Anton Paar

# 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.

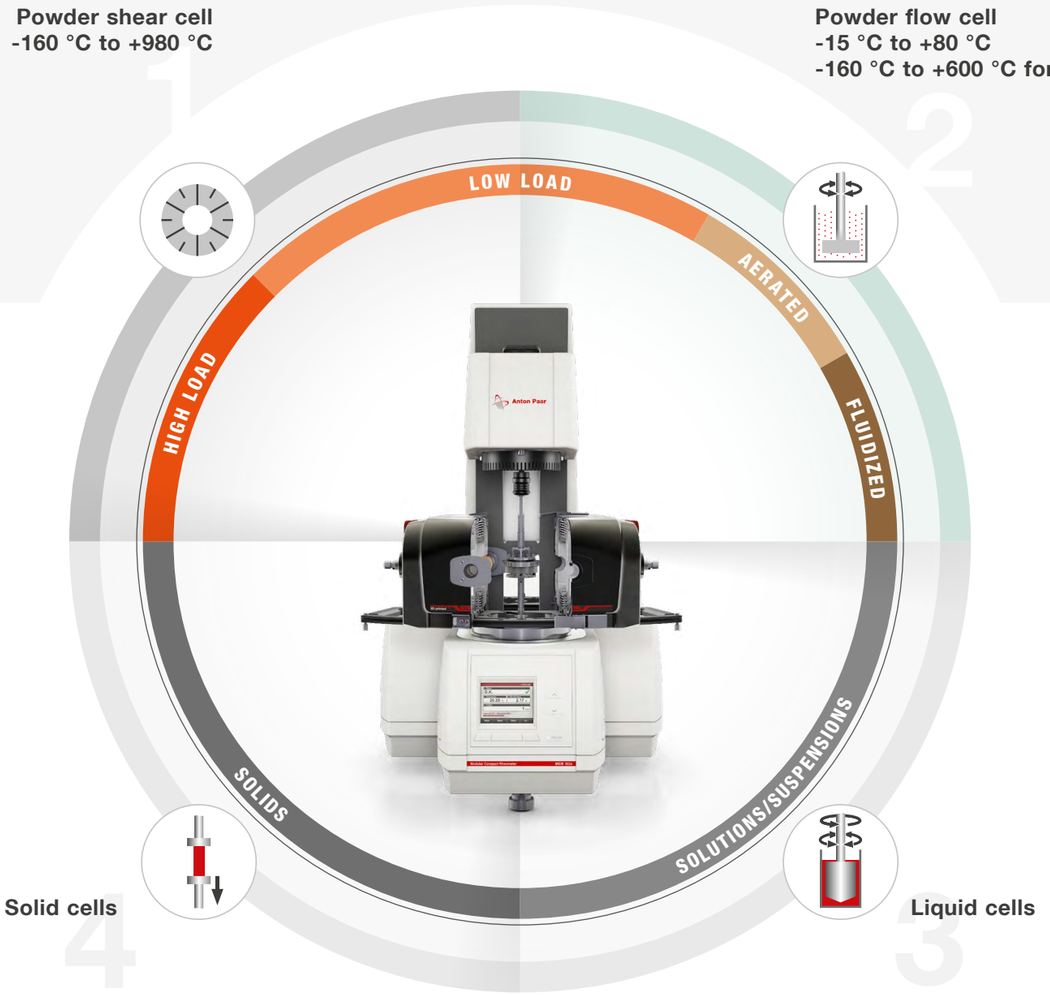
To ensure efficient quality control and smooth powder processing, the powder behavior can be characterized under realistic conditions, simulating the manufacturing process using true powder rheology with the MCR Evolution rheometer.

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 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.

**Powder shear cell**
**-160 °C to +980 °C**

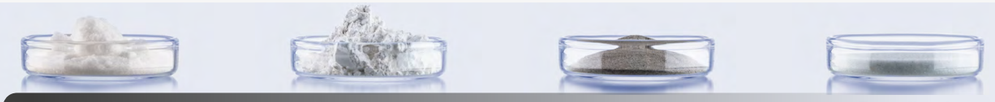
**Powder flow cell**
**-15 °C to +80 °C**
**-160 °C to +600 °C for BFE**




Solid cells

Liquid cells

## General area of application




**IDEAL: Powder shear cell**

**Powder flow cell (possible*)**

**IDEAL: Powder flow cell**

**Powder shear cell (possible*)**

* Adaptions of standard templates required or limited tests with measuring cell possible

## True powder rheology methods

| HIGH LOAD | LOW LOAD | AERATED | FLUIDIZED |
|---|---|---|---|
| Shear testing | Wall friction \| caking | | |
| Flowability \| bulk density \| compressibility | | | |
| | Envelope density | Cohesion strength | |
| | | Permeability | |
| | | Tensile strength | |
| | | Basic flowability energy* | Pressure drop |
| | | Specific energy* | Air retention |
| | | | Fluidized bed viscosity |
| | | | Segregation |

Powder shear cell

Powder shear and flow cell

Powder flow cell 20 and 30

Powder flow cell 30

* Powder flow cell 10 also possible

# Powder flow cell – features

## From powder to solid – True Powder Rheology and Envelope Density with just one measuring cell

True powder rheology helps you really characterize and understand your powders. A wide range of dedicated powder measurement methods are available using the capabilities of rheometers, for example, rotational and oscillating measurements, or even shear-rate- and air-flow-dependent tests.

## Patented dust protection system

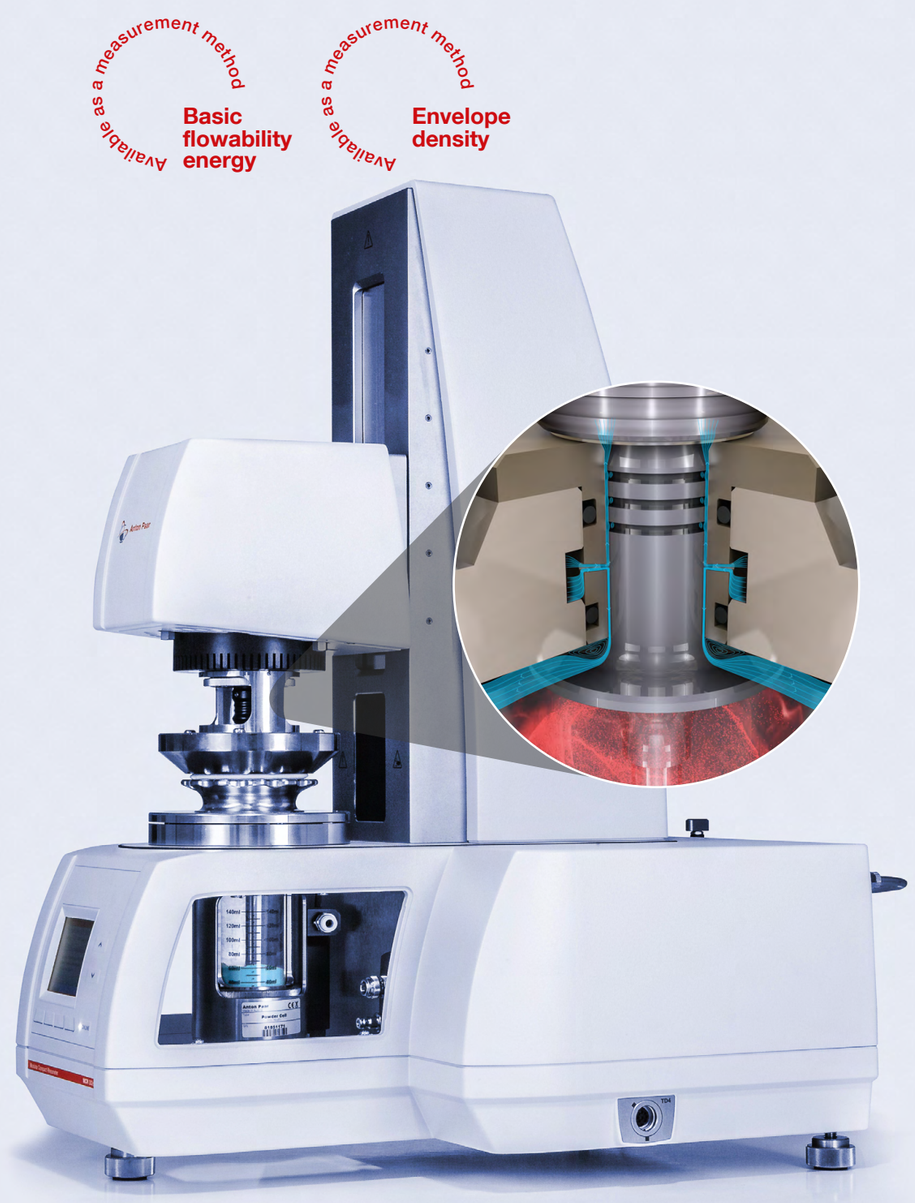
Clean and safe handling of your samples is ensured with the patented (EP 3067684) dust protection hood. It safeguards you and the instrument from fine and potentially hazardous powder, even when it is fully fluidized. The system relies on a fourfold shaft sealing concept combining an air seal with geometric 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 ±0.5 %. The sensitivity helps you differentiate even very similar powders and detect even small changes within your samples.

## More than just powder rheology

Save costs by understanding your powders:
- Get an Anton Paar MCR Evolution rheometer and unlock countless applications such as classical rheology, DMA, Tribology and mechanical testing
- Use the powder flow cell to measure envelope density




## Specifications – powder flow cell

| | PFC 30 ↓ | PFC 20 ↓ | PFC 10 ↓ |
|---|---|---|---|
| **Sample volume** | 60 mL to 120 mL | | 21 mL |
| **Torque range** | 10 nNm to 300 mNm | | |
| **Normal stress** | 22 kPa | | - |
| **Temperature option** | -15 °C to +80 °C | -15 °C to +80 °C (possible with upgrade kit) | -160 °C to +600 °C |
| **Humidity option** | Customizable on request | | 5 %rH to 95 %rH from 5 °C to 120 °C with CTD 180HR and humidity option |
| **Meaurement systems compatible** | - Two-blade stirrer<br>- Helical two-blade stirrer<br>- Warren-Springs geometry<br>- Powder Preparation Set with exchangeable disks (stainless steel, air-permeable, PTFE, further materials on request)<br>- Cylinder and profiled cylinder | | - Helical two-blade stirrer for PFC 10 (further stirrers on request); not compatible with PFC 20 and PFC 30 stirrers |
| **Meaurement method** | For fluidized, aerated and low-load conditions | For non-fluidized, aerated and low-load conditions | For non-fluidized, aerated conditions (BFE and SE) |
| **Dust protection** | incl. | Upgrade kit available | - |
| **Fluidization option** | Choice of 3 mass flow controllers for volumetric flow from 0.05 L/min up to 80 L/min | | - |
| **Accessories** | ø 50 mm PFC with uncoated glass tube<br>Optional: FTO-coated glass/steel tube | | ø 24 mm PFC made of stainless-steel<br>Optional: Measuring cup made of Inconel or disposable cup |
| **Compatibility** | MCR xx2 series and MCR xx2 Evolution | MCR xx1, MCR xx2 and MCR xx2 Evolution | MCR xx2 series and MCR xx2 Evolution |

# Powder flow cell – setup

## Customizable to your application and needs

**Measuring systems** designed for your specific application and measurement

**PFC 10** for basic flowability energy measurements at elevated temperatures

## Envelope density

Simple and safe measurement method for characterising the bulk density of solids in the range of 0.3 $cm^3$ to 25 $cm^3$ sample size by using a reusable, free-flowing displacement powder. Precise volume measurement with a repeatability of up to 1 % is ensured at a sample quantity of at least 25 % of the total filling volume.
In combination with gas pycnometry measurements, which quantifies the absolute density, the porosity and the specific pore volume of solid materials can be determined.

# Powder flow cell – applications

## Measure any application with true powder rheology

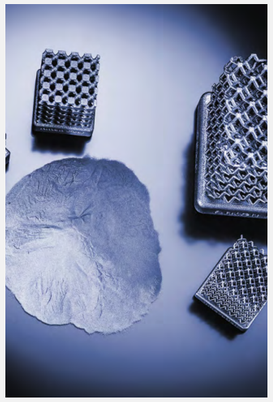
Due to its high versatility, the powder flow cell can be used for in-depth powder characterization or as an easy-to-use quality control tool. You can use it to control the quality of your products with quick tests while benefitting from the precision of Anton Paar's MCR Evolution rheometers. Use one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

## Typical industries

Chemical, polymer

Food

Paints and coatings



Additive manufacturing

## Applications

- Filling and dosing – discharge processes
- Tableting, packaging, and compacting
- Spray drying, wet granulation, and coating
- Mixing and blending
- Conveying
- Fluidized bed reactors
- Attrition investigations
- Raking, doctor blading
- Impact of flow additives
- Influence of humidity
- Envelope density determination of solids

## Standards

- DIN-EN-ISO 8130-15:2024-01 (Powder Coatings)

## 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 | ○ |
| 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 +980 °C) and humidity (5 %rH to 95 %rH) impact your powders during storage, handling, and processing. The ring shear cell design allows for high precision with uniform shear conditions.

## 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 identically prepared, greatly 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 ($ff_c$) 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<br>- Compacting: Up to 110 kPa (sample- and cell-dependent) |
| **Temperature options** | - From -20 °C to +180 °C with CTD 180 HR<br>- From -150 °C to +450 °C with CTD 450<br>- From -160 °C to +600 °C with CTD 600 MDR<br>- Customized up to 980 °C |
| **Humidity option** | - 5 %rH to 95 %rH<br>from 5 °C to 120 °C with CTD 180 HR and humidity option |
| **Measurement systems** | Included in the setup:<br>- Small shear system (4.3 mL)<br>- Large shear system (18.9 mL)<br>- Wall friction system with exchangeable disks (stainless steel, aluminum, PTFE, further materials on request)<br>Additional option for high temperature applications:<br>- Small shear system and lower shaft made of Inconel (shear geometry and compression geometry)<br>- Compression/wall friction system |
| **Accessories** | Included in the setup:<br>- Sample preparation / time consolidation bench<br>- Weight base for small and large shear cell<br>- Weights for small and large shear cell (up to 12 kPa in 1 kPa steps) |
| **Compatibility** | MCR xx2 series and MCR xx2 Evolution |

# 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

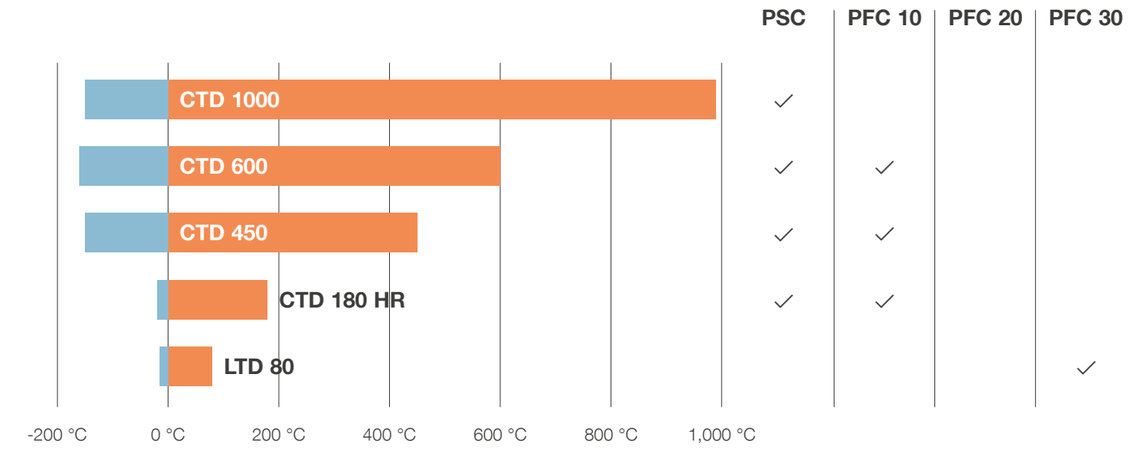
**Wall friction measuring system** with easily exchangeable disks

**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 for PSC and PFC:



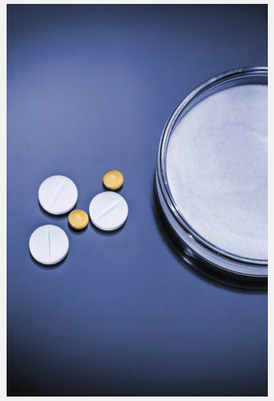

# Powder shear cell – applications

## Reliable shear cell measurements for your application

With its focus on performance, precision and measurement efficiency, this ring shear cell is the perfect tool for powder analysis. The ring shear design ensures consistent shearing conditions throughout the powder bed. 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.

## Typical industries

Pharmaceutical



Chemical, paints, and coatings

Building materials

Food

## Applications

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

## Standards

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

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