MICROTRAC
PARTICLE CHARACTERIZATION
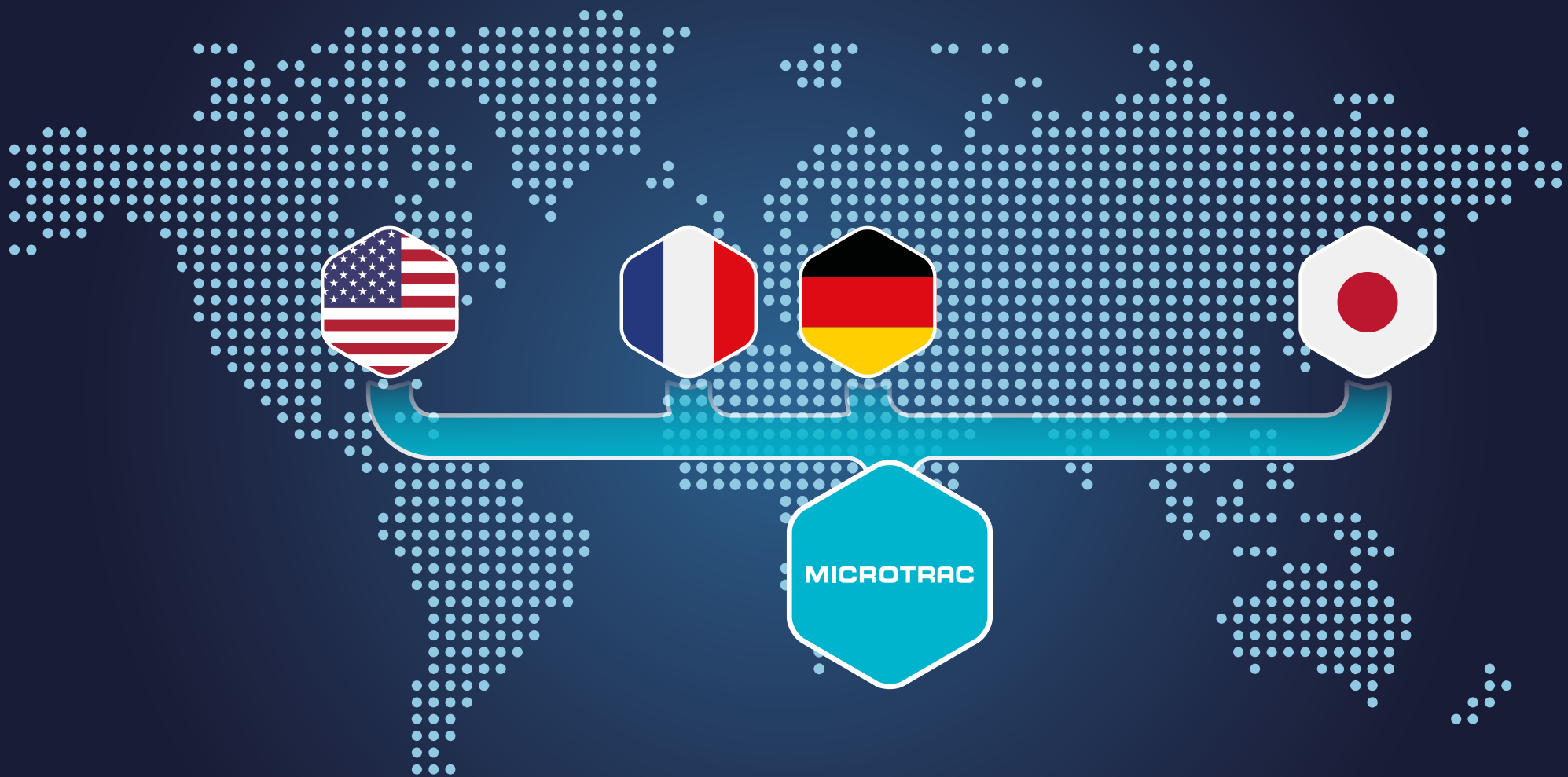
I PARTICLE SIZE & SHAPE

I STABILITY & DISPERSIBILITY ANALYSIS

I SURFACE & POROSITY

A LEADER IN PARTICLE CHARACTERIZATION

part of **VERDER** scientific

MICROTRAC

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.

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

2023
Formulaction, a recognized innovator in the field of Stability & Dispersibility analysis, is integrated into Microtrac.

Three Centers of Excellence

MICROTRAC: GOING FORWARD AS ONE SOLUTION PROVIDER

GAS ADSORPTION MEASUREMENT

The BELSORP and BELPORE analyzers are highly advanced and efficient tools used for gas and vapor adsorption measurement. They are designed to determine the BET surface area and pore size distribution of both porous and non-porous powder materials. These analyzers employ cutting-edge gas adsorption technology and are widely used in various sectors, including Research and Development, Quality Control, and Quality Assurance. These products have a global presence and are utilized by numerous industries worldwide. The BELSORP and BELPORE analyzers are equipped with state-of-the-art features and functionalities, ensuring accurate and reliable results. The competence centers for these product lines are located in Osaka, Japan, and Haan, Germany, providing comprehensive support to customers worldwide. BELSORP and BELPORE analyzers are indispensable tools that enable precise and efficient gas and vapor adsorption measurements.)
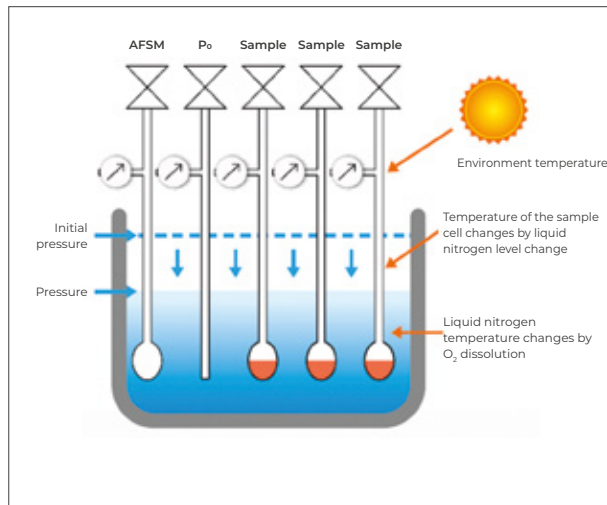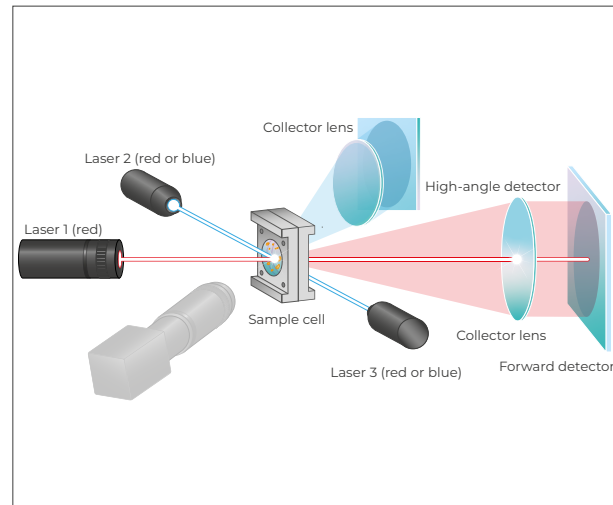
PARTICLE SIZE & SHAPE ANALYSIS

Dynamic Image Analysis (DIA) is used to determine size distributions and shape parameters quickly with excellent accuracy and reproducibility over a wide measuring range. Microtrac's renowned CAMSIZER system was introduced over 20 years ago and has pushed technological innovation ever since. These instruments are developed and built in our production site in Haan, Germany.

In 2024, Microtrac celebrates 50 years of Laser Diffraction (LD) as a global leader. We are pioneers in this field, with our SYNC range. By continuously improving the instrument technology, we offer customers a robust portfolio of laser diffraction instruments that are ideal for particle sizing and characterization. The development and production site for this product line is located in, Pennsylvania, USA.
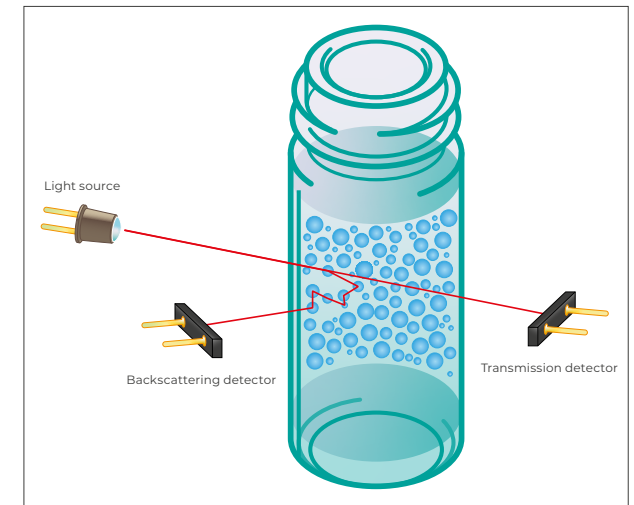
STABILITY & DISPERSIBILITY ANALYSIS

Our Stability Analyzers use Dynamic Light Scattering (DLS), Static Multiple Light Scattering (SMLS), and Zeta Potential (ZP) to measure the stability and dispersibility of all your formulas. DLS is a precise measurement technique for the characterization of particle sizes in suspensions and emulsions. Microtrac is a pioneer of particle analysis technology and has been developing optical systems based on Dynamic Light Scattering for over 30 years.

The latest addition to the Microtrac portfolio is the TURBISCAN range. With TURBISCAN, Microtrac offers the world-leading technology for Shelf-Life and Dispersibility analysis of liquid dispersions and formulations. The TURBISCAN range utilizes SMLS and is developed in our factory in Toulouse, France. The ZP product family consists of analyzers that provide information on particle size, zeta potential, concentration, and molecular weight in a single system.

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

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

Static Multiple Light Scattering is the best method to characterize liquid dispersions in their native state.

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'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'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
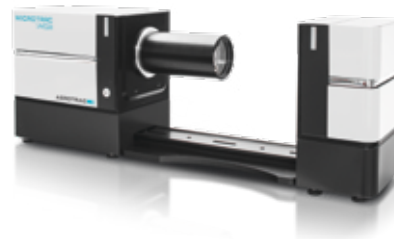- advanced design for optimized sample dispersion

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

Dynamic & Static Image Analysis

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
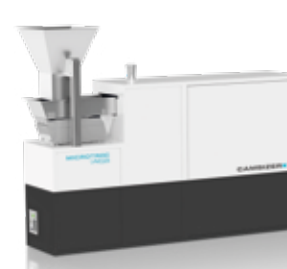| no contamination

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

160 µm – 135 mm

CAMSIZER *XL*

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

Information about particle size & shape is an important aspect of process and quality control. All **DYNAMIC IMAGE ANALYSIS (DIA)** systems by Microtrac 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.

Dynamic Light Scattering & Zeta Potential

Microtrac'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° back-scatter, delivering excellent accuracy, resolution and sensitivity. The DLS signal is evaluated by using a Fast Fourier Transformation.
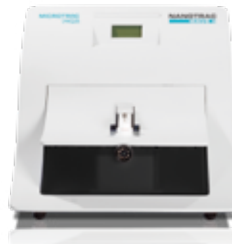
0.3 nm – 10 μm

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

0.3 nm – 10 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

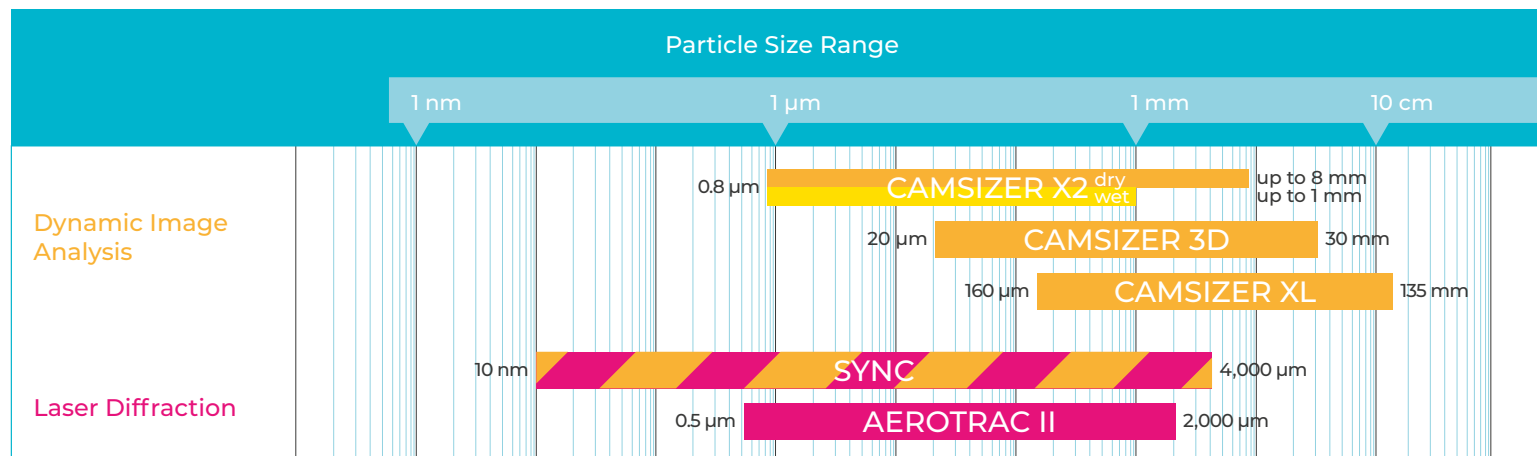measurement range   for wet samples   add-on for existing instrument   new product   product is CE certified

PARTICLE SIZE & SHAPE ANALYSIS
Applications

The products by Microtrac 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.

- 3D printing
- Abrasives
- Activated carbon
- Battery materials
- Catalysts
- Ceramics
- Chemicals
- Coal / coke
- Coatings
- Construction materials

- Cosmetics
- Emulsions
- Extrudates
- Fertilizers
- Food
- Glass / glass beads
- Industrial minerals
- Metal powders
- Paints / pigments
- Pharmaceuticals

- Pharmaceutical pellets
- Polymers
- Sand / gravel
- Superabsorbents
- Refractory products
- Salt and sugar
- Supporting agents
- Wood chips

- … and many more

Particle Size Range

	1 nm	1 µm	1 mm	10 cm

Dynamic Image Analysis

- 0.8 µm — CAMSIZER X2 dry/wet — up to 8 mm / up to 1 mm
- 20 µm — CAMSIZER 3D — 30 mm
- 160 µm — CAMSIZER XL — 135 mm

Laser Diffraction

- 10 nm — SYNC — 4,000 µm
- 0.5 µm — AEROTRAC II — 2,000 µm

STABILITY & DISPERSIBILITY ANALYSIS
Static Multiple Light Scattering

SMLS: STATIC MULTIPLE LIGHT SCATTERING

Powering the TURBISCAN

SMLS offers the ability to investigate the dispersion state and stability of liquid dispersions (emulsions & suspensions), without any dilution, even on highly concentrated samples (up to 95% v/v).

SMLS technology is based on the measurement of the transmission and backscattering intensities versus the sample's height and aging time. It offers an extraordinary resolution to detect size and concentration variation and therefore particle diameter evolution (like aggregation, flocculation, coalescence) and concentration change (like sedimentation, creaming, phase separation) can easily be detected and monitored, up to 1,000 times faster compared to visual observation.

SMLS is in perfect agreement with ISO/TR 13097's recommendation regarding shelf-life and stability measurement as a direct optical method that does not require sample preparation (such as dilution) and is the leading technology to measure **stability** and **shelf-life**.

10 nm – 1,000 µm

TURBISCAN *LAB*

| 1 sample position
| temperature range from RT to 60°C
| fast destabilization detection
| Turbiscan Stability Index (TSI), mean particle size kinetic and particle size distribution

10 nm – 1,000 µm

TURBISCAN *TRILAB*

| 3 sample positions
| temperature range from 20°C to 60°C
| fast destabilization detection
| Turbiscan Stability Index (TSI), mean particle size kinetic and particle size distribution

10 nm – 1,000 µm

TURBISCAN *TOWER*

| 6 sample positions
| temperature range from 4°C to 80°C
| fast destabilization detection
| Turbiscan Stability Index (TSI), mean particle size kinetic and particle size distribution

10 nm – 1,000 µm

TURBISCAN *AGS*

| 54 sample positions
| 3 independent storage racks from RT to 60°C
| fast destabilization detection
| Turbiscan Stability Index (TSI), mean particle size kinetic and particle size distribution

10 nm – 1,000 µm

TURBISCAN *DNS*

| stability and dispersibility via mixing and circulating function
| temperature range from RT to 60°C
| Turbiscan Stability Index (TSI), online particle sizing and particle size distribution

measurement range | for wet samples | add-on for existing instrument | new product | product is CE certified

STABILITY AND DISPERSIBILITY
Applications

CHEMICALS & POLYMERS

Surfactants, stabilizers, polymers and biopolymers, fillers, pigments, latexes, solvents, ...

PHARMACEUTICALS

Injectables, parenterals, vaccines, drug delivery systems, skin treatments, inhalers, cough syrups, ophthalmic suspensions, ...

COATINGS, PAINTS & INKS

Water-based, solvent-based, resins, varnishes, inks, primers, protective and special coatings, ...

BATTERY & ELECTRONICS

Anode & cathode slurries, CMP slurries, multilayer capacitors, LCD and LED display

FOOD & BEVERAGES

Flavor emulsions, beverages, milk and dairy products, vegetable drinks, plant protein, wine & beers, additives, gums and stabilizers, ...
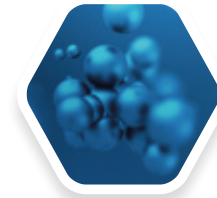
HOME & PERSONAL CARE

Creams & lotions, moisturizers, sunscreens, detergents, fragranced formulations, cleansers, foundations, makeup, nail polishes, ...
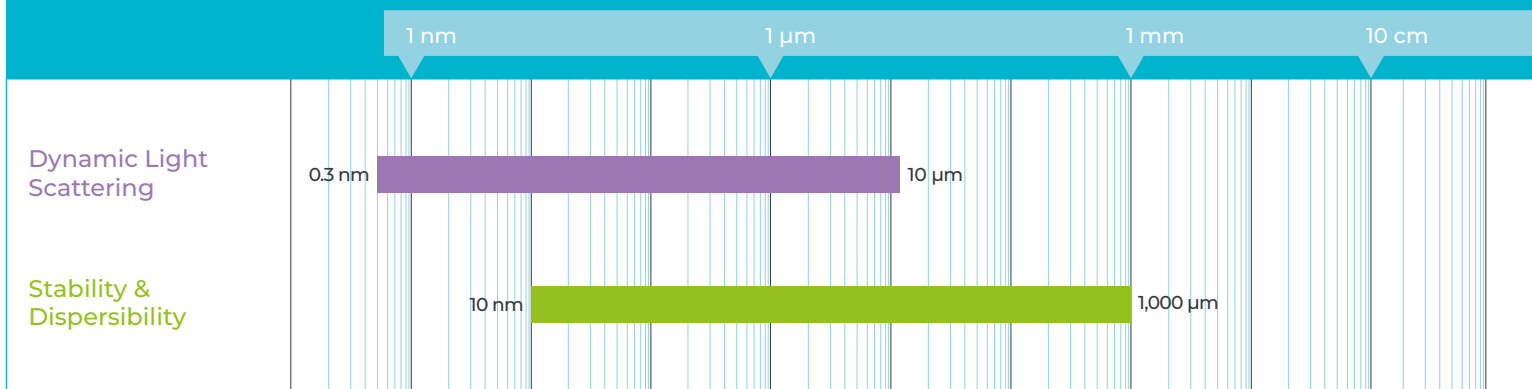
OIL & LUBRICANTS

Water-in-oil demulsification, enhanced oil recovery, drilling fluids, crude oils, heavy fuels, fuel & oil additives, metalworking fluids, lubricating agents, ...

AND MANY MORE

MICROTRAC's Stability and Dispersibility instruments can analyze a very wide variety of samples: opaque or clear, highly concentrated and very diluted, from nanoparticles to large floccs (mm), emulsions, suspensions, colloids, foams, ...

VISIT OUR APPLICATIONS DATABASE

Interested to hear more about applications in each industry, visit the Microtrac website

START EXPLORING!

www.microtrac.com/applications

Particle Size Range

	1 nm	1 µm	1 mm	10 cm
Dynamic Light Scattering	0.3 nm ————— 10 µm			
Stability & Dispersibility		10 nm ————— 1,000 µm		

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
| Special models: MAX HT (high temperature) and MAX HP (high pressure)

⊢⊣ 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*   CE *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.
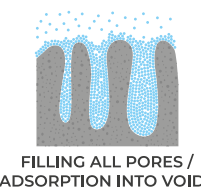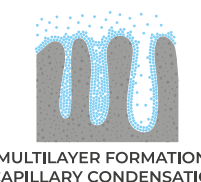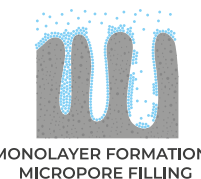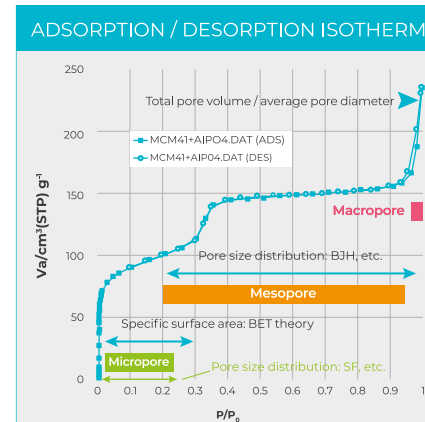| measurement temperature: -120°C – 1100°C

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

Total pore volume / average pore diameter
MCM41+AIPO4.DAT (ADS)
MCM41+AIP04.DAT (DES)
Macropore
Pore size distribution: BJH, etc.
Mesopore
Specific surface area: BET theory
Micropore
Pore size distribution: SF, etc.

Va/cm³(STP) g⁻¹
P/P₀

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 MEASURE-MENT**. 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 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 cm³ - 10 cm³)
| 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 cm³ - 150 cm³)

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

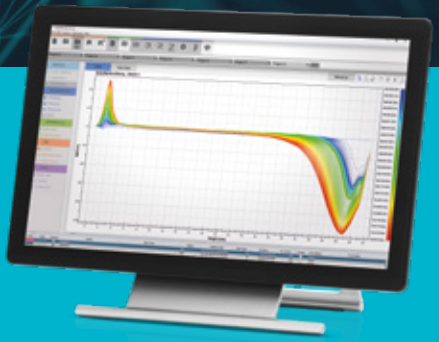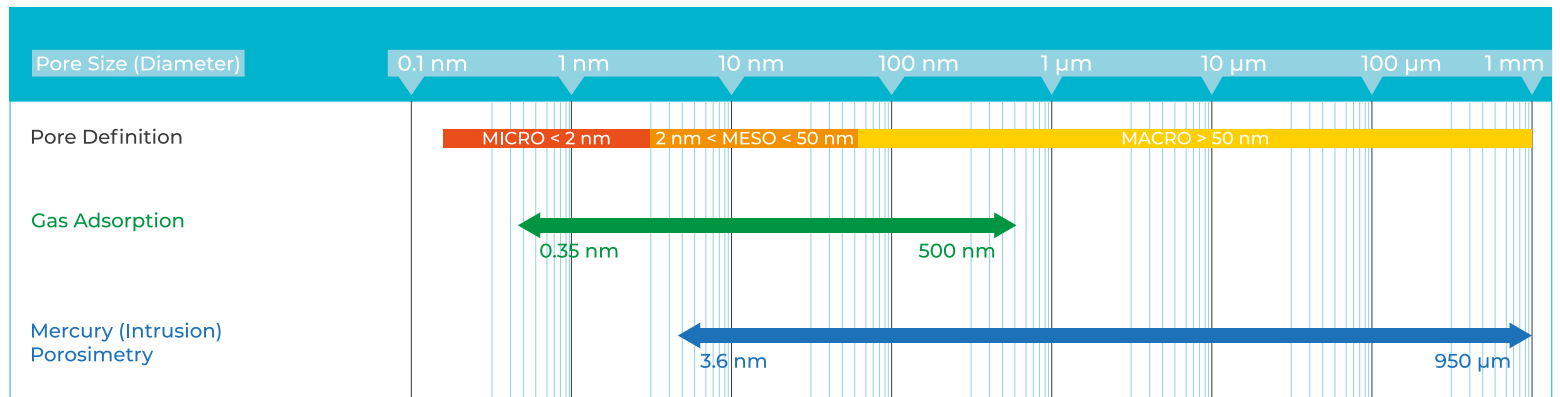⌀ *particle size diameter*   ⌀ *pore size diameter*   **Hg** *uses mercury porosimetry*

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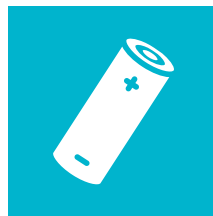
Microtrac's BELPORE series uses the PASCAL method for pressure build-up control. With this method an optimized speed of the pressure build-up is set and controlled automatically. This allows for shorter measuring times with guaranteed equilibrium conditions.

GAS ADSORPTION MEASUREMENT
Applications

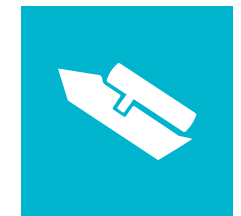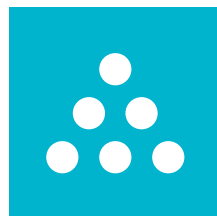| Pore Size (Diameter)	0.1 nm	1 nm	10 nm	100 nm	1 µm	10 µm	100 µm	1 mm
Pore Definition	MICRO < 2 nm		2 nm < MESO < 50 nm		MACRO > 50 nm			
Gas Adsorption		0.35 nm			500 nm			
Mercury (Intrusion) Porosimetry			3.6 nm					950 µm

Catalysts

Batteries

Carbon
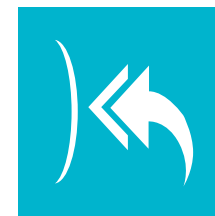
Medicine

Cosmetics

Cement

Toner

Pigments

Ceramics

Semiconductors

Adsorbents

MOFs / PCPs

VISIT OUR APPLICATIONS DATABASE

Interested to hear more about applications in each industry, visit the Microtrac website

START EXPLORING!

www.microtrac.com/applications

VERDER SCIENTIFIC – ENABLING PROGRESS

Microtrac is part of Verder Scientific, the scientific division of the Verder Group. Five more companies are part of the scientific division; Retsch, Carbolite Gero, QATM, Eltra and Erweka. 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 product portfolio please visit our website: **www.microtrac.com**

MICROTRAC
PARTICLE CHARACTERIZATION

Microtrac Inc.
3230 N. Susquehanna Trail
York, PA 17406 · USA

Phone: +1 888 643 5880
marketing@microtrac.com

Microtrac Retsch GmbH
Retsch-Allee 1-5
42781 Haan · Germany

Phone: +49 2104 2333 300
info@microtrac.com

MicrotracBEL Corp.
8-2-52 Nanko Higashi, Suminoe-ku
Osaka 559-0031 · Japan

Phone: +81 6 6655 0360
info@microtrac-bel.com

Microtrac Formulaction SAS
3-5 rue Paule Raymondis
31200 Toulouse · France

Phone: +33 (0)5 62 89 29 29
contact.fr@mtf.verder.com

www.microtrac.com

VERDER
scientific

VERDER SCIENTIFIC

ENABLING PROGRESS.

Under the roof of VERDER SCIENTIFIC we support thousands of customers worldwide in realizing the ambition we share.

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