MICROTRAC MRB

PARTICLE CHARACTERIZATION

- LASER DIFFRACTION & DYNAMIC LIGHT SCATTERING
- DYNAMIC & STATIC IMAGE ANALYSIS
- SURFACE & POROSITY ANALYSIS

A NEW LEADER IN PARTICLE CHARACTERIZATION

part of VERDER scientific

1974
Microtrac launches the first commercial laser diffraction analyzer, Microtrac Model 7991.

1987
Rollout of the high-precision gas adsorption instrument BELSORP 28 by MicrotracBEL.

1998
Retsch Technology develops the CAMSIZER and its patented dual camera system.

2003
Premiere of the catalysis investigation system BELCAT by MicrotracBEL.

2007
Debut of Microtrac's BLUEWAVE laser diffractor that uses real blue lasers for highest resolution and sensitivity.

2011
Introduction of CAMSIZER XT with optional modules for wet and dry measurement.

2013
MicrotracBEL introduces the multi-sample BET surface area measurement system, BELSORP MR6.

2018
Launch of the Microtrac SYNC: laser diffraction and dynamic image analysis combined in one instrument.

2019
Retsch Technology launches the static image analyzer CAMSIZER M1. MicrotracBEL releases the AEROTRAC II laser diffraction system for droplets.

2020
Merging of Retsch Technology, Microtrac & MicrotracBEL into Microtrac MRB under the umbrella of Verder Scientific.

Three Technologies – Three Centers of Excellence

MICROTRAC MRB: GOING FORWARD AS ONE SOLUTION PROVIDER

Microtrac MRB is your superior partner for the characterization of disperse systems. We provide our customers with advanced technologies to obtain consistently reliable results. Innovations and quality form the basis of our success.

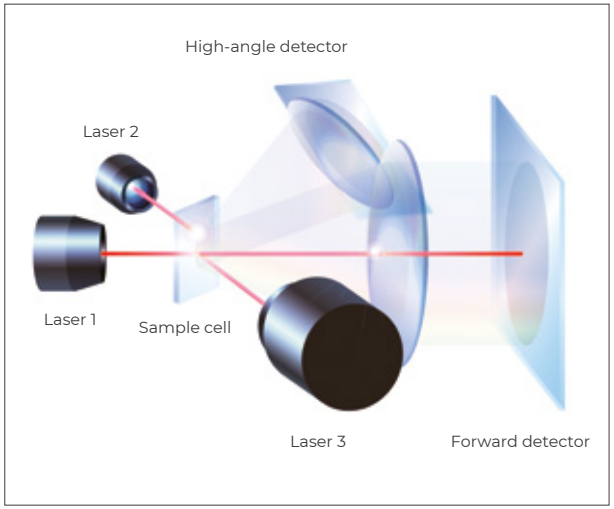
Microtrac MRB offers three product lines with competence centers on three continents.

Scattered light analysis: Microtrac MRB is a leading supplier of laser diffraction systems (static light scattering), a versatile method for particle size determination. The portfolio also includes dynamic light scattering instruments perfectly suited for the characterization of nano particles. The development and production site for this product line is located in Pennsylvania, USA.

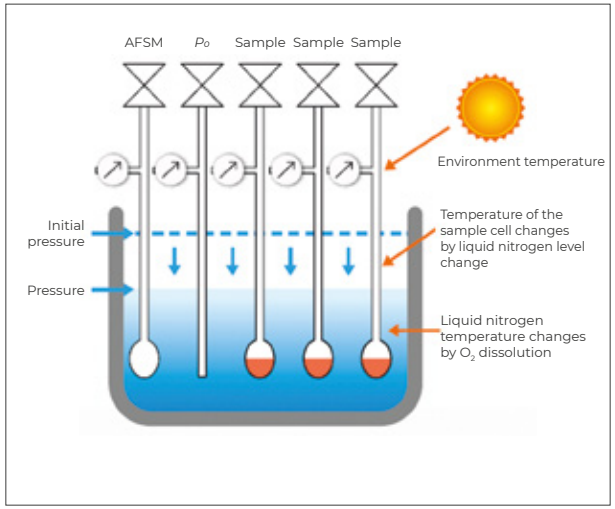
Image analysis: With the CAMSIZER series Microtrac MRB provides high-quality systems for the determination of particle size and particle shape based on imaging techniques. These image analyzers are developed and manufactured in our competence center in Haan, Germany.

Surface and porosity measurement: Another Microtrac MRB product line includes analyzers that determine specific surface area, BET value and porosity of powders by utilizing gas adsorption. Development, production and distribution are carried out by the competence center for surface analysis in Osaka, Japan.

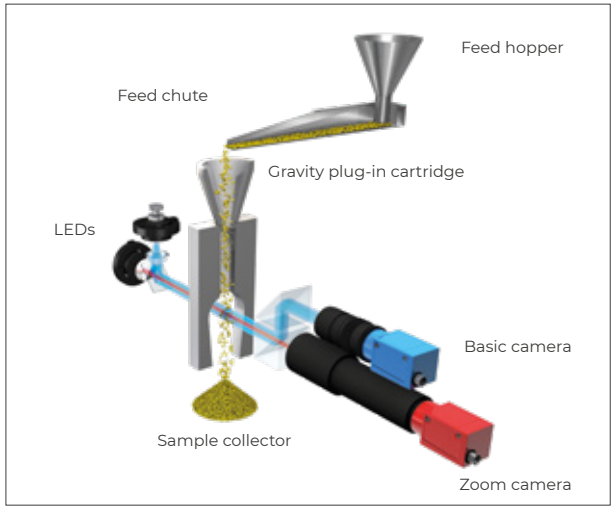
As part of the Verder Scientific group we offer worldwide support through a network of subsidiaries and distributors.



With Microtrac MRB's Tri-Laser technology, the scattered light is measured at different angles.



Porosity measurement based on the unique ASFM™ methods for ultimate reproducibility and precision.



Dynamic image analysis of particle size and particle shape based on the unique dual camera system.

PARTICLE SIZE & SHAPE ANALYSIS

Laser Diffraction

LASER DIFFRACTION (LD) has become the most widely used technique among both suppliers and users of particulate systems in research and industry. It is now a standard for outgoing and incoming particle size quality control, providing the equivalent spherical diameter (ESD) in volume % over a typical range from 10 nanometers to 2-3 millimeters.

In a laser diffraction measurement, a laser beam is passed through a well-dispersed sample. The particle size is measured by detecting the intensity of the scattered light. Small particles scatter light at large angles, while large particles scatter light at small angles relative to the laser beam. With Microtrac MRB's unique Tri-Laser technology, the scattered light can be measured at various angles up to 163 degrees and with up to 151 channels.

All data is collected continuously throughout the measurement, is then analyzed and put through an algorithm using Microtrac MRB's innovative modified Mie scattering theory. The results are accurate particle size distributions for both spherical and non-spherical particles.

0.01 µm – 4 mm

SYNC

- laser diffraction & dynamic image analysis combined in one analyzer
- synchronous size and shape analysis from 0.01 to 4,000 µm
- dispersion modules enable fast switch between wet & dry measurements
- easy-to-use operating software
- advanced design for optimized sample dispersion

0.01 µm – 2 mm

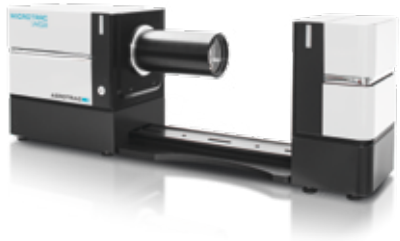
FLOWSYNC

- wet dispersion unit
- compatible with organic and inorganic samples
- integrated ultrasonic probe
- self-cleaning mechanism

0.2 µm – 4 mm

TURBOSYNC

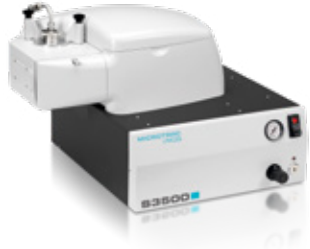
- dry dispersion unit
- sample volumes as small as 0.1 cc
- consistent control of aspiration
- measurement time of 10 seconds with TURBOSYNC autoscan



0.5 µm – 2 mm

AEROTRAC II

- analyzer for droplets, spray particles, powder, mist, etc.
- accurate particle analyses at short intervals (0.02 ~ 500 msec)
- equipped with a semi-conductor laser
- different measurement modes to support various applications
- including multiple scattered light correction software as a standard



0.02 µm – 2.8 mm

S3500

- multi-detector system with 3 red lasers
- fixed detectors and lasers
- enclosed optical path ensures protection of optical components

measurement range *for dry samples* *for wet samples* *add-on for existing instrument*

PARTICLE SIZE & SHAPE ANALYSIS

Dynamic Light Scattering & Zeta Potential

0.3 nm – 10 µm

NANOTRAC FLEX

- external “dip-in” probe with 180° backscatter
- allows for turning any vessel into a sample cell
- small volume, as little as one drop of liquid
- universal solvent compatibility
- molecular weight determination

STABINO ZETA

- Zeta and streaming potential in one measurement
- Up to 5 measurement points simultaneously
- Measurement range from 0.3 nm up to 300 µm
- High concentration from 0.01 to 40 vol%
- can be combined with NANOTRAC FLEX for particle size analyses

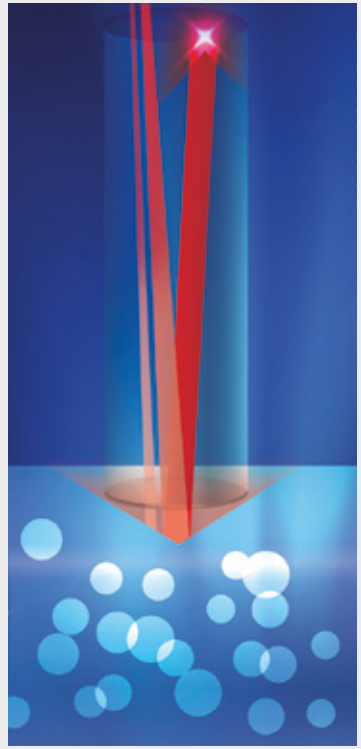
0.8 nm – 6.5 µm

NANOTRAC WAVE II

- particle size & zeta potential instrument with removable sample cell (Teflon or stainless steel)
- unique probe design, fixed optics, Reference Beating and 180° backscatter
- multiple flow cell options & titrator connection

new product *product is CE certified*

Microtrac MRB‘s innovative approach on **DYNAMIC LIGHT SCATTERING (DLS)** is based on a unique probe design. By focusing the laser probe at the material interface, the benefits of a short path length are combined with Reference Beating and 180° backscatter, delivering excellent accuracy, resolution and sensitivity. The DLS signal is evaluated by using a Fast Fourier Transformation.



PARTICLE SIZE & SHAPE ANALYSIS

Dynamic & Static Image Analysis

Information about particle size & shape is an important aspect of process and quality control. All **DYNAMIC IMAGE ANALYSIS (DIA)** systems by Microtrac MRB determine the particle shape of the sample material in a detailed and representative manner.

Due to its superior capability, dynamic image analysis is often used as an alternative to conventional methods such as sieve analysis or laser diffraction.

The unique dual camera measuring setup of the CAMSIZER 3D / X2 makes it possible to measure an extremely wide dynamic size range accurately, without having to switch measuring ranges or making hardware adjustments. The sample is transported to the measurement field by a vibratory feeder. During the measurement the basic camera records large particles, while the zoom camera records the small ones.

The CAMSIZER 3D detects particles in free fall several times in different orientations (particle tracking) so that the shape of the particles can be determined with highest accuracy.

0.8 µm – 5 mm

CAMSIZER X2 *(with X-DRY module & X-JET cartrigde)*

- unique dual camera system
- for wet & dry samples
- efficient high-pressure dispersion for particles as small as 1 µm

10 µm – 8 mm

X-FALL CARTRIDGE *(for X-DRY module)*

- contact-free dispersion of free-flowing, non-agglomerated particles
- complete sample recovery
- no contamination

0.8 µm – 1 mm

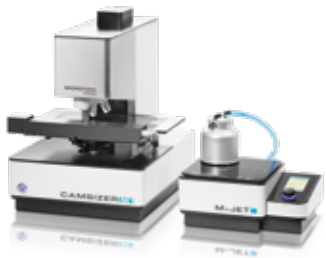
X-FLOW MODULE

- X-Change module for suspensions & emulsions
- integrated ultrasonic module
- resistant to organic solvents
- various cells available

20 µm – 30 mm

CAMSIZER 3D

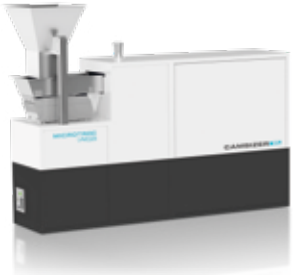
- dynamic image analyzer for granulates & bulk material
- proven dual camera technology
- patented 3D measurement
- alternative to sieve analysis



0.5 nm – 1.5 µm

CAMSIZER M1

- static image analyzer with 18.1 MPx color camera
- accurate shape information
- efficient powder dispersion with M-JET module (add-on)



160 µm – 135 mm

CAMSIZER XL

- non-contact measurement of large particles
- more than 40 morphological parameters (incl. 3D)
- customizable sample introduction

measurement range *for dry samples* *for wet samples* *online analyzer for process loops* *add-on for existing instrument*

PARTICLE SIZE & SHAPE ANALYSIS

Online Solutions for Process Control

22 µm – 35 mm

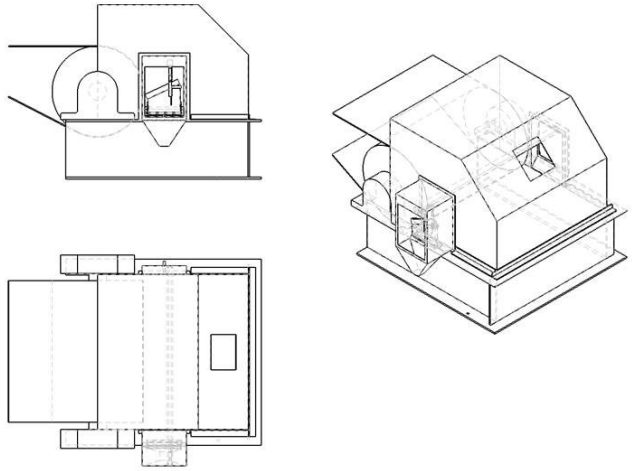
CAMSIZER ONLINE

- characterizes 32 morphological parameters, including 3D
- 100 fps high-resolution camera
- developed for utilization in various industries
- customizable sample introduction
- self-cleaning mechanism

160 µm – 135 mm

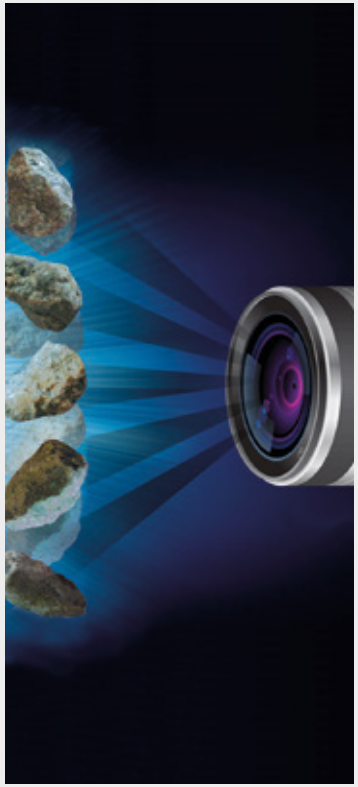
CAMSIZER ONLINE XL

- characterizes 32 morphological parameters, including 3D
- non-contact measurement of large particles
- easy integration of 3rd party sample delivery devices
- enclosed optical system which reduces downtime for maintenance



Representative cross-stream sampling via conveyor belt sampler

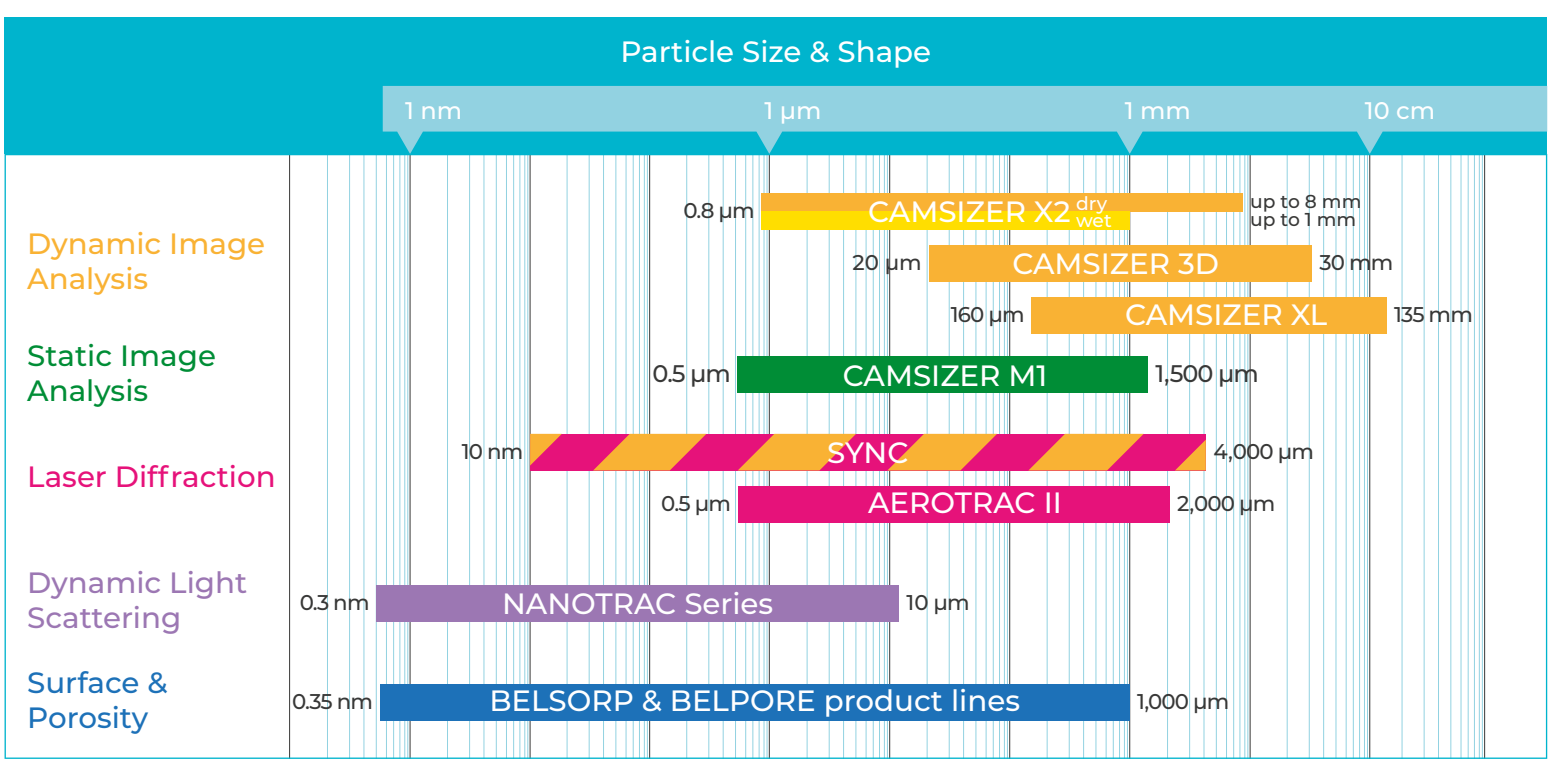
Microtrac MRB's **CAMSIZER ONLINE SYSTEMS** for industrial use provide reliable results in real-time by utilizing dynamic image analysis. The analyzers are used in numerous applications. The results help the user to map production processes and immediately detect deviations. This ensures process optimization and quality improvement.



new product *product is CE certified*

Applications

The products by Microtrac MRB cover a wide range of **APPLICATIONS.** Our analysis systems for particle size & shape are used in numerous industry segments, including the agricultural industry, geology, for catalysts, coal & carbon black, building materials, glass, metal powders, plastics, as well as in the chemical, pharmaceutical and food industries.



Measurement Methods by Comparison

	LASER DIFFRACTION	DYNAMIC LIGHT SCATTERING	DYNAMIC IMAGE ANALYSIS	STATIC IMAGE ANALYSIS
Measurement range	10 nm – 4,000 µm	1 nm – 6,500 nm	0.8 µm – 135 mm	0.5 µm – 1,500 mm
Size calculation	indirect, from light scattering pattern	indirect, from Brownian motion	directly from particle images	directly from particle images
Analysis of individual particles	no	no	yes	yes
Measurement speed	10 – 60 seconds	30 – 180 seconds	2 – 5 minutes	10 – 60 minutes
Sample preparation effort	low effort	medium effort	low effort	high effort
Particle shape analysis	⊕ (SYNC) -	-	⊕	⊕
Wet analysis	⊕	⊕	⊕	⊕
Dry analysis	⊕	-	⊕	⊕
Zeta potential & molecular weight	-	⊕	-	-
Correlation with sieve analysis	-	-	⊕	+
Key advantages	speed, versatility, repeatability, user-friendliness	analysis of nanomaterials, wide concentration range	replacing sieve analysis, accuracy, robustness	shape measurement with highest resolution

⊕ *suitable* + *suitable to a limited extent* - *not suitable*

GAS ADSORPTION MEASUREMENT

Surface Area & Pore Size Distribution

The **SPECIFIC SURFACE AREA** is calculated via BET theory. This theoretical model can be applied to either single point or multi point adsorption measurements. The single point BET is often used for quality control applications. More data can be obtained by multi point BET.

The **PORE SIZE DISTRIBUTION** via gas adsorption is measured through N_2, Ar or CO_2 isotherms as a standard, enabling analyses of the pore size from several hundred nanometers down to the molecular size range.

The following methods can be utilized for **CATALYST EVALUATION:** Pulse chemisorption, metal dispersion rate, temperature-programmed desorption (TPD), reduction (TPR), oxidation (TPO) and more.

∅ 0.7 nm – 500 nm (opt. 0.35 ~)

0.01 m²/g or more

BELSORP *MINI X*

- simultaneous measurement of up to 4 samples
- short-time measurement by "Gas Dosing Optimization" function
- high reproducibility with Advanced Free Space Measurement (AFSM™) and AFSM™2

∅ 0.35 nm – 500 nm

0.0005 m²/g or more

BELSORP *MAX G*

- micro- / meso- / macropore measurement (BET) with 1 sample port
- measurement without He gas via the new Advanced Free Space Measurement 2 (AFSM2™)
- High performance PSD analysis

∅ 0.35 nm – 500 nm

0.0005 m²/g or more

BELSORP *MAX X*

- highest throughput with simultaneous measurement of up to 4 samples
- Advanced Free Space Measurement: AFSM™ and AFSM2™ (Helium-free)
- low specific surface area evaluation by Kr adsorption at 77.4 K
- chemisorption option

0.01 m²/g or more

BELSORP *MR1*

- fast & precise single-point BET via flow adsorption method
- auto zero function with highly sensitive thermal conductivity detector (TCD)
- calibration valve, Dewar elevator & cooling fan

measurement range *pore size diameter* *uses gas adsorption* *uses vapor adsorption* *product is CE certified*

GAS ADSORPTION MEASUREMENT

Catalyst Evaluation & High-Pressure Gas Adsorption

BELCAT II

- fully automated catalyst analyzer (TPD / TPR / TPO / Pulse), breakthrough curve measurement available
- precise gas control by 3 high performance mass flow controllers
- automatic gas injection system for calibration
- measurable gas: H_2, O_2, CO, CO_2, NO, N_2O, NH_3, H_2O, VOC, etc.
- measurement temperature: -120°C – 1100°C

BELSORP HP

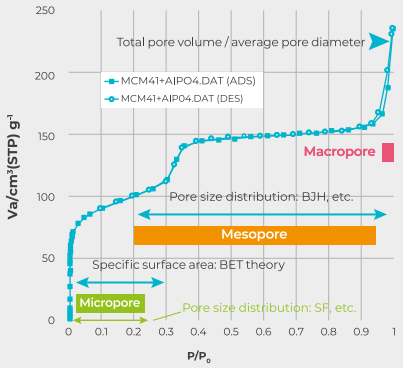
- high-pressure gas adsorption analyzer
- maximum pressure: 13.5 MPa
- compact design, easy to use interface
- operating temperature range: -10°C to 800°C
- H_2, CO_2, O_2, N_2, non-corrosive gas

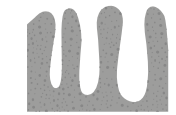
1 amu – 200 amu

BELMASS II

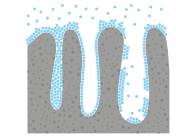
- mass spectrometer for both qualitative and quantitative gas analyses
- heated hose enables the analysis of vapors
- built-in vaccum pump
- provides information on desorped gases of gas / vapor mixtures and their breakthrough curves when combined with BELCAT II

ADSORPTION / DESORPTION ISOTHERM

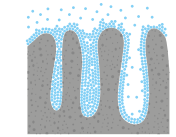




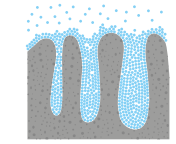
BEFORE ADSORPTION



MONOLAYER FORMATION / MICROPORE FILLING



MULTILAYER FORMATION / CAPILLARY CONDENSATION



FILLING ALL PORES / ADSORPTION INTO VOIDS

measurement range *uses gas adsorption* *product is CE certified*

GAS ADSORPTION MEASUREMENT

Density Measurement & Sample Preparation

The gas displacement method is used for the **DENSITY MEASUREMENT**. An inert gas, such as nitrogen or helium, is used as the displacement medium. The gas is directed to the closed sample compartment and then expands into an empty compartment with a defined volume. The pressure difference allows to determine the exact sample volume. The sample density can be calculated from the measured sample volume and the mass.

Microtrac MRB provides optional systems for **SAMPLE PREPARATION**. All models guarantee a high reproducibility of the sample.
The sample pretreatment can be done independently of the measurements.

BELPYCNO

- quick & reliable true density measurements via gas displacement
- highly precise measurement with variable cell volumes (1 cm^3 - 10 cm^3)
- sample cell cap without grease
- convenient one-hand operation via touch screen
- measurable gas: He, N_2 or other inert gases

BELPYCNO L

- fully automated density & volume measurement of powders, granulates, porous materials, mixtures, pastes and liquids
- multi-volume capability for easy choice of best configuration
- built-in accurate ATC (Automatic Temperature Control)
- variable sample volume (4 cm^3 - 150 cm^3)

BELPREP VAC III

- vacuum / heat degassing pretreatment device for specific surface area & pore distribution analysis (flow / heat optional)
- can be operated independently to perform pre-processing parallel to the measurement
- 6 pretreatment ports

BELPREP VAC II

- vacuum / heat degassing pretreatment device for specific surface area & pore distribution analysis
- can be operated independently to perform pre-processing parallel to the measurement
- 3 pretreatment ports

uses gas adsorption *product is CE certified*

POROSITY

Mercury Porosimetry

Hg CE

∅ 330 µm – 15 µm, 3000 µm with ultramacropore dilatometer ∅ 180 µm – 3.8 µm, 900 µm with ultramacropore dilatometer

BELPORE LP

- automatic sample degassing & vertical mercury filling, maximum pressure: 400 kPa
- 5 dilatometer models for various sample dimensions & shapes
- particle size can be determined automatically by second intrusion
- measurement of wet material & particle size distribution of powders possible
- avoids any risk of powder elutriation via special proportional valve

Hg CE

∅ 40 µm – 0.01 µm ∅ 15 µm – 0.0036 µm

BELPORE HP

- operates up to a maximum pressure of 414 MPa
- particularly suited for ceramics, sintered metals, very hard materials, and solids with porosity in the macro- and mesopore range
- highly recommended for R&D and QC labs
- high accuracy and reproducibility via PASCAL method

Hg CE

∅ 40 µm – 0.015 µm ∅ 15 µm – 0.0065 µm

BELPORE MP

- operates up to a maximum pressure of 228 MPa
- automatic autoclave opening / closing simplifies operation
- different dilatometer sizes to cover all materials & sample types
- for hetero- & homogeneous material with low as well as high porosity

∅ *particle size diameter* ∅ *pore size diameter* Hg *uses mercury porosimetry*

MERCURY POROSIMETRY is the most widely used method for determining the pore size distribution of solids in the range of macro- and mesopores. This technique provides reliable information about the pore size distribution, sample volume and the apparent and true density of most porous materials, regardless of their type and shape.

The method is based on the intrusion of mercury into a porous system under applied pressure. Using the Washburn equation, the corresponding pore size can be calculated from the pressure.

Microtrac MRB's BELPORE series uses the PASCAL method for pressure build-up control. With this method an optimized speed of the pressure build-up is set and controlled automatically. This allows for shorter measuring times with guaranteed equilibrium conditions.

Applications & Measurement Methods by Comparison


Catalysts

Batteries


Carbon

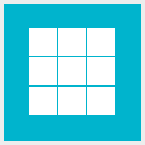

Medicine


Cosmetics


Cement


Toner

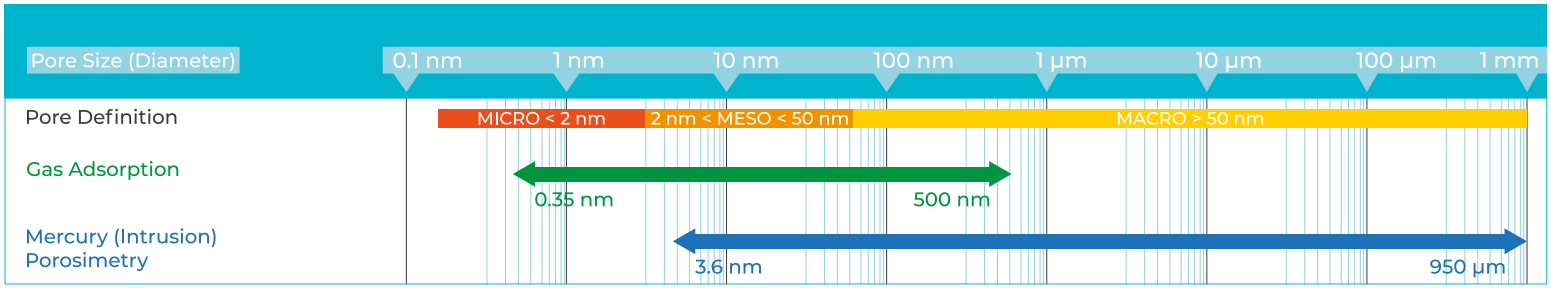

Pigments


Ceramics


Semiconductors


Adsorbents


MOFs / PCPs



	BELSORP MINI X	BELSORP MAX	BELSORP MAX X	BELSORP MR1	BELSORP HP	BELCAT II	BELPYCNO / L	BELPORE LP / HP / MP
Pore size distribution	⊕	⊕	⊕	-	+	-	-	⊕
Micropore	+	⊕	⊕	-	+	-	-	-
Mesopore	⊕	⊕	⊕	-	+	-	-	⊕
Macropore	⊕	⊕	⊕	-	-	-	-	⊕
Isotherm	⊕	⊕	⊕	-	⊕	-	-	-
BET surface area	⊕	⊕	⊕	⊕	+	+	-	+
Single point BET	+	+	+	⊕	+	⊕	-	-
Vapor adsorption	-	⊕	⊕	-	-	+	-	-
High pressure sorption	-	-	+	-	⊕	-	-	-
Chemisorption	-	⊕	-	-	-	⊕	-	-
TPD / TDR / TPO	-	+	-	-	-	⊕	-	-
Pulse chemisorption	-	+	-	-	-	⊕	-	-
Breakthrough curve	-	-	-	-	-	⊕	-	-
Multi gas adsorption	-	-	-	-	-	+	-	-
True density	-	+	+	-	+	-	⊕	+
Mercury Porosimetry	-	-	-	-	-	-	-	⊕

⊕ *suitable* + *suitable to a limited extent* - *not suitable*

Verder Scientific – Science for Solids

Microtrac MRB is part of Verder Scientific, the scientific division of the Verder Group. Apart from Microtrac MRB four more companies are part of the scientific division; Retsch, Carbolite Gero, QATM and Eltra. Together we set new standards in the development and manufacturing of lab and analysis equipment, as well as sample preparation tools, which are used in areas such as quality control, research and development.

For more details about the extensive Microtrac MRB product portfolio please visit our new website: **www.microtrac.com**

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MICROTRAC MRB
PARTICLE CHARACTERIZATION

part of VERDER scientific

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