

# pulverisette® 4



## Vario-Planetary Mill

- Grinding conditions infinitely variable
- Mechanical alloying and activation
- Particularly suitable for research and development

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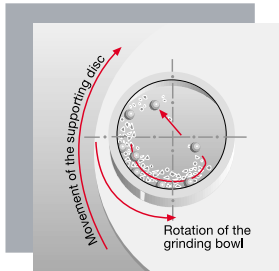
CE



Made in Germany

# Vario-Planetary Mill "pulverisette 4"

Working principle



Vario-Planetary Mill "pulverisette 4"



## Field of application

The "pulverisette 4" vario-planetary mill is capable of emulating ball mills of conventional design, precisely simulating the types of stress entailed and thus reproducing or optimising grinding processes. Due to the high flexibility available for selecting the grinding parameters, it is possible to achieve results unattainable with any other ball mills.

This is the ideal mill for mechanical activation and alloying. The main applications are in the field of materials research and, of course, wherever a powerful, innovative planetary mill is required.

When particles < 10 mm are fed in, a final fineness up to 0.1  $\mu\text{m}$  can be achieved. The useful capacity is between 2 x 30 ml in the case of 80 ml grinding bowls and 2 x 225 ml when 500 ml grinding bowl are used.

grinding balls at will so that the balls strike the inner wall of the bowl vertically (high impact energy), approach each other tangentially (high friction) or just roll down the inner wall of the bowl (centrifugal mills).

All intermediate levels and combinations of frictional and impact pressures can be set as required. By changing the transmission ratio it is therefore possible for the first time to carry out mechanical activation as well as mechanical alloying.

Furthermore, it is also possible for the first time to optimally adjust a planetary ball mill to the material to be ground, the size of the grinding bowls and the grinding balls.

## Method of operation

With standard planetary ball mills the grinding bowls are rotating and mounted eccentrically on a rotating support disc. The rotational speed of the supporting disc can be selected at will; the grinding bowl rotates at a fixed transmission ratio.

Due to the overlapping of grinding bowls and supporting disc, the material to be ground and the grinding balls execute movements and trajectories in the grinding bowl whose form and effect depend on the transmission ratio. Comminution is the result of a combination of friction and impact at high energy. Planetary ball mills with a fixed transmission ratio are optimised for a single grinding process only.

But with the "pulverisette 4" vario-planetary mill the rotational speeds of grinding bowls and supporting disc can be adjusted completely independently of each other. By varying the transmission ratio it is possible to control the movements and trajectories of the

# Vario-Planetary Mill "pulverisette 4"

grinding bowls and balls



grinding in an inert atmosphere with the "pulverisette 4"



"pulverisette 4" with GTM-System



## Design characteristics

- Free selectable, controlled rotation speed for grinding bowls and supporting disc
- Variable transmission ratio adjustable
- RS232 interface for programming and to transfer grinding parameters to the PC (Validation) as well as for controlling the "pulverisette 4"
- PC-programmable grinding and break times as well as grinding cycles
- Real-time display of the speeds to monitor the grinding process
- WINDOWS™ control and evaluation programme
- Reversing option
- Forced-air-ventilated grinding chamber
- High-performance drive belts for long service life
- Safety interlock of the grinding chamber with downtime monitoring
- Overload protection through adaptation to speed of rotation
- Maintenance-free drive
- Permanently lubricated bearings
- Membrane keyboard
- Connection to 3~ 400 V mains (transformer required for other mains voltages)
- Robust steel housing
- Service-friendly design

## Advantages

- Unique free selectable transmission ratio
- Programming of the grinding parameters by PC software as desired
- Emulation of various ball mills
- Variably adjustable pressure on sample (friction and/or impact)
- Final fineness < 1 µm
- Simultaneous grinding of up to 4 samples
- Quick, secure fastening of the grinding bowls "safe lock"
- Ease of cleaning
- Wide choice of accessories
- Safety standard EN 61010 and CE mark
- 2 year guarantee

## Accessories

### ■ GTM – gas pressure and temperature measuring system

This system enables the vario-planetary mill to be converted into an analytical measuring system. Continual monitoring of gas pressure and temperature enable thermal effects and physical and chemical reactions (pressure increase or decrease) to be monitored "in situ" in the grinding bowl. Without having to modify the mill itself, a grinding bowl is used with an integral radio transmitter in the lid.

A receiver transfers the data to a computer, and a WINDOWS™ programme presents the measured values in graph form. In EXCEL™, the data is presented in tabular form.

### ■ Grinding in an inert atmosphere

- Special lid – Using a special lid for the grinding bowl, material can also be ground in an inert atmosphere. The cover is fitted with an inlet and outlet valve with quick-action vent.
- Additional lock-system – If the grinding bowl should be filled in a glove box, the additional lock-system must be used for the transport of the filled grinding bowl.
- Special lid and additional lock-system can also be combined.

## ■ Grinding bowls and balls

Grinding bowls and balls are available in 9 different materials to avoid contamination of sample caused by unwanted abrasion of grinding components.

An adapter makes it possible to use grinding bowls of 12, 25 and 45 ml volume.

| Material  | Density g/cm <sup>3</sup> | Abrasion resistance | Material to be ground                       |
|---|---------------------------|---------------------|---|
| Hardmetal tungsten carbide<br>bowls: 93.5 % WC + 6 % CO<br>lids: 84.5 % WC + 15 % CO<br>balls: 93.2 % WC + 6 % CO | 14.89<br>13.97<br>14.7    | very good           | hard, abrasive sample                       |
| Tempered steel<br>bowls: 11-12 % Cr<br>balls: 1.0-1.65 % Cr   | 7.9                       | good                | hard, brittle sample                        |
| Stainless steel<br>bowls: 17-19 % Cr + 8-10 % Ni<br>balls: 12.5-14.5 % Cr + 1 % Ni                                | 7.8                       | fairly good         | medium-hard as well as brittle sample       |
| Agate<br>99.9 % SiO <sub>2</sub>  | 2.65                      | good                | soft to medium-hard sample                  |
| Silicon nitride<br>90% Si <sub>3</sub> N <sub>4</sub>   | 3.1                       | extremely good      | abrasive sample, iron-free grinding         |
| Sintered corundum<br>99.7 % Al <sub>2</sub> O <sub>3</sub>  | > 3.8                     | fairly good         | medium-hard as well as fibrous sample       |
| Sintered corundum-2<br>85-90 % Al <sub>2</sub> O <sub>3</sub>   | > 3.8                     | fairly good         | medium-hard as well as fibrous sample       |
| Zirconium oxide<br>94.8 % ZrO <sub>2</sub>  | 5.7                       | very good           | fibrous as well as abrasive sample          |
| bowls: plastics Polyamide<br>bowls: Polypropylene<br>balls: PTFE with steel core                                  | 1.0<br>0.9<br>3.0         | adequate            | soft, brittle sample and for homogenisation |

## Recommended number of balls per grinding bowl

| grinding bowl/<br>useful capacity | 12 ml<br>0.5-5 ml | 25 ml<br>1-10 ml | 45 ml<br>3-20 ml | 80 ml<br>1-30 ml | 250 ml<br>30-125 ml | 500 ml<br>80-225 ml |
|-----------------------------------|-------------------|------------------|------------------|------------------|---------------------|---------------------|
| <b>balls Ø</b>                    |                   |                  |                  |                  |                     |                     |
| 5 mm                              | 10-12             | 13-15            | 24-28            | 100-120          | 200                 | 400-500             |
| 10 mm                             | 6-8               | 10-12            | 18-20            | 30               | 50                  | 100                 |
| 12 mm                             | 4                 | 7                | 12               | 15               | 30                  | 60                  |
| 15 mm                             |                   |                  | 7                | 10               | 20                  | 40                  |
| 20 mm                             |                   |                  |                  | 5                | 15                  | 25                  |
| 30 mm                             |                   |                  |                  |                  | 6                   | 10                  |
| 40 mm                             |                   |                  |                  |                  |                     | 4                   |

## Technical data

|  |  |                         |  |
|--|--|-------------------------|--|
| Maximum feed particle size               | <= 10 mm                                       | Weight                  | net 320 kg,<br>gross 380 kg                              |
| Feed quantity                            | up to 2 x 225 ml                               | Dimensions<br>W x D x H | 60 x 80 x 110 cm   |
| Final fineness                           | < 1 µm   | Packing details         | Wooden case<br>85 x 85 x 140 cm                          |
| Electrical details                       | 400 V/3~, 50-60 Hz<br>9000 W                   | Noise development       | approx. 70 dB(A)<br>with 250 ml bowls<br>and 10 mm balls |
| Motor-shaft-power according to VDE 0530: | 4 kW supporting disc<br>1.5 kW planetary discs |                         |  |

## Ordering data

| Order no.  | Description   | For rapid fax quotation tick here! |
|------------|---|------------------------------------|
| 04.1030.00 | <b>Vario-Planetary Mill "pulverisette 4" incl. "safe lock" clamping system, without grinding bowls and balls</b><br>for 400 V/3~, 50-60 Hz, 9000 W<br><br><b>Attention: The "pulverisette 4" with voltage data „400 V/3~“ can <u>only</u> be operated on a 3-phase 400 V AC mains! Other voltages available on request!</b> |                                    |
|            | <b>Grinding bowls and grinding balls</b><br><b>Grinding bowls with lid and seal ring</b>  |                                    |
| 50.2080.00 | hardmetal tungsten carbide, 250 ml volume   |                                    |
| 50.4080.00 | hardmetal tungsten carbide, 80 ml volume  |                                    |
| 50.7080.00 | hardmetal tungsten carbide, 45 ml volume  |                                    |
| 50.6080.00 | hardmetal tungsten carbide, 25 ml volume  |                                    |
| 50.5080.00 | hardmetal tungsten carbide, 12 ml volume  |                                    |
| 50.1090.00 | tempered steel, 500 ml volume   |                                    |
| 50.2090.00 | tempered steel, 250 ml volume   |                                    |
| 50.4090.00 | tempered steel, 80 ml volume  |                                    |
| 50.7090.00 | tempered steel, 45 ml volume  |                                    |
| 50.6090.00 | tempered steel, 25 ml volume  |                                    |
| 50.5090.00 | tempered steel, 12 ml volume  |                                    |
| 50.1100.00 | stainless steel, 500 ml volume  |                                    |
| 50.2100.00 | stainless steel, 250 ml volume  |                                    |
| 50.4100.00 | stainless steel, 80 ml volume   |                                    |
| 50.7100.00 | stainless steel, 45 ml volume   |                                    |
| 50.6100.00 | stainless steel, 25 ml volume   |                                    |
| 50.5100.00 | stainless steel, 12 ml volume   |                                    |
| 50.1050.00 | agate, 500 ml volume  |                                    |
| 50.2050.00 | agate, 250 ml volume  |                                    |
| 50.4050.00 | agate, 80 ml volume   |                                    |
| 50.7050.00 | agate, 45 ml volume   |                                    |
| 50.6050.00 | agate, 25 ml volume   |                                    |
| 50.5050.00 | agate, 12 ml volume   |                                    |
| 50.1310.00 | silicon nitride, 500 ml volume  |                                    |
| 50.2310.00 | silicon nitride, 250 ml volume  |                                    |
| 50.4310.00 | silicon nitride, 80 ml volume   |                                    |
| 50.7310.00 | silicon nitride, 45 ml volume   |                                    |
| 50.6310.00 | silicon nitride, 25 ml volume   |                                    |
| 50.5310.00 | silicon nitride, 12 ml volume   |                                    |
| 50.1060.00 | sintered corundum (99.7% Al <sub>2</sub> O <sub>3</sub> ), 500 ml volume  |                                    |
| 50.2060.00 | sintered corundum (99.7% Al <sub>2</sub> O <sub>3</sub> ), 250 ml volume  |                                    |
| 50.4060.00 | sintered corundum (99.7% Al <sub>2</sub> O <sub>3</sub> ), 80 ml volume   |                                    |
| 50.7060.00 | sintered corundum (99.7% Al <sub>2</sub> O <sub>3</sub> ), 45 ml volume   |                                    |
| 50.6060.00 | sintered corundum (99.7% Al <sub>2</sub> O <sub>3</sub> ), 25 ml volume   |                                    |
| 50.5060.00 | sintered corundum (99.7% Al <sub>2</sub> O <sub>3</sub> ), 12 ml volume   |                                    |
| 50.1070.00 | sintered corundum-2 (85% Al <sub>2</sub> O <sub>3</sub> ), 500 ml volume  |                                    |
| 50.2070.00 | sintered corundum-2 (85% Al <sub>2</sub> O <sub>3</sub> ), 250 ml volume  |                                    |
| 50.1110.00 | zirconium oxide, 500 ml volume  |                                    |
| 50.2110.00 | zirconium oxide, 250 ml volume  |                                    |
| 50.4110.00 | zirconium oxide, 80 ml volume   |                                    |
| 50.7110.00 | zirconium oxide, 45 ml volume   |                                    |
| 50.6110.00 | zirconium oxide, 25 ml volume   |                                    |
| 50.5110.00 | zirconium oxide, 12 ml volume   |                                    |
| 50.1200.00 | plastics polyamide, 500 ml volume   |                                    |
| 50.2200.00 | plastics polyamide, 250 ml volume   |                                    |
| 50.4200.00 | plastics polyamide, 80 ml volume  |                                    |
| 50.7200.00 | polypropylene (disposable bowl), 45 ml volume   |                                    |
| 07.3280.13 | bowl adapter (for disposable bowl)  |                                    |
| 90.1120.09 | adapter grinding bowl (for all 12-80 ml bowls)  |                                    |
|            | <b>Replacement seal rings PTFE</b>  |                                    |
| 50.1230.20 | 116/110 mm dia. = for all bowls (except silicon nitride) of 500 ml volume   |                                    |
| 50.1010.20 | 110/101 mm dia. = for all silicon nitride bowls of 500 ml volume  |                                    |
| 50.2230.20 | 90/75 mm dia. = for all bowls (except silicon nitride) of 250 ml volume   |                                    |
| 50.2010.20 | 85/76 mm dia. = for silicon nitride bowls of 250 ml volume  |                                    |
| 50.4230.20 | 80/66 mm dia. = for all bowls of 80 ml volume   |                                    |
| 50.7250.20 | 50/40 mm dia. = for all bowls of 45 ml volume   |                                    |
| 50.6250.20 | 47/32 mm dia. = for all bowls of 25 ml volume   |                                    |
| 50.5250.20 | 37/26 mm dia. = for all bowls of 12 ml volume   |                                    |

## Ordering data

| Order no.  | Description   | For rapid fax quotation tick here! |
|------------|---|------------------------------------|
|            | <b>Grinding balls</b>   |                                    |
| 55.0400.08 | hardmetal tungsten carbide, 40 mm dia.  |                                    |
| 55.0300.08 | hardmetal tungsten carbide, 30 mm dia.  |                                    |
| 55.0200.08 | hardmetal tungsten carbide, 20 mm dia.  |                                    |
| 55.0150.08 | hardmetal tungsten carbide, 15 mm dia.  |                                    |
| 55.0120.08 | hardmetal tungsten carbide, 12 mm dia.  |                                    |
| 55.0100.08 | hardmetal tungsten carbide, 10 mm dia.  |                                    |
| 55.0050.08 | hardmetal tungsten carbide, 5 mm dia.   |                                    |
| 55.0400.09 | tempered steel, 40 mm dia.  |                                    |
| 55.0300.09 | tempered steel, 30 mm dia.  |                                    |
| 55.0200.09 | tempered steel, 20 mm dia.  |                                    |
| 55.0150.09 | tempered steel, 15 mm dia.  |                                    |
| 55.0120.09 | tempered steel, 12 mm dia.  |                                    |
| 55.0100.09 | tempered steel, 10 mm dia.  |                                    |
| 55.0050.09 | tempered steel, 5 mm dia.   |                                    |
| 55.0400.10 | stainless steel, 40 mm dia.   |                                    |
| 55.0300.10 | stainless steel, 30 mm dia.   |                                    |
| 55.0200.10 | stainless steel, 20 mm dia.   |                                    |
| 55.0150.10 | stainless steel, 15 mm dia.   |                                    |
| 55.0120.10 | stainless steel, 12 mm dia.   |                                    |
| 55.0100.10 | stainless steel, 10 mm dia.   |                                    |
| 55.0050.10 | stainless steel, 5 mm dia.  |                                    |
| 55.0300.05 | agate, 30 mm dia., polished   |                                    |
| 55.0200.05 | agate, 20 mm dia., polished   |                                    |
| 55.0150.05 | agate, 15 mm dia., polished   |                                    |
| 55.0120.05 | agate, 12 mm dia., polished   |                                    |
| 55.0100.05 | agate, 10 mm dia., polished   |                                    |
| 55.0400.31 | silicon nitride, 40 mm dia.   |                                    |
| 55.0300.31 | silicon nitride, 30 mm dia.   |                                    |
| 55.0200.31 | silicon nitride, 20 mm dia.   |                                    |
| 55.0150.31 | silicon nitride, 15 mm dia.   |                                    |
| 55.0120.31 | silicon nitride, 12 mm dia.   |                                    |
| 55.0100.31 | silicon nitride, 10 mm dia.   |                                    |
| 55.0400.06 | sintered corundum (99.7% Al <sub>2</sub> O <sub>3</sub> ), 40 mm dia.   |                                    |
| 55.0300.06 | sintered corundum (99.7% Al <sub>2</sub> O <sub>3</sub> ), 30 mm dia.   |                                    |
| 55.0200.06 | sintered corundum (99.7% Al <sub>2</sub> O <sub>3</sub> ), 20 mm dia.   |                                    |
| 55.0150.06 | sintered corundum (99.7% Al <sub>2</sub> O <sub>3</sub> ), 15 mm dia.   |                                    |
| 55.0120.06 | sintered corundum (99.7% Al <sub>2</sub> O <sub>3</sub> ), 12 mm dia.   |                                    |
| 55.0100.06 | sintered corundum (99.7% Al <sub>2</sub> O <sub>3</sub> ), 10 mm dia.   |                                    |
| 55.0400.27 | zirconium oxide, 40 mm dia.   |                                    |
| 55.0300.27 | zirconium oxide, 30 mm dia.   |                                    |
| 55.0200.27 | zirconium oxide, 20 mm dia.   |                                    |
| 55.0150.27 | zirconium oxide, 15 mm dia.   |                                    |
| 55.0120.27 | zirconium oxide, 12 mm dia.   |                                    |
| 55.0100.27 | zirconium oxide, 10 mm dia.   |                                    |
| 55.0300.20 | PTFE with steel core, 30 mm dia.  |                                    |
| 55.0150.20 | PTFE with steel core, 15 mm dia.  |                                    |
| 55.0120.20 | PTFE with steel core, 12 mm dia.  |                                    |
| 55.0100.20 | PTFE with steel core, 10 mm dia.  |                                    |
|            | <b>Accessories for grinding in an inert atmosphere and for mechanical alloying lid with 2 valves and seal ring</b>  |                                    |
| 50.8600.00 | hardmetal tungsten carbide, 250 ml volume   |                                    |
| 50.8400.00 | tempered steel, 500 ml volume   |                                    |
| 50.8500.00 | tempered steel, 250 ml volume   |                                    |
| 50.8700.00 | tempered steel, 80 ml volume  |                                    |
| 50.8200.00 | stainless steel, 500 ml volume  |                                    |
| 50.8300.00 | stainless steel, 250 ml volume  |                                    |
| 50.8800.00 | stainless steel, 80 ml volume   |                                    |
| 50.8000.00 | agate, 500 ml volume  |                                    |
| 50.8100.00 | agate, 250 ml volume  |                                    |
| 90.1400.00 | additional lock-system (for the transport of the closed grinding bowl)  |                                    |
|            | <b>Replacement seal ring made of Viton for lid with 2 valves</b>  |                                    |
| 50.1230.16 | for all bowls 500 ml volume   |                                    |
| 50.2230.16 | for all bowls 250 ml volume   |                                    |
| 50.4230.16 | for all bowls 80 ml volume  |                                    |
|            | <b>Accessories for "in situ" determination of grinding parameters Gas pressure and temperature measuring system (GTM)</b><br>Detailed brochure available on request |                                    |