



## SKIVEMØLLE MM 500 CONTROL

**The MM 500 control is a high energy laboratory ball mill that can be used for dry, wet and cryogenic grinding with a frequency of up to 30 Hz. It is the first mixer mill in the market that allows to monitor and control the temperature of a grinding process.**

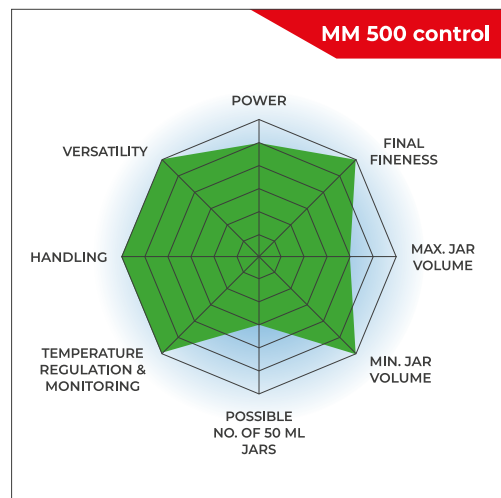
The temperature area covers a range from -100 to 100 °C. For maximum flexibility, the mill can be operated with various thermal fluids, enabling the use of different tempering devices for cooling or heating. If liquid nitrogen is chosen for cooling, the mill needs to be equipped with the optionally available extension device cryoPad. The innovative cryoPad technology allows to select and control a specific cooling temperature in the range from - 100 to 0 °C for the grinding process.



[Click to view video](#)

### THE ONLY MIXER MILL WITH TEMPERATURE CONTROL

- | Max. speed 30 Hz
- | Horizontal oscillation causes strong impact effects for effective sample processing
- | Up to 10 mm feed size and 0.1 µm final fineness
- | 2 grinding stations for jars of min. 2 ml and max. 125 ml, adapter for 18 x 2 ml single use vials
- | Various possibilities for heating or cooling with thermal fluid or liquid nitrogen for cryogenic grinding, temperature regulation between -100 °C and 100 °C, monitoring of temperature
- | GrindControl to measure temperature and pressure inside the jar.
- | Aeration lids to control the atmosphere inside the jar
- | Bench top model, touch screen, easy jar clamping, jars can stay clamped for subsampling, storable SOPs and cycle programs, 4 different jar materials for dry and wet grinding



## ADVANTAGES THROUGH DESIGN

- | Dry, wet and cryogenic grinding with up to 30 Hz for high energy grinding
- | Fast and comfortable sample processing with two screw lock jars of up to 125 ml each
- | Patented hermetically closed fluid system ensures the safe operation of thermal fluids
- | Wide range of accessories available, including ventilation lids and heavy-metal-free grinding jars (also for cryogenic grinding)
- | Ergonomic jar clamping, low noise level, user friendly parameter setting via touch display



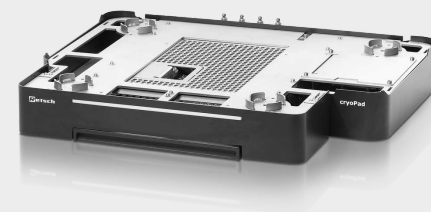
## TEMPERATURE MONITORING AND CONTROL

- | Continuous temperature monitoring throughout a grinding process
- | Cooling and heating in a range from -100 to 100°C
- | Operation is possible with liquid nitrogen or other thermal fluid
- | High flexibility in terms of selecting a tempering device for temperature regulation (LN<sub>2</sub> supply, cryostat, chiller, ...).
- | Low temperature grinding is possible without LN<sub>2</sub>



## CRYOPAD

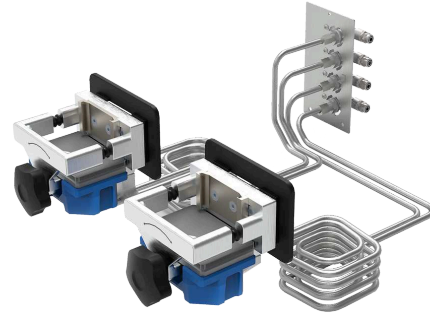
- | Extension device cryoPad is required for the operation with LN<sub>2</sub>
- | The cryoPad regulates the flow of LN<sub>2</sub> through the thermal plate
- | The cryoPad technology allows to select and maintain a specific cooling temperature in the range between -100 and 0°C while using LN<sub>2</sub>



SKIVEMØLLE MM 500 CONTROL

## TEMPERATURE REGULATION BASED ON THERMAL PLATES

The cooling and heating of the sample material is realized with the patented concept of thermal plates, making sample cooling with, e. g., open liquid nitrogen baths or dry ice obsolete. For tempering, the grinding jars are simply placed on top of the thermal plates. When the grinding jars come in contact with the thermal plates, heat is effectively transferred from or to the jars via the tempering device. The patented hermetically sealed fluid design allows to operate the mill with different thermal fluids, ensuring a flexible and safe temperature regulation and requiring only minimal effort for the user. Depending on the operational setup that is built up, the temperature of the thermal plates can be set in the range from -100 to +100 °C.



## SKIVEMØLLE MM 500 CONTROL CONFIGURATIONS

To control the temperature of a grinding process, the mill needs to be connected to an external tempering device. Basically, there are two options:

### 1. Temperature regulation with liquid nitrogen

The mill is operated with liquid nitrogen and connected to a nitrogen tank. In this setup the mill must be extended with the optionally available extension device cryoPad. The patented PID (proportional–integral–derivative) system of the cryoPad controls the flow of liquid nitrogen and herewith the temperature of the thermal plates. In this setup, it is possible to select and maintain the temperature of the thermal plates at a specific value. The desired temperature is adjusted via the touch display and can be selected within a range from -100 to 0 °C, in steps of 10.

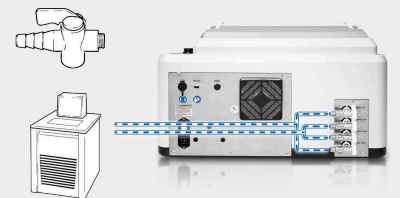
Setup 1: Extension device cryoPad and LN<sub>2</sub> tank for the operation with liquid nitrogen.



### 2. Cooling or heating with a liquid thermal fluid

In this setup, the mill can either be connected to a cryostat, to a chiller or to the water tap. The external tempering device regulates the corresponding thermal fluid to a defined temperature and the thermal fluid transfers this temperature to the thermal plates. As during a grinding process, a significant amount of heat may also develop inside the jar, the temperature of the thermal plates may be manipulated. To sum up, the actual temperature of the thermal plates depends on both, on the temperature of the thermal fluid and on grinding parameters, like frequency, time, jar volume, size of grinding balls. For a maximum control of the grinding process, the actual temperature of the thermal plates is continuously monitored in the touch display.

Setup 2: Operation with an external tempering device; e.g. water tap, chiller or thermostat.



## SKIVEMØLLE MM 500 CONTROL

### BRUKSEKSEMPLER

The temperature regulation of the MM 500 control is especially designed for the processing of temperature-sensitive sample materials. Cooling or heating may have different objectives.

#### Cooling can be used for example:

- | Preserving temperature-sensitive analytes (like volatile substances or pharmaceutical and food ingredients)
- | Embrittlement
- | Wet grinding below room temperature
- | Mechanochemistry

Some applications are improved if the sample material is heated up during the process. Examples for heating are:

- | Paste making (in food industry)
- | Intensifying mechanochemical reactions

The required temperatures and the operational setup depend on the specific application.



[Click to view video](#)

## PRESERVING TEMPERATURE-SENSITIVE ANALYTES

Some analytes are modified, destroyed or vaporized if the sample material gets too warm. If specific temperature levels are exceeded, the structure of, for example, proteins, pharmaceutical substances or food ingredients may be essentially changed.

By keeping the temperature at a moderate level throughout the grinding process, temperature-sensitive natural substances are physically preserved in their original state for analysis.



Grinding of coffee beans at low temperatures for natural substance analysis.

## CRYOGENIC GRINDING

Temperatures below 0 °C are suitable for the embrittlement and homogenization of for example ductile or sticky food. If heavy-metal-free grinding is required, jars of zirconium oxide or tungsten carbide can be used.

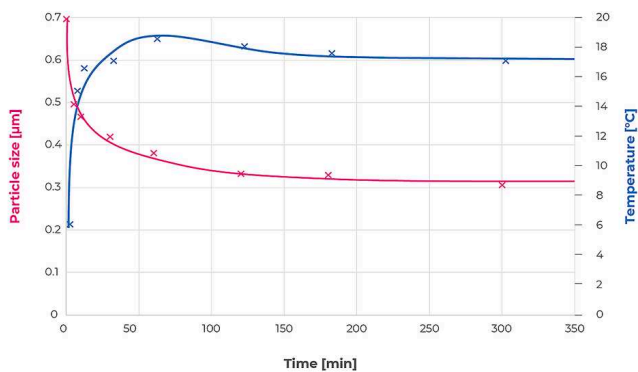
If cooled down to -100 °C, it is also possible to successfully embrittle some polymers.



Fast milling of black Fluoro-carbon rubber (FKM) by embrittling the sample in two 125 ml jars at -100 °C.

## WET GRINDING < 30 °C

If using a chiller, powerful wet grinding can be performed at 30 Hz and below room temperature without considering any cooling breaks.

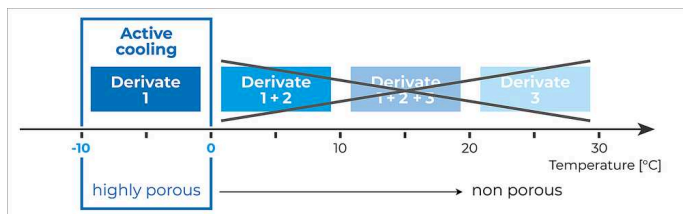


Particle size and temperature development for TiO<sub>2</sub> in a wet grinding process with 30 Hz and 2 x 125 ml jars

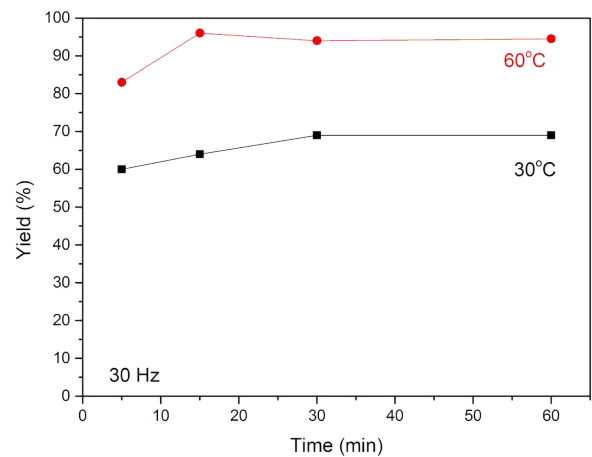
## MECHANOCHEMISTRY

By cooling the sample throughout a mechanochemical process, the formation of undesired derivatives can be prevented. It is also possible to apply some heating, for example to initiate chemical reactions and increase product yields.

By keeping the temperature below 0 °C, the formation of non-porous zeolitic metal organic compound is inhibited.



By increasing the temperature during synthesis, the yield of a metal organic compound can be increased.  
© Stuart James, Queens University Belfast.



SKIVEMØLLE MM 500 CONTROL

## ACCESSORIES FOR MAXIMUM FLEXIBILITY



### GRINDING JARS IN 3 DIFFERENT MATERIALS

Available grinding jar sizes are 50 ml, 80 ml and 125 ml, materials include stainless steel, tungsten carbide and zirconium oxide, ensuring contamination-free sample preparation. Heavy-metal-free grinding is possible, also at -100 °C



[Click to view video](#)

### AERATION LID (VIDEO)

RETSCH offers a special aeration lid for the grinding jars designed for applications where a special atmosphere is to be maintained in the ball mill jar.



### GRINDCONTROL

The GrindControl measures temperature and pressure inside the jar. The system includes a sensor and transmission unit as well as an analysis software.

## MULTI-CAVITY JARS & ADAPTER

Simultaneous processing of several small samples is possible with the multi-cavity jars and an adapter for reaction vials. This is a typical requirement, for example, for pharmaceutical, chemical and biochemical applications. The small cavity jars provide new opportunities for mechanochemical research activities involving small amounts of chemicals.

The cavities in the jars have an oval shape which ensures effective mixing. The pouring aids allow for safe sample handling. The multi-cavity jars are made of stainless steel, thus providing effective heat transfer to or from the sample.

The adapter accommodates up to 18 disposable reaction vials of 1.5 or 2.0 ml (e.g. Eppendorf vials) or nine 2.0 ml steel tubes. With its two grinding stations, the MM 500 control mixer mill can now process up to 36 samples in one working run. 2.0 ml steel tubes should be used if samples need to be frozen or heated, as polymeric reaction vessels cannot withstand mechanical load at extreme temperatures. The adapter is made of aluminum so that heat is efficiently transferred to and from the reaction tubes.



Multi-cavity jars of 4 x 10 ml and 2 x 25 ml, made of stainless steel, incl. PTFE pouring aids.



Adapter for 18 x 2 ml safe-lock reaction vials or 9 x 2 ml steel tubes, made of aluminum

SKIVEMØLLE MM 500 CONTROL

## TYPICAL SAMPLE MATERIALS

As the MM 500 control can be used with or without cooling, the mill offers a wide variety of applications. It can be used to homogenize, for example, waste, soil, chemical products, coated tablets, drugs, ores, grain, tissue, glass, hair, ceramics, bones, plastics, alloys, minerals, oil seeds, plants, sewage sludge, pills, textiles, wool etc.



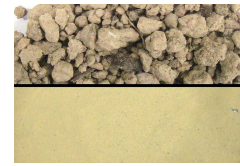
raisins



drasjeer



polystyren



soil



[Click to view video](#)

Parsley

SKIVEMØLLE MM 500 CONTROL

## VIRKEMÅTE

The grinding jars of the mixer mill MM 500 control 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 grinding jars and pulverize it. High energy milling is possible by operating at high frequencies up to 30 Hz. The movement of the grinding jars combined with the movement of the balls further causes grinding effects due to friction and additionally result in an effective mixing of the sample. The degree of mixing can be increased even further by using several smaller balls.



[Click to view video](#)

TECHNICAL DATA

## SKIVEMØLLE MM 500 CONTROL

<b>funksjon</b>	mechanochemistry, mechanical alloying, size reduction, mixing, homogenization, cryogenic grinding
<b>bruksområde</b>	biologi, byggematerialer, geologi / metallurgi, glass / keramikk, kjemi / plast, landbruk, maskinbygging / elektroteknikk, matvarer, medisin / legemidler, miljø / gjenvinning
<b>matemateriale</b>	hardt, middels hardt, mykt, sprøtt, elastisk, fibrøs
<b>nedmalingsprinsipp</b>	sammenstøt, friksjon
<b>matestørrelse*</b>	<= 10 mm
<b>sluttfinhet*</b>	~ 0.1 µm
<b>prøvevolum*</b>	max. 2 x 45 ml
<b>volum prøvebeholder</b>	max. 2 x 125 ml
<b>antall malestasjoner</b>	2
<b>Vibrational frequency</b>	3 - 30 Hz (180 -1800 min <sup>-1</sup> )
<b>Setting of temperature setpoint</b>	digital, 0 ... -100 °C (only with cryoPad)
<b>Setting of sample cooling time</b>	digital, 0 ... 60 min (only with cryoPad)
<b>innstilling av maletid</b>	digital, 10 s - 8 h
<b>Total grinding time</b>	99 h
<b>SOPer som kan lagres</b>	12
<b>Number of storable cycle programs</b>	4 (with 99 repeats)
<b>typisk maletid</b>	30 s - 2 min
<b>tørr nedmaling</b>	ja
<b>våtmaling</b>	ja
<b>kryogen nedmaling</b>	ja
<b>type malebeger</b>	screw-lock jar with integrated safety closure devices, multi cavity jar, adapter for safe-lock reaction vials
<b>material i maleverktøyet</b>	herdet stål, rustfritt stål, wolframkarbid, zirkoniumoksid
<b>Størrelse på malebeger</b>	10 ml / 25 ml / 50 ml / 80 ml / 125 ml
<b>Elektriske tilkoblingsdata</b>	100-120 V, 50/60 Hz; 200-230 V, 50/60Hz
<b>Nettilkobling</b>	1-fase
<b>kapslingstype</b>	IP 30
<b>kraftforbruk:</b>	750 W

<b>b x h x d lukket</b>	690 x 375 x 585 mm
<b>W x H x D closed with cryoPad</b>	690 x 485 x 585 mm
<b>nettovekt</b>	~ 63 kg
<b>Normer / standarder</b>	CE
<b>Connection thread size device input</b>	G 1/4" (inner thread)
<b>Connection thread size tubing set</b>	G 3/8" (outer thread)
<b>Permissible operating pressure cooling device (provided by customer)</b>	0 ... 5 bar
<b>typical pressure range of continous cooling unit e.g. cryostat</b>	1 ... 2 bar
<b>permissible pressure range of LN2 supply</b>	1.2 ...1.4 bar
<b>Permissible fluids</b>	water, water-glycole mixture, thermal oil, liquid nitrogen
<b>Thermal applications</b>	embrittling, cooling, heating, temperature control
<b>temperature range of fluids</b>	+100 °C ... -196 °C
<b>temperature range of cooling plates</b>	+100 °C ... -100 °C

\*avhengig av matemateriale og apparatkonfigurering /apparatinnstillinger

TECHNICAL DATA

**CRYOPAD**

<b>funksjon</b>	cryogenic grinding with liquid nitrogen
<b>Grensesnitt</b>	RS-232 (MM 500 control)
<b>Communication connection</b>	via included connection cable
<b>Power supply</b>	via external power supply
<b>Electrical supply data (input external power supply)</b>	100-230V, 50/60 Hz
<b>External power supply classification</b>	Medical grade isolation level
<b>Electrical supply data (input cryoPad)</b>	24 V, 1 A
<b>Tilbehør</b>	LN2 Autofill 150L, LN2 Autofill 50L
<b>LED status light</b>	ja
<b>b x h x d</b>	670 x 110 x 590 mm
<b>nettovekt</b>	~ 26 kg
<b>Normer / standarder</b>	CE
<b>Connection thread size device input</b>	G 1/4" (inner thread)
<b>Connection thread size of stainless steel tubing adapter</b>	UNF 3/4"
<b>Permissible pressure range of LN2 supply</b>	1.2 ...1.4 bar
<b>Permissible fluids</b>	Liquid nitrogen
<b>Emissions</b>	Liquid nitrogen gas, condensation
<b>Connection</b>	via included tubing set
<b>Exhaust outlet</b>	via included Exhaust adapter and aluminum corrugated tube
<b>temperature range of fluids</b>	-196 °C
<b>temperature control algorithm</b>	PID temperature control
<b>Setting of temperature setpoint</b>	digital, 0 ... -100 °C
<b>Setting of sample cooling time</b>	digital, 0 ... 60 min

[/mm500-control](#)

## BESTILLINGSINFO

### MIXER MILL MM 500 CONTROL

**Mixer Mill MM 500 control with quick release clamp  
(please order grinding jars, balls and items required for  
temperature controlled grinding separately)**


20.767.0001  MM 500 control 200–230 V, 50/60 Hz

20.767.0002  MM 500 control 100–120 V, 50/60 Hz

**For temperature control please order a Mixer Mill MM 500 control set or accessories as shown in table “Items required for temperature control”**

### DEVICE EXTENSION CRYOPAD FOR THE OPERATION WITH LN2

#### DEVICE EXTENSION CRYOPAD FOR LN2 CONTROL

70.950.0002  cryoPad 100–230 V, 50/60 Hz (incl. connection tube, safety valve;  
for LN2 supply provided by customer)

#### ACCESSORIES FOR TEMPERATURE CONTROL

02.480.0003  Autofill 150 l, incl. connection tube and safety valve

02.480.0002  Autofill 50 l, incl. connection tube and safety valve

02.707.0188 Tubing set for liquid thermal fluids

### SCREW-LOCK GRINDING JARS MM 500 CONTROL/NANO

#### HARDENED STEEL

01.462.0463  50 ml

01.462.0468



80 ml

01.462.0470



125 ml

#### STAINLESS STEEL

01.462.0447



50 ml

01.462.0467



80 ml

01.462.0420



125 ml

#### TUNGSTEN CARBIDE

01.462.0466



50 ml

01.462.0479



80 ml

#### ZIRCONIUM OXIDE

01.462.0464



50 ml

01.462.0417



80 ml

01.462.0471



125 ml

## MULTI CAVITY GINDING JARS MM 500 CONTROL/NANO

01.462.0537



4 x 10 ml, 1.4112 stainless steel, incl. 3 pouring aids

22.462.0014



Pouring aid for 10 ml Multi cavity jar

01.462.0536



2 x 25 ml, 1.4112 stainless steel, incl. 1 pouring aid

22.462.0015



Pouring aid for 25 ml Multi cavity jar

#### ACCESSORIES FOR GRINDING IN 1.5 OR 2 ML VIALS

22.008.0012



Adapter made of aluminum for 18 x 2.0 ml / 1.5 ml Safe-lock reaction vials or 9 x 2.0 ml reaction vials made of stainless steel 316L

22.749.0001



Safe-lock reaction vials 2.0 ml, 1000 pcs.

22.749.0002



Safe-lock reaction vials 1.5 ml, 1000 pcs.

22.749.0008



Reaction vials made of stainless steel 316L, 2.0 ml, 10 pcs.

## ACCESSORIES FOR GRINDING UNDER INERT ATMOSPHERE

### AERATION LID FOR SCREW-LOCK GRINDING JARS

## ACCESSORIES FOR GRINDING JARS MM 500 CONTROL/NANO

22.486.0006

Grinding jar stabilization pad

02.486.0050

Jar wrench for grinding jars

05.114.0057



O-ring for grinding jars 50 ml, 1 piece

05.114.0158

O-ring for grinding jars 80 ml, 1 piece

05.114.0122



O-ring for grinding jars 125 ml, 1 piece

## ACCESSORIES FOR COLD GRINDING MM 500 CONTROL/NANO

22.354.0003

Cryo kit for cooling the grinding jars with liquid nitrogen (incl. insulated container 4-liter, 2 grinding jar holders, 1 pair of safety glasses)

## ACCESSORIES MM 500 CONTROL/NANO



05.114.0197	O-ring PTFE for grinding jars 50 ml, 1 piece, for cryogenic grinding
05.114.0196	O-ring PTFE for grinding jars 80 ml, 1 piece, for cryogenic grinding
05.114.0195	O-ring PTFE for grinding jars 125 ml, 1 piece, for cryogenic grinding
05.114.0208	O-ring for multi cavity jars, 4 x 10 ml, 1 piece
05.114.0207	O-ring for multi cavity jars, 2 x 25 ml, 1 piece
05.114.0212	O-ring for multi cavity jars, 4 x 10 ml, 1 piece, for cryogenic grinding
05.114.0213	O-ring for multi cavity jars, 2 x 25 ml, 1 piece, for cryogenic grinding
99.200.0040	IQ/OQ Documentation for MM 500 control

## PRESSURE AND TEMPERATURE MEASURING SYSTEM GRINDCONTROL FOR MIXER MILLS

**incl. sensors and transmitter unit, case, opening aid and cleaning accessories for MM 500 control / nano / Emax (please order lid insert and grinding jar separately)**

22.782.0032	GrindControl for MM 500 control/nano/Emax grinding jar 125 ml
03.474.0242	GrindControl lid insert for MM 500 control/nano and Emax grinding jar 125 ml, stainless steel
03.474.0245	GrindControl lid insert for MM 500 control/nano and Emax grinding jar 125 ml, zirconium oxide

## ACCESSORIES FOR MM 500 CONTROL/NANO GRINDCONTROL

05.114.0122	 O-ring for 125 ml grinding jars (MM 500 control/nano and Emax)
22.186.0007	Sintered filter with O-ring, set of 10 pieces
22.864.0001	 Valve set M8x1 for GrindControl and aeration lids

## 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


05.368.0033  20 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)

22.455.0003  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

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



#### ZIRCONIUM OXIDE

32.368.0005 0.1 mm Ø, 0.5 kg (approx. 135 ml)



32.368.0003 0.5 mm Ø, 0.5 kg (approx. 135 ml)



32.368.0004 1 mm Ø, 0.5 kg (approx. 135 ml)



05.368.0089 2 mm Ø, 0.5 kg (approx. 135 ml)



05.368.0090 3 mm Ø, 0.5 kg (approx. 140 ml)



22.455.0007 3 mm Ø, 200 pieces (approx. 6 ml)



22.455.0009



5 mm Ø, 200 pieces (approx. 25 ml)

05.368.0146

7 mm Ø

05.368.0094



10 mm Ø

05.368.0096



12 mm Ø

05.368.0113



15 mm Ø