MIXER MILL
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.

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Product Video

ADVANTAGES THROUGH DESIGN

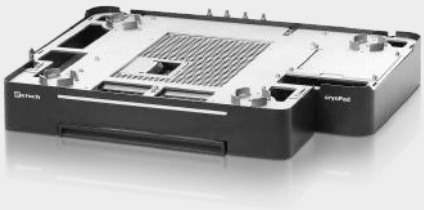
- Dry, wet and cryogenic grinding with up to 30 Hz for high energy grinding
- Fast and comfortable sample processing with two screw lock jars of up to 125 ml each
- Patented hermetically closed fluid system ensures the safe operation of thermal fluids
- Wide range of accessories available, including 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_2 supply, cryostat, chiller, ...).
- Low temperature grinding is possible without LN_2

CRYOPAD

- Extension device cryoPad is required for the operation with LN_2
- The cryoPad regulates the flow of LN_2 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_2



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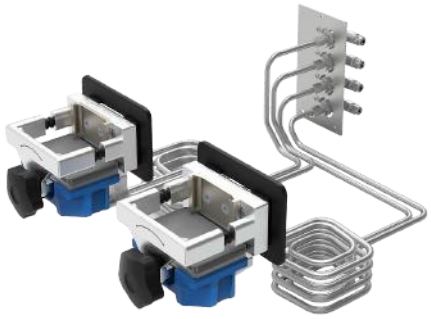
TEMPERATURE REGULATION BASED ON THERMAL PLATES

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.



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_2 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.

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APPLICATION EXAMPLES

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

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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.

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

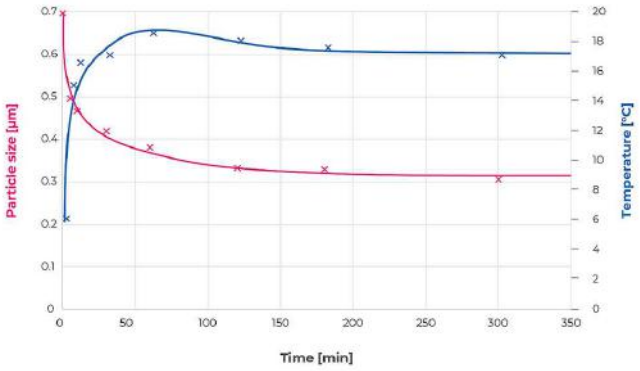
Temperatures below 0 °C are suitable for the embrittlement and homogenization of for example ductile or sticky food. If heavy-metal-free grinding is required, jars of zirconium oxide or tungsten carbide can be used.

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

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

WET GRINDING < 30 °C

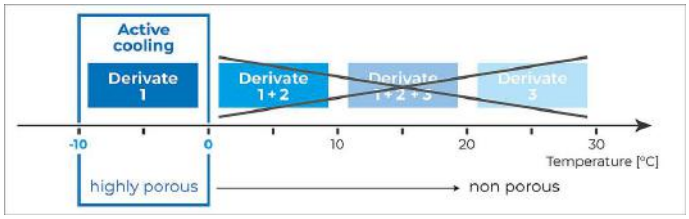
If using a chiller, powerful wet grinding can be performed at 30 Hz and below room temperature without considering any cooling breaks.



Particle size and temperature development for TiO_2 in a wet grinding process with 30 Hz and 2 x 125 ml jars

MECHANOCHEMISTRY

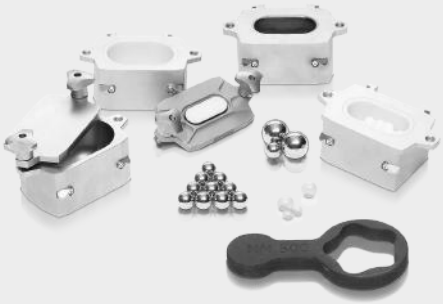
By cooling the sample throughout a mechanochemical process, the formation of undesired derivatives can be prevented. It is also possible to apply some heating, for example to initiate chemical reactions and increase product yields.



Fast formation of ZIF-8 at 30 Hz. By keeping the temperature below 0 °C, the formation of non-porous Zeolitic Imidazolate Frameworks (ZIF-8) is inhibited.

ACCESSORIES FOR MAXIMUM FLEXIBILITY

The MM 500 control is equipped with two grinding stations for screw-lock jars, available in the materials stainless steel, hardened steel, zirconium oxide and wolfram carbide in different jar sizes up to 80 ml or 125 ml. Heavy-metal-free grinding is possible, also at low temperatures. Ventilation lids allow for ventilation of the jars and for working under inert atmospheres.



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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

coated tablets

polystyrene

soil

TECHNICAL DATA

MIXER MILL MM 500 CONTROL

Applications	mechanochemistry, mechanical alloying, size reduction, mixing, homogenization, cryogenic grinding
Field of application	agriculture, biology, chemistry / plastics, construction materials, engineering / electronics, environment / recycling, food, geology / metallurgy, glass / ceramics, medicine / pharmaceuticals
Feed material	hard, medium-hard, soft, brittle, elastic, fibrous
Size reduction principle	impact, friction
Material feed size*	<= 10 mm
Final fineness*	~ 0.1 µm
Batch size / feed quantity*	max. 2 x 45 ml
Grinding chamber volume	max. 2 x 125 ml
No. of grinding stations	2
Setting of vibrational frequency	digital, 3 - 30 Hz (180 -1800 min-1)
Setting of temperature setpoint	digital, 0 ... -100 °C (only with cryoPad)
Setting of sample cooling time	digital, 0 ... 60 min (only with cryoPad)
Setting of grinding time	digital, 10 s - 8 h
Total grinding time	99 h
Storable SOPs	12
Number of storable cycle programs	4 (with 99 repeats)
Typical mean grinding time	30 s - 2 min
Dry grinding/ Wet grinding/ Cryogenic grinding	yes/ yes/ yes
Type of grinding jars	screw-lock with integrated safety closure devices
Material of grinding tools	hardened steel, stainless steel, tungsten carbide, zirconium oxide
Grinding jar sizes	50 ml / 80 ml / 125 ml
Electrical supply data	100-120V, 50/60 Hz; 200-230V, 50/60Hz
Power connection	1-phase
Protection code	IP 30
Power consumption	750 W
W x H x D closed	690 x 375 x 585 mm
W x H x D closed with cryoPad	690 x 485 x 585 mm

Net weight	~ 63 kg
Standards	CE
Connection thread size device input	G 1/4" (inner thread)
Connection thread size tubing set	G 3/8" (outer thread)
Permissible operating pressure cooling device (provided by customer)	0 ... 5 bar
typical pressure range of continous cooling unit e.g. cryostat	1 ... 2 bar
permissible pressure range of LN2 supply	1.2 ...1.4 bar
Permissible fluids	water, water-glycole mixture, thermal oil, liquid nitrogen
Thermal applications	embrittling, cooling, heating, temperature control
temperature range of fluids	+100 °C ... -196 °C
temperature range of cooling plates	+100 °C ... -100 °C

*depending on feed material and instrument configuration/settings

TECHNICAL DATA

CRYOPAD

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

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FUNCTIONAL PRINCIPLE

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.

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