

# Powder rheology

## MCR Evolution



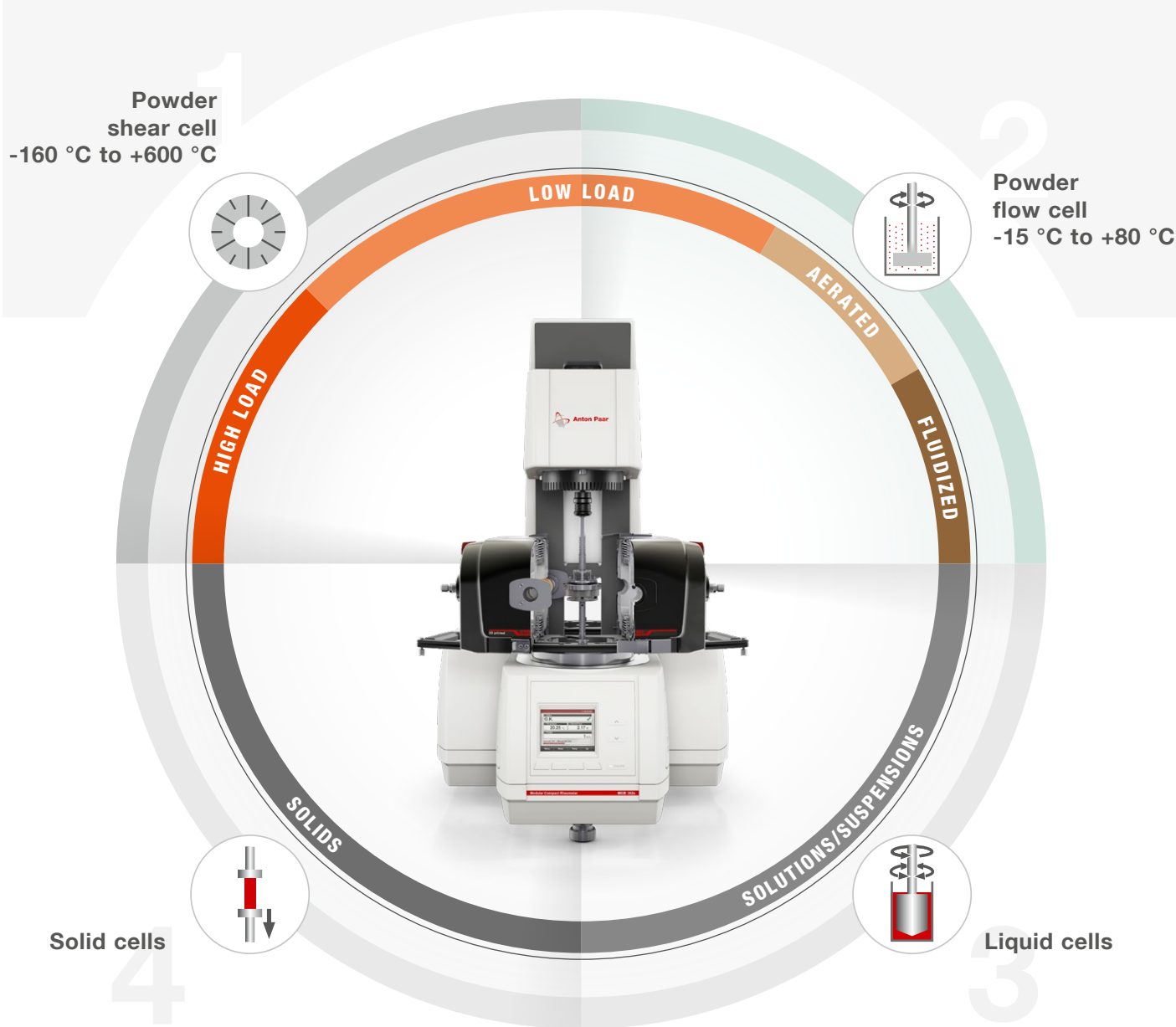
# The only high-precision system for powder characterization

Working with powder and granular media can be challenging, particularly when it comes to processing and storage. A wide range of factors influence powders, for example particle shape, particle size and size distribution, chemical structure, humidity, and temperature. As a result, powders – as mixtures of solids, liquids, and gases – are complex.

To ensure efficient quality control and smooth powder processing, the powder behavior can be characterized under realistic conditions, simulating the manufacturing process. True powder rheology with the renowned MCR Evolution rheometers gathers important information for the adjustment and optimization of manufacturing processes.

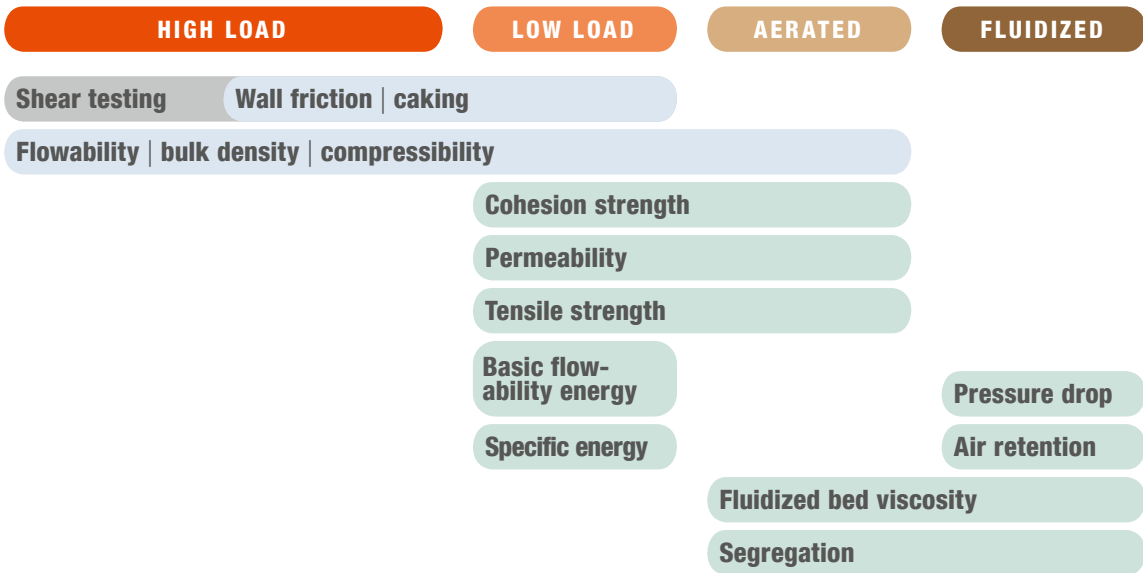
An MCR Evolution rheometer combined with the **powder shear cell** and the **powder flow cell** gives you all the possibilities you need for comprehensive powder characterization. This unique system guarantees the determination of powder behavior with the highest sensitivity and delivers the best results. With the world's most versatile modular rheometer platform, you can measure your powders, liquids, suspensions, and solids.

With the intuitive user interface of the RheoCompass software, you can run fully automated measurements with only a few clicks while maintaining complete autonomy over all measurement parameters. It supports “managed lab” with multiple clients and features a central database as well as ERP connectivity. RheoCompass (compatible with Windows 10 or higher) even complies with QM requirements, for example, GLP and GMP or 21 CFR Part 11 for the pharmaceutical industry.



At Anton Paar, we take powder rheology seriously and follow a scientific approach to provide you with the tools you need to understand your powders. With your applications in mind, our devices are designed to deliver reliable and reproducible results. A wide range of methods help you characterize your powders under any conditions exactly reflecting your applications.

## True powder rheology methods



# Powder flow cell – features

## True powder rheology

True powder rheology helps you really characterize and understand your powders. A wide range of dedicated powder measurement methods are available using the advantages of rheometers, for example, rotational and oscillating measurements, or even shear-rate- and air-flow-dependent tests. The automated methods are fast and easy to perform but also include elaborate techniques for both quality control and scientific purposes.

## Patented dust protection system

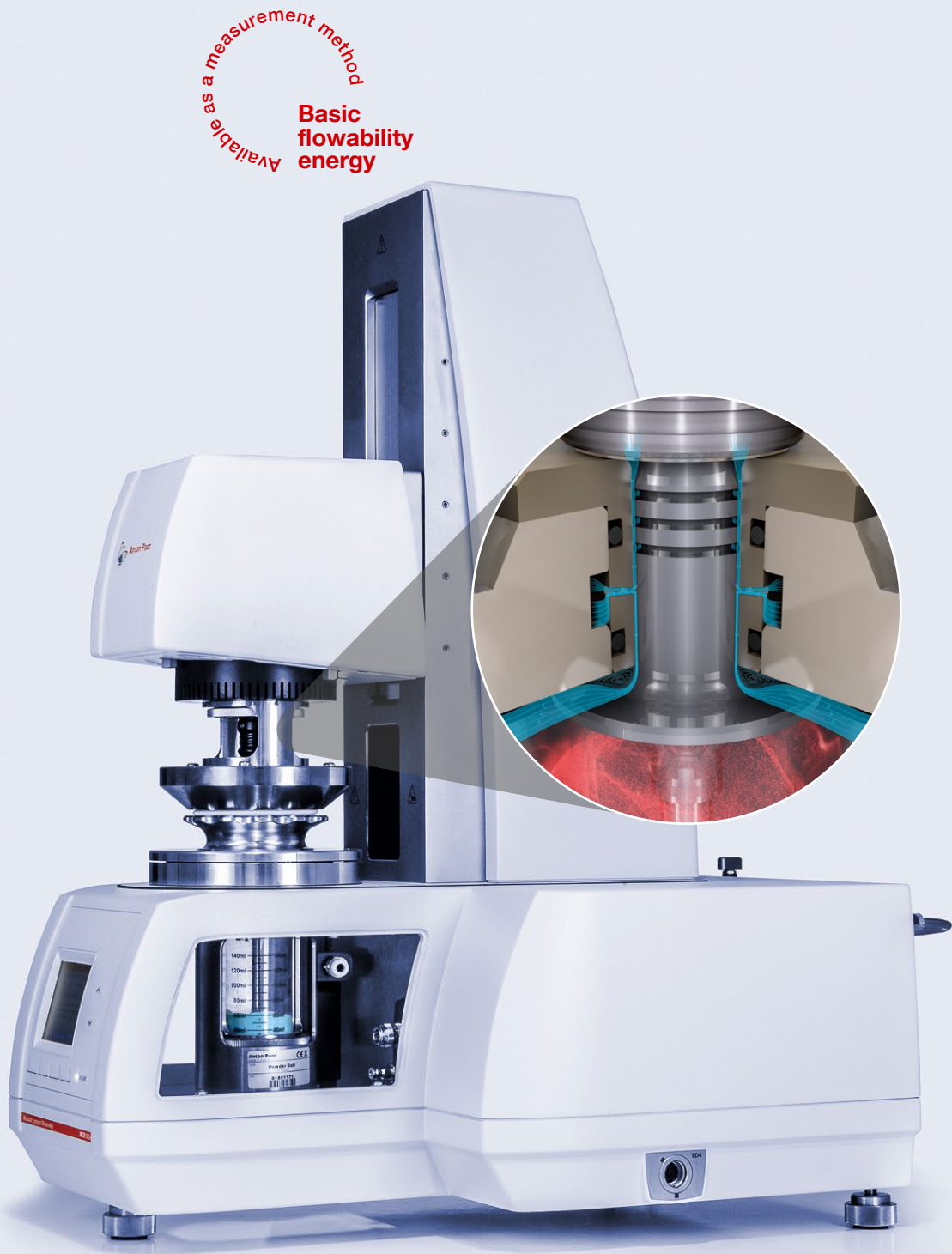
Clean and safe handling of your samples is ensured with the patented (EP 3067684) dust protection hood. It safeguards you and the instrument from fine and potentially hazardous powder even when it is fully fluidized. The system relies on a fourfold shaft sealing concept combining an air seal with geometric barriers, making the powder flow cell one hundred percent dustproof while retaining the MCR Evolution rheometer's extraordinary accuracy and resolution down to 10 nNm and below.

## Reliable results with powder preparation modes

Anton Paar combines the extremely high sensitivity of the air-bearing rheometers with automated sample preparation modes for unrivaled reproducibility of up to  $\pm 0.5$  %. The sensitivity helps you differentiate even very similar powders and detect even small changes within your samples.

## Perfect control and optimization

- Save costs by understanding your powders:
- Reduce inefficiencies or even lost batches during production by controlling and optimizing the processing/ manufacturing parameters.
  - Keep the run time of your plant up, the throughput at optimal rates, and reduce energy costs during processing.
  - Increase the quality of your products and reduce waste by analyzing quality aspects.



## Specifications – powder flow cell

Sample volume	60 mL to 120 mL
Torque range	10 nNm to 300 mNm (device-dependent)
Normal stress range	Up to 22 kPa
Dust protection hood	- $d \geq 5 \mu\text{m}$ : 100 % dustproof - $5 \mu\text{m} \geq d > 1 \mu\text{m}$ : 90 % to 95 % dustproof
Fluidization options	- Scientific option: choice of 3 mass flow controllers for volumetric flow from 0.05 L/min up to 80 L/min, with pressure sensor - Quality control option: proportional valve
Temperature option	Customizable on request
Humidity option	Customizable on request
Measurement systems	- Two-blade stirrer - Helical two-blade stirrer - Warren-Springs geometry - Powder Preparation Set with exchangeable disks (stainless steel, air-permeable, PTFE, further materials on request) - Cylinder - Profiled cylinder
Accessories	- Uncoated glass / FTO-coated glass / steel measuring tube - HD webcam
Compatibility	MCR xx1 series, MCR xx2 series and MCR xx2 Evolution

*\*Basic instrument specification on last page.*



# Powder flow cell – setup

## Customizable to your application and needs



Measuring systems designed for your specific application and measurement



Non-coated glass, stainless steel and FTO-coated glass measuring tubes for good visibility, hard particles, and even reduced electrostatic charging

### With this setup you can characterize powders with various methods:

- Basic flowability energy, specific energy
- Cohesion strength in aerated state and under consolidation
- Caking or time-dependent behavior
- Compressibility and bulk density
- Tensile strength
- Wall friction and adhesion
- Pressure drop
- Permeability
- Air retention
- Fluidized bed viscosity
- Segregation

# Powder flow cell – applications

## Measure any application with true powder rheology

Due to its high versatility, the powder flow cell can be used for in-depth powder characterization or as an easy-to-use quality control tool: You can use it to control the quality of your products with quick tests while benefitting from the precision of Anton Paar's MCR Evolution rheometers. Use one of the many measurement methods to characterize your powder as it is during processing, handling, and storage.

## Applications

- Quality control
- Filling and dosing – discharge processes
- Tableting, packaging, and compacting
- Spray drying, wet granulation, and coating
- Mixing and blending
- Conveying (pneumatic, vacuum, chute, screw, and belt)
- Fluidized bed reactors
- Attrition investigations
- Raking, doctor blading
- Impact of flow additives
- Influence of humidity

## Typical industries

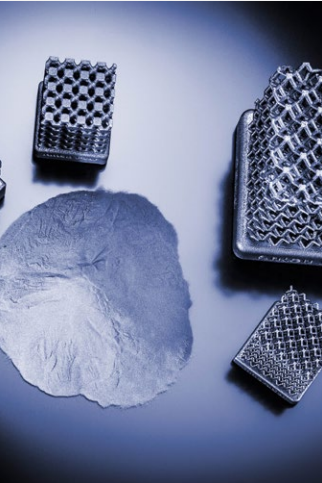
Chemical, polymer industry



Food



Paints and coatings



Additive manufacturing

## Specifications MCR Evolution rheometer

Bearing	Air
EC motor	✓
Rotation mode	✓
Oscillation mode	✓
Toolmaster™	✓
QuickConnect for measuring systems	✓
Virtually gradient-free (horizontal, vertical) temperature control	✓
T-Ready™	○
TruRate™	○
TruStrain™	○

## RheoCompass software

Test designer	✓
Report designer	✓
Managed lab, multiple clients, and server	○
Fully automatic temperature calibration	✓
○ optional	✓ included

# Powder shear cell – features

## The only system with temperature and humidity control

The powder shear cell is designed to be combined with a temperature device that can be connected to a humidity generator so you can find out how temperature (-160 °C to +600 °C) and humidity (5 %rH to 95 %rH) impact your powders during storage, handling, and processing.

## Absolute reproducibility – even for small sample volumes

An MCR Evolution rheometer, together with the powder shear cell, lets you run powder shear tests with impeccable precision and sensitivity, even if you measure small amounts down to 4.3 mL. The included sample preparation bench ensures that the samples are always prepared identically, strongly reducing operator influence and thereby increasing reproducibility. The sample preparation bench can also be used for time consolidation tests, so you know how powder behavior will change over time – without blocking your device for other measurements.

## Powerful software for incomparable control

With the intuitive user interface, you can run fully automated measurements with only two clicks while maintaining full autonomy over all measurement parameters. You can adapt all measurements to your needs. The software also features an automatic analysis of all shear cell measurement parameters such as flow function ( $ff_0$ ) and angle of internal friction.

## Designed to increase efficiency and boost your business

- Reduce costs and waste:
- Increased efficiency by avoiding dosing and discharge issues.
  - Ideal use of equipment with processing parameters optimized for your powder according to its behavior.
  - Optimal quality control and maximized efficiency by characterizing your powders at regular intervals.



## Specifications – powder shear cell

Sample volume	4.3 mL and 18.9 mL
Torque range	0.5 nNm to 300 mNm (device-dependent)
Normal stress range	- Shearing: Up to 30 kPa - Compacting: Up to 110 kPa (sample- and cell-dependent)
Temperature options	- From -20 °C to +180 °C with CTD 180 HR - From -160 °C to +600 °C with CTD 600 MDR - Customized up to 1000 °C
Humidity option	- 5 %rH to 95 %rH  from 5 °C to 120 °C with CTD 180 HR and humidity option
Measurement systems	Included in the setup:  - Small shear system (4.3 mL) - Large shear system (18.9 mL) - Wall friction system with exchangeable disks (stainless steel, aluminum, PTFE, further materials on request)
Accessories	Included in the setup:  - Sample preparation / time consolidation bench - Weight base for small and large shear cell - Weights for small and large shear cell (up to 12 kPa in 1 kPa steps)
Compatibility	MCR xx2 series and MCR xx2 Evolution

*\*Basic instrument specification on last page.*



# Powder shear cell – setup

## Complete setup for all your shear measurements



**Large shear cell** with a volume of 18.9 mL for larger particles



**Small shear cell** with a volume of 4.3 mL for small particles, valuable samples, and high normal loads up to 30 kPa



**Wall friction measuring system** with easily exchangeable disks



**High-tech measuring shaft** with integrated temperature sensor for the most accurate temperature control



**Sample preparation bench** for consistent sample preparation with reduced operator influence



**Bench and weights** for the small and large shear cell for time consolidation without blocking your device

## Accessories to apply temperature and humidity:

### CTD 180 HR

Peltier-based convection temperature control (from -20 °C to +180 °C) with optional humidity control

### Humidity option

The humidity option for CTD 180 HR uses a humidity generator to control the relative humidity in the temperature device up to 95 % depending on the actual temperature

### CTD 600 MDR

State-of-the-art temperature control (from -160 °C to +600 °C) based on combined convection and radiation

# Powder shear cell – applications

## Reliable shear cell measurements for your application

With its focus on performance and measurement efficiency, this ring shear cell is the perfect tool for powder analysis. Anton Paar's MCR Evolution rheometers can be equipped with heating and humidity options. By precisely controlling the ambient conditions, you can find out for your specific application how temperature and humidity impact the behavior of your powder.

## Applications

- Silo design
- Flow behavior (e.g., ffc)
- Time consolidation behavior (caking)
- Wall friction
- Bulk density

## Typical industries

### Pharmaceutical



### Chemical, paints, and coatings



### Building materials



### Food

## Standards

- ASTM D6773
- DIN 1055
- USP 1174
- Ph.Eur.2.9.49.

