测量系统

GRINDCONTROL

SEE WHAT OTHERS CAN'T SEE

Modern laboratory applications demand maximum control, highest reproducibility, and complete process transparency. The latest generation of GrindControl provides a solution that consistently meets these requirements — powerful, intelligent, and intuitive to operate.

GrindControl is used in ball mill processes and continuously records pressure and temperature inside the grinding jar. The system consists of a hardware measuring unit and dedicated analysis software, enabling real-time visualization and evaluation of the key process parameters, pressure and temperature.

This makes sample preparation more efficient, protects temperature-sensitive materials, and ensures stable conditions even in demanding applications — for example in mechanochemical syntheses. GrindControl creates transparency in the ball milling process and forms the foundation for reliable and reproducible results.

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磨削控制一览

- 精确温度监测范围为-20°C至+100°C，分辨精度达0.1°C。
- 准确测量罐内压力，范围为0至5bar，精度达1mbar。
- 通过专用进气/排气阀门轻松引入或释放气体。
- 直观的实时软件，用于监控、记录和分析所有数据。

技术带来的优势

- 完全独立的系统——无需对研磨仪进行任何改造。
- 模块化顶盖设计，可快速切换不同材质和尺寸的罐体。
- 同时监控多达四个GrindControl单元。
- 可靠的无线传输距离可达5米，电池续航时间长达80小时。
- Fast and easy operation and cleaning: tools included.

GRINDCONTROL

测量温度和压力的好处

Monitoring temperature and pressure provides significant advantages for optimally designing and controlling ball mill processes for particle size reduction, sample preparation, and research applications.

有助于改善

质量: Pressure and temperature monitoring for reliable and reproducible results.

效率: Real-time monitoring enables precise control of process conditions. Process parameters such as cooling, frequency, duration, and grinding pause intervals can be adjusted as needed.

安全: Critical changes in pressure and temperature can be detected at an early stage, preventing process errors and safety risks.

Research & development: Deeper insights into mechanochemical reactions can be obtained. The relationship between the results and the relevant state variables can be analyzed.

Grindcontrol系统适用于行星式球磨仪、MM 500nano/control混合球磨仪及Emax系列设备。该系统包含压力与温度测量硬件及分析软件。

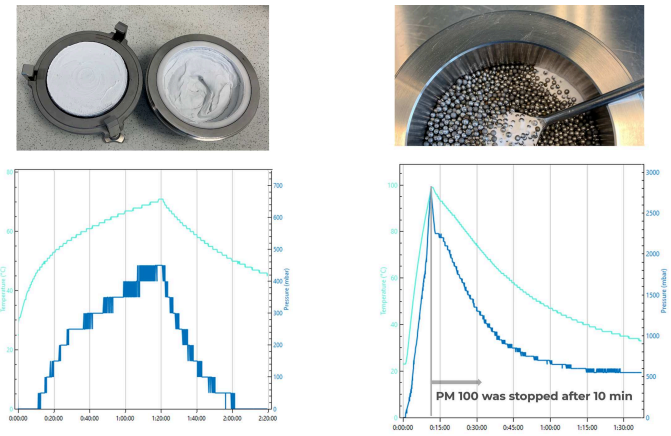
ANALYSIS OF PRESSURE AND TEMPERATURE DEVELOPMENT DURING BALL MILLING

GrindControl supports a broad range of applications, delivering enhanced safety and accurate temperature regulation for controlled and reproducible ball milling.

EXAMPLE 1: MAXIMUM SAFETY DURING WET GRINDING

During ball milling, temperature and pressure profiles can develop differently depending on the filling level of the grinding jar, the jar material, and the process parameters.

While temperature and pressure increase gradually during the wet grinding of corundum in a 250 ml grinding jar in a planetary ball mill (left diagram), a significantly stronger increase is observed at the same rotational speed in a 500 ml grinding jar with steel balls of larger diameter (right diagram).



By continuously monitoring these state variables with GrindControl, the process can be specifically controlled and overall operational safety can be enhanced. Grinding jars with elevated temperatures must only be handled with protective gloves. Pressurized grinding jars may only be opened with extreme caution.

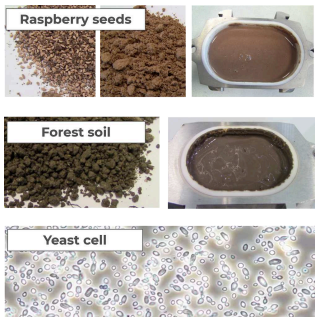
In addition, GrindControl enables the optimal selection of grinding and pause times, particularly for long-term grinding processes.

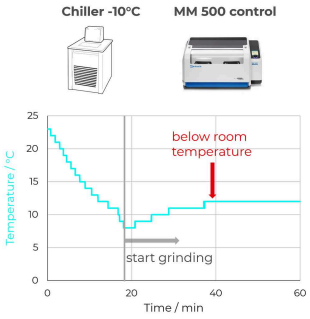
EXAMPLE 2: GENTLE BALL MILLING OF TEMPERATURE-SENSITIVE SAMPLES

When grinding temperature-sensitive materials, temperature control plays a crucial role. For such samples, targeted cooling or grinding pauses are often applied to protect sensitive substances from thermal damage. This is particularly advantageous when processing food products, organic samples, or during cell disruption, as it prevents the loss or denaturation of temperature-sensitive components.

In this example, the system is operated with the MM 500 control, which is connected to an external chiller. Using GrindControl, the process parameters inside the grinding chamber are continuously monitored. As illustrated, the grinding chamber is pre-cooled to below 10 °C and remains below room temperature throughout the entire process.

Continuous temperature monitoring with GrindControl enables precise process control, ensures reproducible results, and simultaneously protects sensitive materials.



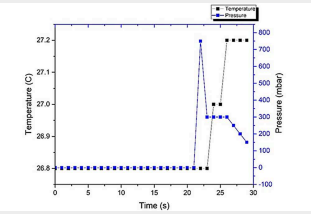


SYSTEMATIC ANALYSIS OF PARAMETERS AFFECTING MECHANOCHEMICAL REACTIONS

监测压力和温度可为研磨罐内部发生的情况提供宝贵信息。GrindControl技术被广泛应用于研究材料合成过程，例如机械合金化及其他机械化学反应。

案例1：自传播机械化学合成反应（MSR）的监测

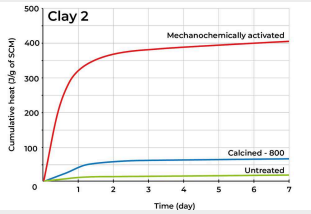
在配备GrindControl系统的MM 500nano球磨仪中，采用125毫升不锈钢研磨罐进行机械化学合成。反应物与32×10毫米研磨球在空气环境下以20赫兹频率进行研磨。
研磨约20秒后发生点火事件，导致压力升至约730毫巴并伴随温度上升。GrindControl精确捕捉了点火时刻——这是该自推进机械化学合成反应（MSR）的关键参数
[8]

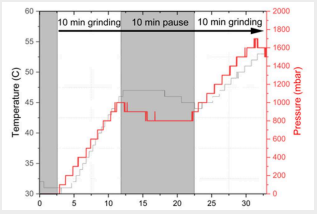


EXAMPLE 2: MECHANOCHEMICAL ACTIVATION OF CLAYS FOR “GREEN CEMENT”

In research on sustainable cement, the GrindControl system supports the analysis of the mechanochemical activation of clay minerals. In this process, the pozzolanic reactivity can be significantly increased compared to untreated or calcined samples (see left figure). The activated clays serve as Supplementary Cementitious Materials (SCMs) and enable a reduction in CO_2 emissions by partially replacing clinker.

Processing is carried out in a PM 100 planetary ball mill at 500 rpm, using a 500 ml grinding jar with twelve 20 mm stainless steel balls (ball-to-powder ratio of 25:1). By linking pressure and temperature data with reactivity measurements, the activation process can be specifically monitored and controlled. [9]

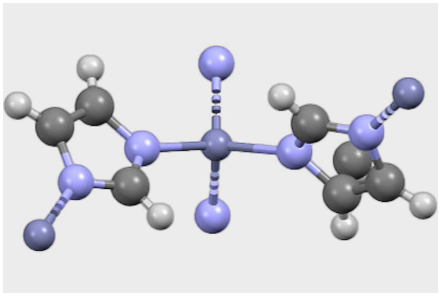




APPLICATION AREAS

When processing temperature-sensitive materials, the temperature must be monitored precisely. With GrindControl, compliance with specified temperature limits can be reliably ensured.

During wet grinding processes, long grinding times and high energy input can lead to significant temperature increases and pressure build-up. GrindControl enhances operational safety during handling and enables the optimization of grinding and pause intervals.

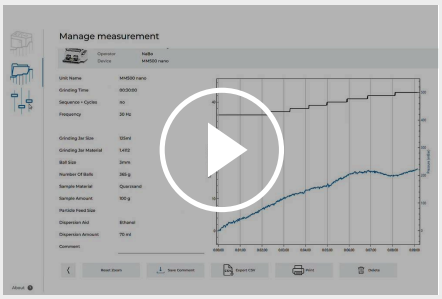


In mechanochemistry, specific temperature and pressure conditions are crucial. With GrindControl, these parameters can be precisely monitored and systematically correlated with the respective reaction outcomes.

GRINDCONTROL IN PRACTICE

The following videos provide a concise overview of the available versions, the system structure, and proper cleaning procedures.

点击观看视频



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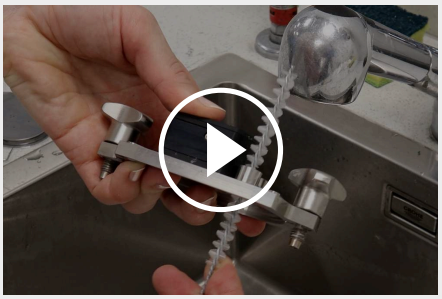

点击观看视频

HARDWARE

This video introduces the different available GrindControl versions and explains the respective hardware components. It also provides an overview of compatibility with various mill types and materials.

SOFTWARE

This video demonstrates how to use the software and explains its structure. It also clearly illustrates the acquisition and visualization of the measured data.

CLEANING

This video demonstrates the proper cleaning procedure for the GrindControl system after use. It provides important instructions on safe handling and the preservation of components to ensure long-term and reliable operation.

作用原理

Pressure and temperature are transmitted in real time via Bluetooth from the GrindControl electronics to a PC. The software records five measurements per second, generating a detailed log of the pressure and temperature profiles.

The sensors are integrated into the lid of the grinding jar, capturing the physical conditions in a

way that most accurately reflects the environment inside the jar.

Sintered filters reliably protect the sensors from contact with solid sample material. At the same time, they prevent material from escaping the grinding jar when the gas inlets are used.

The software is available free of charge and is supported from Windows 11 onward.

GRINDCONTROL

技术参数

应用	pressure and temperature measuring for Planetary Ball Mills, Emax and Mixer Mills MM 500 nano/control
应用领域	material synthesis, 农业, 化学 / 合成材料, 医药品, 地质 / 冶金, 工程/ 电子, 建筑原料, 环境 / 资源回收利用, 玻璃/ 陶瓷, 生物, 食物
测量范围 压力	gas pressure: 0 - 500 kPa (5 bar) temperature: -20°C - +100 °C
干磨	是
湿磨	是
低温研磨	yes min. -20 °C
研磨罐种类	Screw-Lock (MM) and EasyFit jars (PM)
研磨套件材料：	hardened stainless steel, 氧化锆
研磨罐尺寸	125 ml (MM); 50 - 500 ml (PM)
Transmission frequency	5 /s
串行接口	
电源数据：	battery (up to 80 h operation time)
附件：	opening aid, cleaning tools, o-ring, Software download, sintered filter, (lid insert not included)
净重	lid with sensor unit 360 g (MM) 1780 g / 1140 g (PM)
标准	CE
Technical requirements	PC with Windows 11 and Bluetooth 5.0 or higher
Software	live monitoring of measurement data, full measurement protocol, storable templates, list of performed measurements, data export in .pdf and .csv

MM = Mixer Mill; PM = Planetary Ball Mill | The GrindControl for the planetary ball mills is only compatible with the EasyFit grinding jars. Grinding jars "comfort" have other dimensions and are not compatible.

参考资料

[8] Reaction scheme and performance of the experiments: Dr. Matej Balaz, Institute of Geotechnics, Slovak Academy of Sciences (SAS).

[9]: Department of Architecture & Civil Engineering, Centre for Climate Adaptation & Environment Research, University of Bath

www.retsch.cn/grindcontrol

ORDER DATA

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

PRESSURE AND TEMPERATURE MEASURING SYSTEM GRINDCONTROL FOR PLANETARY BALL MILLS

incl. sensors and transmitter unit, inseert of lid, software, case, opening aid and cleaning accessories for PM (please order grinding jars separately)

22.782.0033	GrindControl for PM grinding jar EasyFit 50 - 125 ml
22.782.0034	GrindControl for PM grinding jar EasyFit 250 - 500 ml

GRINDCONTROL LID INSERTS

03.474.0243	GrindControl lid insert for 50, 80, 125 ml, stainless steel
03.474.0246	GrindControl lid insert for 50, 80, 125 ml, zirconium oxide
03.474.0244	GrindControl lid insert for 250 or 500 ml, stainless steel
03.474.0247	GrindControl lid insert for 250 or 500 ml, zirconium oxide

ACCESSORIES FOR PM GRINDCONTROL WITH GRINDING JARS EASYFIT

05.114.0056		O-ring for 50, 80 or 125 ml
05.114.0054		O-ring for 250 ml - 500 ml grinding jars EasyFit (PM)
03.111.0438		Flat gasket for 50 ml, 80 ml or 125 ml
03.111.0439		Flat gasket for 250 ml - 500 ml
22.186.0007		Sintered filter with O-ring, set of 10 pieces
22.864.0001		Valve set M8x1 for GrindControl and aeration lids