 ml stainless steel jar with 3 x 10 mm balls for 5 min at 25 Hz, then EPTMAC was added, and the mixture was milled for additional 30 min. The subsequent aging of the reaction mixture at 50 °C for 24 h, followed by Soxhlet extraction (48 h) and freeze drying, resulted in the isolation of pure cCF material.

### **Why is this exciting for pharma?**

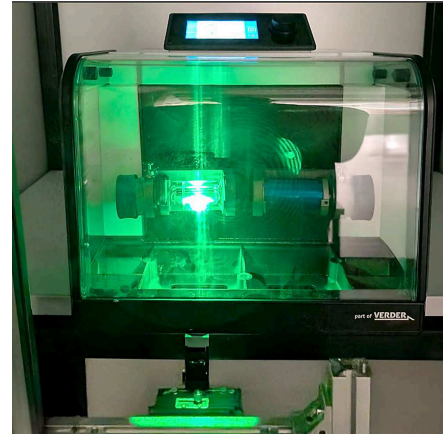
These cationic fibers show strong electrostatic binding to viruses, enabling efficient removal of pathogens from water and process streams—critical for sterile manufacturing and clean water applications. Beyond filtration, the material offers potential in drug delivery, antimicrobial surfaces, and bioprocessing aids. The process achieves outstanding sustainability metrics aligning with green chemistry principles and industry goals. It also allows precise control over charge density for tailored performance.

This innovation demonstrates how mechanochemistry can deliver high-value, eco-friendly solutions for pharmaceutical production—combining safety, efficiency, and sustainability in one breakthrough approach.

## MIKSERLİ ÖĞÜTÜCÜ 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.

GÜVENLİ VE ETKİLİ ÖÇÜTME İŞLEMLERİ İÇİN  
**MIKSER ÖÇÜTÜCÜ MM 400 AKSESUARLARI**



#### GRINDING JARS IN 7 DIFFERENT MATERIALS

Vidalı öğütme kavazolarının nominal hacmi 1.5 ml ila 50 ml arasında değişir; Mevcut malzemeler arasında sertleştirilmiş çelik, paslanmaz çelik, akik, tungsten karbür, zirkonyum oksit ve PTFE bulunur ve kontaminasyonsuz numune hazırlama sağlar.

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.



#### TEK KULLANIMLIK ŞİŞELER İÇİN ADAPTÖRLER

0.5 / 1.5 / 2/5 ml'lik tek kullanımlık şişeler için adaptörler MM 400'de kullanılabilir. Daha büyük numune miktarları için, örn. g. protein ekstraksiyonu için 50 ml konik santrifüj tüpleri veya 30 ml geniş ağızlı şişeler için adaptörler mevcuttur.



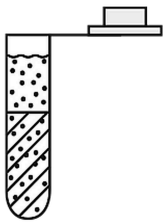
#### ADAPTERS FOR INCREASED SAMPLE THROUGHPUT

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

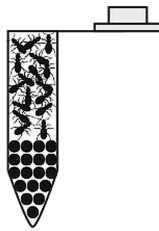
Safe-lock  
single-use vials  
2 x 10 vials max.



- | 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

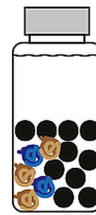
Safe-lock  
single-use vials  
2 x 5 vials max.



- | 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

MIKSERLİ ÖĞÜTÜCÜ 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.

Grinding jar nominal volume	Sample amount	Max. feed size	Recommended ball charge (pieces)						
			Ø 5 mm	Ø 7 mm	Ø 10 mm	Ø 12 mm	Ø 15 mm	Ø 20 mm	Ø 25 mm
1.5 ml	0.2 – 0.5 ml	1 mm	1–2	-	-	-	-	-	-
5 ml	0.5 – 2 ml	2 mm	-	1–2	-	-	-	-	-
10 ml	2 – 4 ml	4 mm	-	5–7	1–2	1–2	-	-	-
25 ml	4 – 10 ml	6 mm	-	-	5–6	2–4	1–2	-	-
35 ml	6 – 15 ml	6 mm	-	-	6–9	4–6	2–3	1	-
50 ml	8 – 20 ml	8 mm	-	-	12–14	6–8	3–4	1	1

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.

MIKSERLİ ÖĞÜTÜCÜ MM 400

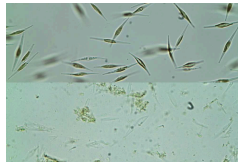
## TIPIK ÖRNEK MALZEMELER

RETSCH mikser değirmenleri gerçek anlamda çok yönlüdür. Örneğin alışımlar, hayvan yemi, kemikler, seramikler, tahıllar, kimyasal ürünler, kömür, kok kömürü, ilaçlar, elektronik hurda, cam, tahıllar, saç, mineraller, yağlı tohumlar, cevherler, kağıt, bitki malzemeleri, plastikler, kanalizasyon çamur, toprak, saman, tablet, tekstil, doku, tütün, atık numuneleri, odun, yün vb.



### 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



Videoyu izlemek  
için tıklayın

### PARSLEY



**TOUGH-FIBROUS:  
WOOD**

**ELASTIC-TOUGH:  
POLYURETHANE  
PELLETS**

**FIBROUS:  
CANNABIS**

**HARD-BRITTLE:  
CONCRETE**

5 ml sample  
10 ml zirconium  
oxide jar  
2 x 12 mm  
zirconium oxide  
balls  
3 min at 30 Hz

20 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

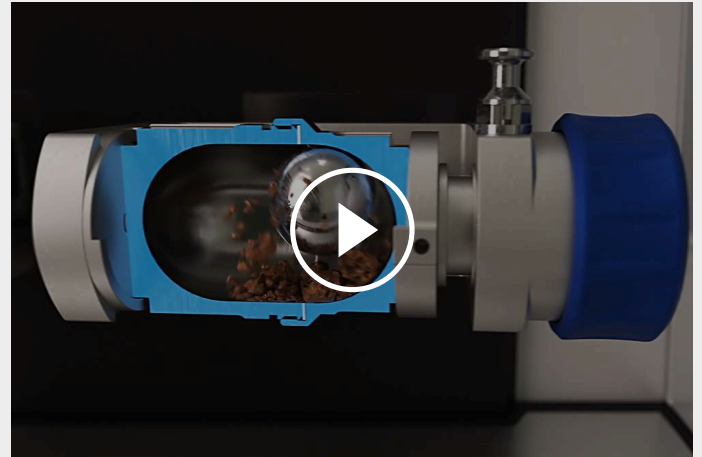
3 g sample  
50 ml stainless  
steel jar  
1 x 25 mm  
stainless steel ball  
embrittlement  
with LN<sub>2</sub> for 2 min  
90 s at 30 Hz

10 ml sample  
25 ml zirconium  
oxide jar  
2 x 15 mm  
zirconium oxide  
balls  
2 min at 30 Hz

MIKSERLİ ÖĞÜTÜCÜ MM 400

**FONKSİYON PRENSİBİ**

MM 400 mikser değirmeninin öğütme kavanozları, yatay konumda radyal salınımlar gerçekleştirir. Öğütme bilyelerinin ataleti, kavanozların yuvarlak uçlarındaki numune malzemeye yüksek enerji ile çarpmalarına ve toz haline getirmelerine neden olur. Ayrıca, kavanozların hareketi ile topların hareketi birleştiğinde numunenin yoğun şekilde karıştırılmasına neden olur. Birkaç küçük bilye kullanılarak karıştırma derecesi daha da artırılabilir. Birkaç küçük top kullanılırsa (örneğin cam boncuklar), örneğin biyolojik hücreler bozulabilir. Boncuklar arasındaki büyük sürtünme etkisi etkili hücre bozulmasını sağlar.



[Videoyu izlemek için tıklayın](#)

MIKSERLİ ÖĞÜTÜCÜ MM 400

**TEKNİK VERİ**

**Uygulamalar**

size reduction, mixing, homogenization, cell disruption, cryogenic grinding, mechanochemistry

**Uygulama alanı**

biyoloji, kimya / plastik, tarım, ..

**Besleme malzemesi**

sert, orta sert, yumuşak kırılğan, elastik ...

**Boyut küçültme prensibi**

etki, sürtünme

**Malzeme giriş büyüklüğü**

Ürün Özellikleri

**Çıkış büyüklüğü**

~ 5 µm

**Parti boyutu / besleme miktarı**

max. 2 x 20 ml

**Öğütücü istasyon sayısı**

2

**Vibrational frequency**

3 - 30 Hz (180 - 1800 min-1)

**Tipik ortalama öğütme süresi**

30 s - 2 dk

**Max. grindig time**

99 h

**Kuru öğütme**

evet

**Islak eleme**

evet

**Kroyojenik öğütme**

evet

**Reaksiyon şişeleri ile hücre parçalama**

evet, 20 x 2.0 ml ye kadar

**Kendinden merkezli kapak**

evet

**Öğütücü hazne tipi**

vida üst dizayn

**Öğütücü elemanların malzemesi**

Sertleştirilmiş çelik, Paslanmaz çelik, Tungsten karbür, Akik, Zirkonyum oksit, Ptfе, PMMA

**Öğütücü hazne ebatları**

1.5 ml / 5 ml / 10 ml / 25 ml / 35 ml / ...

**Öğütme süresi ayarı**

dijital, 10 sn - 8 sa

**Kaydedilebilir SOP**

12

**Depolanabilir döngü programları**

6

**Elektriksel veriler**

100-240 V, 50/60 Hz

**Güç bağlantısı**

1-faz

**Koruma kodu**

IP 30

**Güç tüketimi**

165W

**G x Y x D kapalı**

385 x 350 x 470 mm

**Net ağırlık**

~ 27,5 kg

**Standartlar**

CE

\* besleme malzemesi ve cihaz yapılandırmasına / ayarlarına bağlıdır

## 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.

[3] Tatsiana Nikonovich, Yao Yu, Mikko Korhikoski, Chengji Yang, Iris Seitz, Daniel Langerreiter, Mauri A. Kostainen, Eduardo Anaya-Plaza, and Sandra Kaabel; Solid-State Synthesis of Cationic Cellulose Fibers from Low-Processed Cotton for Efficient Virus Capture; ACS Sustainable Chemistry & Engineering 2025 13 (42), DOI: 10.1021/acssuschemeng.5c07884

[4] With permission of Dr Erli Lu, Associate Professor in Mechanochemistry & Sustainable Synthesis School of Chemistry, University of Birmingham

[www.retsched.com.tr/mm400](http://www.retsched.com.tr/mm400)

## SIPARIŞ BİLGİSİ

### MIKSER ÖĞÜTÜCÜ MM 400

**Mikser Öğütücü MM 400 hızlı açılır kelepçeli**  
(lütfen öğütme kavanozlarını ve bilyelerini ayrı olarak sipariş edin)

20.715.0001



MM 400

100–240 V, 50/60 Hz

### ÖĞÜTME KAVANOZLARI MM 400, VIDALI ÜST TASARIM

#### SERTLEŞTİRİLMİŞ ÇELİK

01.462.0237



25 ml

#### PASLANMAZ ÇELİK

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

#### TUNSGTEN KARBÜR

01.462.0235



10 ml

01.462.0217



25 ml

AGAT

01.462.0232



5 ml

01.462.0233



10 ml

ZIRKONYUM OKSİT

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

22.041.0004



Mixing beakers of polystyrene, 56 ml, 100 pcs.

PMMA, TRANSPARENT JARS FOR MECHANOSYNTHESSES

01.462.0539



10 ml, 10 pieces

02.462.0539



10 ml, 2 pieces

ACCESSORIES FOR AERATION AND INCREASED PRESSURE


01.462.0548


Jar set incl. aeration jar 28 ml stainless steel, filter 10 µm, sealings and fittings 2 x 1/

8" for hose diameter 3 mm and 0.65 mm wall thickness (2x3 m hose included)


22.050.0005 Conversion kit including 2 connectors for the hoses on grinding arm, bottom plate for leading hoses out of the housing, counterweight

## MM 400 ÖĞÜTME KAVANOZLARI İÇİN AKSESUARLAR

22.486.0005  Opening aid for grinding jars, 2 pcs.


02.706.0351  Adapter for use of 2/4 grinding jars 5 ml (01.462.0550)


22.085.0007  Gasket for grinding jar 1.5 ml, 10 pcs.

22.085.0008  Gasket for grinding jar 5 ml, 10 pcs. (for grinding jar 01.462.0231)


22.111.0001  Gasket for grinding jar 5 ml, 10 pcs. (for grinding jar 01.462.0550)

22.085.0009  Gasket for grinding jar 10 ml, 10 pcs.

22.085.0006  Gasket for grinding jar 25 ml hardened steel and stainless steel, 10 pcs.

22.085.0003  Gasket for grinding jar 25 ml zirconium oxide and tungsten carbide, 10 pcs.


22.085.0005  Gasket for grinding jar 35 ml stainless steel, 10 pcs.

22.085.0004  Gasket for grinding jar 35 ml zirconium oxide, 10 pcs.

22.085.0002  Gasket for grinding jar 50 ml stainless steel, 10 pcs.

## MM 400 KARIŞTIRMA VE HÜCRE BOZULMASI İÇİN AKSESUARLAR

22.001.0020  4 konik santrifüj tüpü için adaptör (örn. Falcon® Tüpleri), 2 parça, dahil. 20 tüp

05.026.0001  Konik santrifüj tüpleri, 50 ml, 20 adet

22.001.0021  4 geniş ağızlı şişe için adaptör, 2 parça, dahil. 12 geniş ağızlı şişe, 30 ml

## MM 400 SOĞUK ÖĞÜTME AKSESUARLARI

22.354.0001



Öğütme kavanozlarını sıvı nitrojenle soğutmak için kriyo kiti (2 yalıtımlı kap (1 ve 4 litre), 2 çift öğütme kavanozu maşası, 1 çift güvenlik gözlüğü dahil)

## AKSESUAR MM 400

99.200.0043

MM 400 için IQ / OQ Belgeleri

## HÜCRE VE DOKU BOZULMASI İÇİN AKSESUARLAR

22.008.0010



5 reaksiyon şişesi 5,0 ml için adaptör, PTFE'den yapılmıştır

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



PTFE'den yapılmış 0,2 ml 10 reaksiyon şişesi için adaptör

22.749.0006

Güvenli kilitli reaksiyon şişeleri 5,0 ml, 200 adet.

22.749.0001



Güvenli kilitli reaksiyon şişeleri 2.0 ml, 1000 adet.

22.749.0002



Güvenli kilitli reaksiyon şişeleri 1.5 ml, 1000 adet.

22.749.0004



Güvenli kilitli reaksiyon şişeleri 0,2 ml, 1000 adet.

22.749.0008



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

## ÖĞÜTME BİLYALARI

### SERTLEŞTİRİLMİŞ ÇELİK

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



#### PASLANMAZ ÇELİK

22.455.0010 2 mm Ø, 500 g (yaklaşık 110 ml)



22.455.0011 3 mm Ø, 500 g (yaklaşık 120 ml)



22.455.0002 3 mm Ø, 200 parça (yaklaşık 6 ml)



22.455.0001 4 mm Ø, 200 parça (yaklaşık 14 ml)



22.455.0003 5 mm Ø, 200 adet (yaklaşık 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

#### TUNSGTEN KARBÜR

22.455.0006



3 mm Ø, 200 parça (yaklaşık 6 ml)

22.455.0005



4 mm Ø, 200 parça (yaklaşık 14 ml)

22.455.0004



5 mm Ø, 200 adet (yaklaşık 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

#### AGAT

05.368.0024



5 mm Ø

05.368.0025



7 mm Ø

05.368.0067



10 mm Ø


05.368.0027





12 mm Ø

#### ZIRKONYUM OKSİT


05.368.0089  2 mm Ø, 0,5 kg (yaklaşık 135 ml)


05.368.0090  3 mm Ø, 0,5 kg (yaklaşık 140 ml)

22.455.0007  3 mm Ø, 200 parça (yaklaşık 6 ml)


22.455.0009  5 mm Ø, 200 adet (yaklaşık 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

#### ÇELİK ÇEKİRDEKLI PTFE

05.368.0045  10 mm Ø

05.368.0046  12 mm Ø

05.368.0114  15 mm Ø

05.368.0047  20 mm Ø

#### BEHERLERI KARIŞTIRMAK İÇİN POLIAMİD

05.368.0042  5 mm Ø

05.368.0043



7 mm Ø

05.368.0044



9 mm Ø

05.368.0003



12 mm Ø

#### CAM BONCUKLAR

22.222.0001



0.10 - 0.25 mm Ø, 500 g (yaklaşık 320 ml)

22.222.0002



0,25 - 0,50 mm Ø, 500 g (yaklaşık 320 ml)

22.222.0003



0,50 - 0,75 mm Ø, 500 g (yaklaşık 320 ml)

22.222.0004



0,75 - 1,00 mm Ø, 500 g (yaklaşık 320 ml)

22.222.0005



1,00 - 1,50 mm Ø, 500 g (yaklaşık 320 ml)