

MICROTRAC

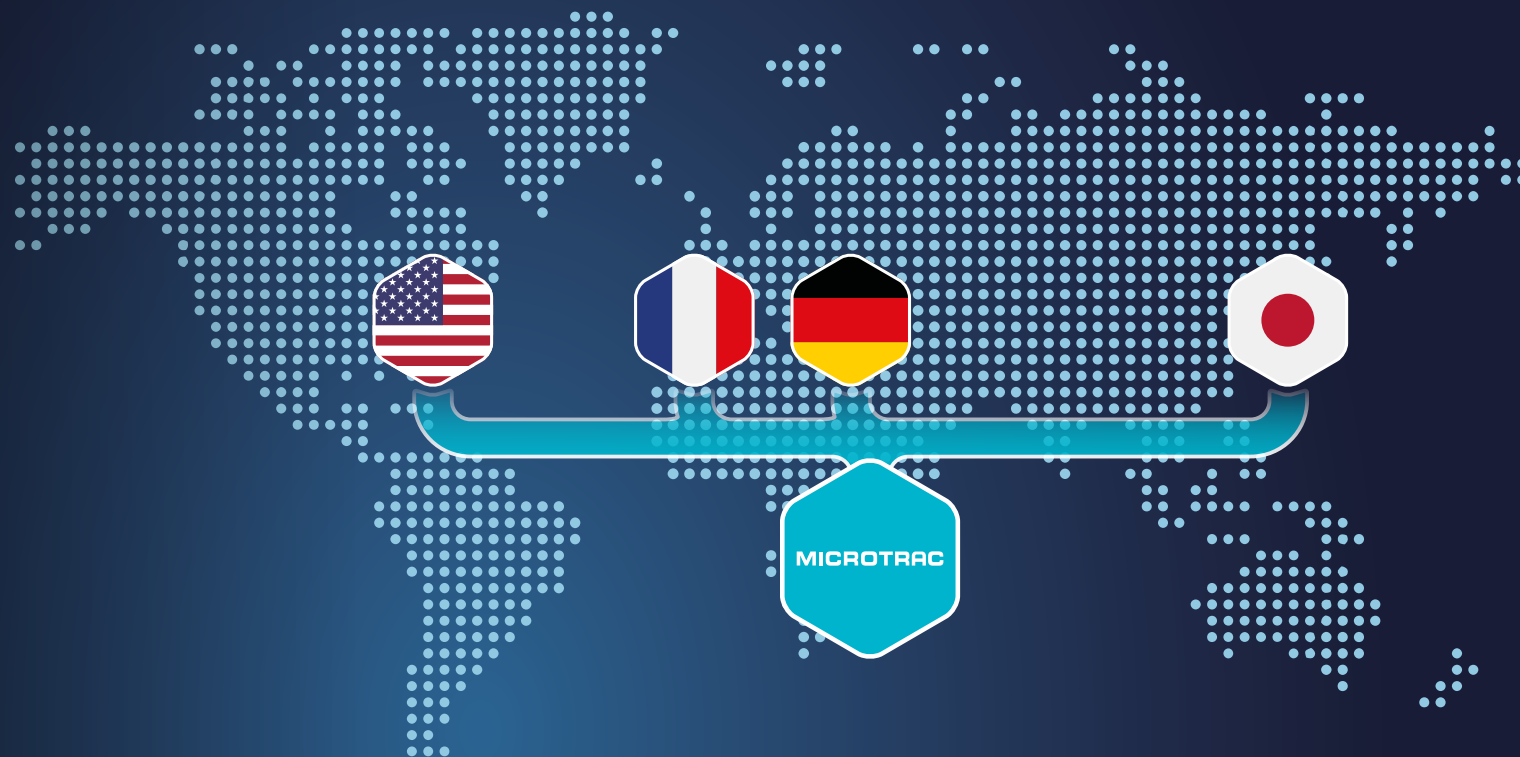
a **VERDER** company



BELSORP **MINI X**

BET SURFACE AREA AND PORE SIZE DISTRIBUTION ANALYZER

**SIMPLE, FAST AND HIGHLY ACCURATE
CHARACTERIZATION OF POROUS MATERIALS**



MICROTRAC

PARTICLE CHARACTERIZATION AT ITS BEST

Microtrac is your preferred partner for the comprehensive characterization of particulate systems. We provide our customers with advanced technologies to obtain consistently reliable results. Innovation and quality are at the core of everything we do.

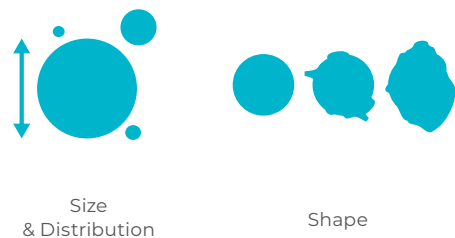
As part of Verder Scientific, we provide worldwide support through a network of subsidiaries and distributors.



Three Centers of Excellence

MICROTRAC: A SINGLE-SOURCE SOLUTION PROVIDER FOR PARTICLE CHARACTERIZATION

PARTICLE SIZE & SHAPE FOR PARTICLE ANALYSIS



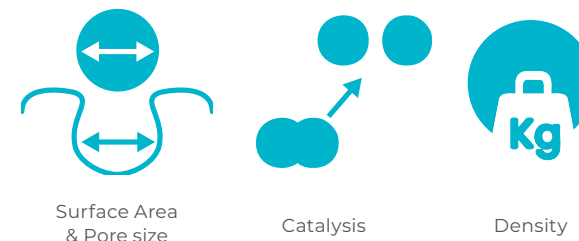
Our expertise in particle size distribution and shape analysis ensures optimal product quality control and supports advanced research efforts. At the core of our technology are **Dynamic Image Analysis (DIA) used on the Camsizer** and a combination of **Laser Diffraction (LD) and Dynamic Image Analysis used on the SYNC** systems. These two technologies cover all your needs for particle size analysis, ranging from 10 nm to 135 μm , whether for dry or wet samples. Our unique size & shape analysis technology utilizes advanced light scattering, state-of-the-art cameras, and sophisticated computational software to deliver outstanding accuracy and repeatability.

COLLOIDS AND FORMULATIONS CHARACTERIZATION



When working with colloids or formulations, the three main parameters to consider are **particle size, zeta potential and stability/shelf-life**. At MICROTRAC, we address all these needs with our comprehensive technology platforms: **NANOTRAC, STABINO, and TURBISCAN**. Our solutions analyze these critical factors to ensure rapid R&D and quality control for the highest product quality. Utilizing **Dynamic Light Scattering (DLS), Static Multiple Light Scattering (SMLS), and Zeta Potential (ZP)**, our systems offer unique features such as non-dilution, high accuracy, and fast measurement—enabling you to make fast decisions based on reliable data.

GAS ADSORPTION FOR MATERIALS CHARACTERIZATION



We offer advanced solutions for measuring surface area, porosity, and catalytic properties of materials. The MICROTRAC analyzers, celebrated for their precision in **gas and vapor adsorption measurements**, determine BET surface area and pore size distribution for both porous and non-porous 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 tools are trusted worldwide, reflecting the renowned craftsmanship and quality of Japanese engineering, with comprehensive support provided by our competence centers in Japan (Osaka), Germany (Haan), USA (Newtown, PA) and France (Toulouse). The **BELSORP** and **BELPORE** analyzers are essential for achieving accurate gas and vapor adsorption analysis.

BELSORP MINI X

SMALLEST & LIGHTEST IN THE WORLD

- | 4 independent measurement ports and one dedicated port for saturated vapor pressure measurements
- | Dedicated pressure transducers for each ports
- | High-precision measurement with AFSM™
- | Quick BET mode for high throughput
- | Simultaneous control of up to 20 measurement ports via multi-device control (5 units)
- | IoT: Process monitoring via e-mail notification system
- | Gas adsorption isotherm & NET adsorption measurement through AFSM™2 without the need of He-gas
- | Optional micropore analysis by molecular probe method
- | Optional FDA 21 CFR Part 11 compliance



BELSORP MINI X Features

- ▶ The BELSORP MINI X is available as 3 or 4 port model
- ▶ Specific surface area range:
| 0.01 m²/g or more (N₂)
- ▶ Pore size distribution range:
| 0.7 to 500 nm (opt. ~0.35 nm)
- ▶ Three modes are available:
 - | High-precision mode for R&D
 - | Quick BET mode for QC
 - | Multi-sample mode and GDO for high throughput

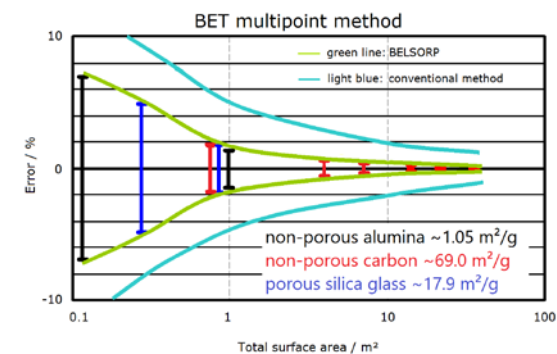


Microtrac's BELSORP MINI X shows outstanding features resulting into the world's highest repeatability with significantly reduced measurement time. The instrument is equipped with up to 4 sample measurement ports and new high-throughput functions including multi-device control. Equipped with dedicated pressure sensors on each sample measuring port and a dedicated port for saturated vapor pressure, it enables completely independent simultaneous measurements. In addition, the new measurement software improves user productivity by displaying the measurement progress,

grasping the maintenance timing, and sending the measurement results via e-mail. Further, the new analysis software, BELMASTER (Ver. 7), enables the structural evaluation of a wider range of materials than ever before. The BELSORP MINI X allows measuring specific surface area, pore size distribution and total pore volume.

With AFSMTM, an initial free space of both the sample cell and the reference cell is determined simultaneously. Since the change in free space in the sample and reference cells is the same, the free space change is continuously tracked across

the reference cell. Therefore, AFSMTM allows the adsorbed volume to be calculated based on the measured free space at any point without the need to keep the liquid level constant.



BELSORP high precision determination of BET surface areas

BELSORP MINI X

BELCONTROL OPERATION SOFTWARE

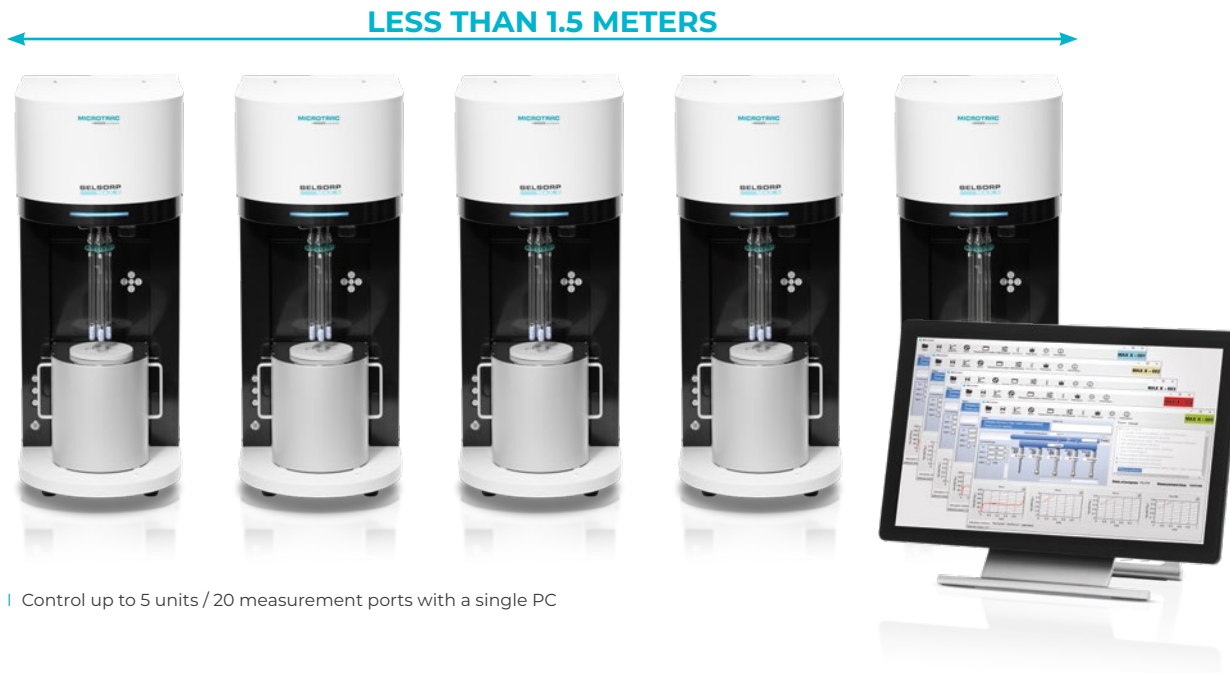
The software has given the highest priority to simplify the operation and has been equipped with many functions to increase the labor productivity. Since the BELSORP instruments offer many features and possibilities, it gets more and more important to simplify the use. Our software will guide you step-by-step for the implementation of several procedures e.g. execution of measurements, replacement of gas cylinder, purging of the manifold and degassing of liquid adsorbent. This user-friendly feature is making the instrument accessible even for non-experienced users.

For the isotherm measurement conditions two possibilities are offered depending on the level of user-experience.

Firstly, the 'automated setting' enables an easy operation by entering the sample information, selecting pretreatment conditions (skippable if externally done) and measurement points/range. Therefore, it is ideal for measurement of unknown samples or unexperienced users. If a prior measurement with comparable sorption behavior is available, the GDO function can be used to reduce the measurement time.

Secondly, the 'advanced setting' offers detailed configuration possibilities for control of dosing amounts and equilibrium criteria to optimize measurement conditions manually. The e-mail notification automatically sends the measurement status and results as an e-mail. With this function easy and reliable monitoring will be given. Our instruments are equipped with a diagnostic service tool, the so-called System Check. It enables functionality proof of the main parts and the equipment status. The System Check result is saved as a report, summarizing the leakage rates, functionality of single parts.





| Control up to 5 units / 20 measurement ports with a single PC

High Precision Mode

For high-precision measurements the amount of free space change in the sample section is simultaneously measured at the reference port (AFSM™). The other remaining ports are used for measuring the adsorption / desorption isotherms, while the saturated vapor pressure is constantly monitored with a dedicated port.

| Resolution: 0.01 m²

| Reproducibility:

Total surface area 1 m² → ± 1.2%*

Total surface area 10 m² → ± 0.4%

Multi-Sample Mode

This mode allows for measuring adsorption and desorption isotherms with up to four samples, while the saturation vapor pressure is constantly measured at the dedicated port. The free space change is automatically calculated from the prior saved free space file (*dvd*).

| Resolution: 0.01 m²

| Reproducibility:

Total surface area 10 m² → ± 0.5%

Software Features

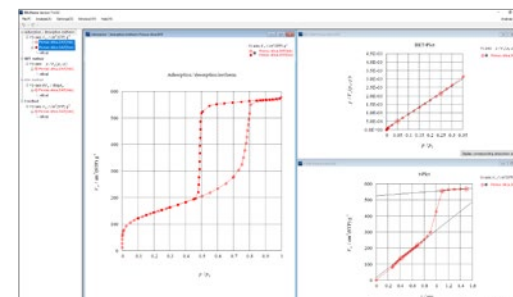
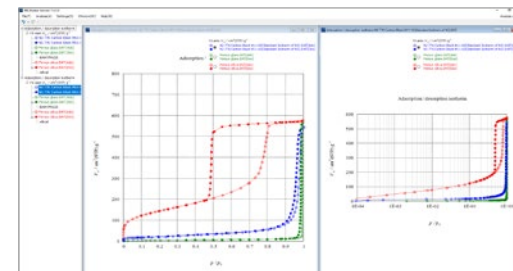
- ▶ Microtrac's measurement operation software features a uniform user experience and can be used with BELSORP MINI X, MAX G, and MAX X
- ▶ The software offers automated and manual settings so that optimization can be made based on user experience
- ▶ Three sub modes are available:
 - | High-precision mode for R&D
 - | Multi-sample mode for high throughput
 - | Quick BET mode for QC

Quick BET Mode

The quick BET mode can be used to maximize the sample throughput. In this mode it is possible to measure three BET adsorption points for four samples in approx. 15 minutes.

* The total surface area (m²) is the product of both the specific surface area (m²/g) and the sample mass.

BELSORP MINI X

BELMASTER
EVALUATION
SOFTWARE

Software Features

- ▶ Analysis data and results can be saved by Drag & Drop (MS Excel format)
- ▶ Easy change of chart overwriting, X-Y axis scaling, unit conversion, and more
- ▶ Result window can be saved for further analysis after a computer restart
- ▶ Routine analysis setting function (useful for repeated analyses)
- ▶ Customized data can be registered as standard reference isotherms in pore profile analyses, t-plot and α_s
- ▶ Improved visibility for different analyses through individual color setting for custom data

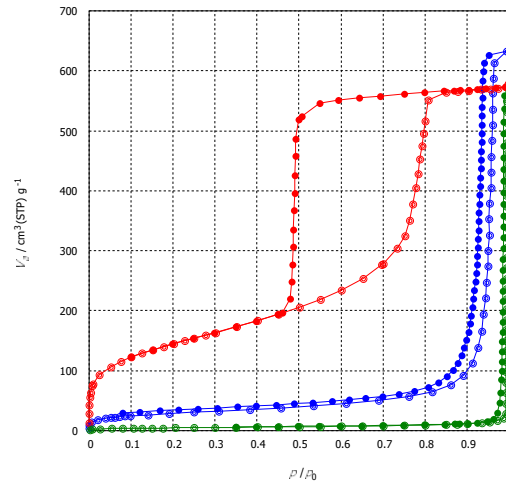
The evaluation software BELMASTER offers a wide range of both basic and advanced analytical theories which have been developed over many years of experience and provides the widest characterization of the samples:

- | Adsorption-desorption isotherm / PCT curve
- | BET Specific Surface Area, incl. ISO9277 / Rouquerol plot for Type I isotherms
- | Langmuir & Freundlich specific surface area
- | INNES, BJH DH & CI method (mesopores)
- | HK, SF & CY method (optional)
- | t-plot method (micro to mesopore analysis)

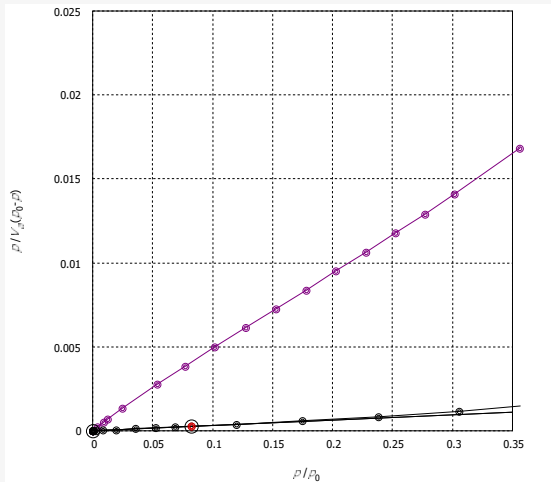
- | α_s plot method (micro to mesopore analysis)
- | MP method (micropore distribution)
- | Dubinin-Astakhov & Dubinin-Radushkevich method (micropore volume)
- | Isosteric heat of adsorption (optional)
- | Differential adsorption isotherm
- | Fractal dimension
- | Molecular Probe Method (ultra micropore analysis; optional)
- | Adsorption rate analysis
- | BELSim™: NLDFT / GCMC (ISO15901-2) for micro- to- macropore distribution

MEASUREMENT RESULTS

BELSORP MINI X



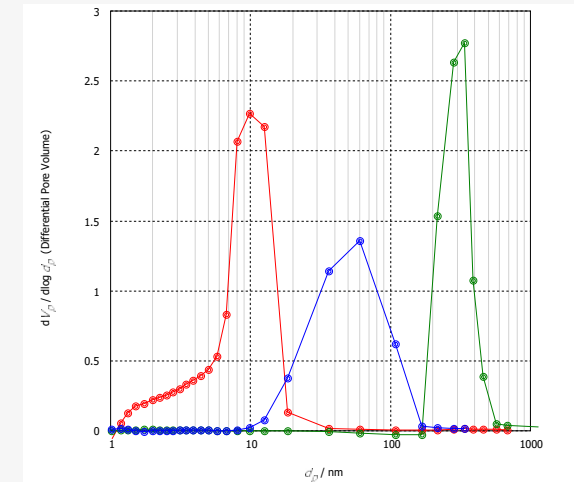
Nitrogen sorption isotherms of silica materials at 77.4 K



BET plot: The specific surface area is usually determined by the BET method (named after Brunauer-Emmett-Teller) for physisorbed gases. The calculation is done according to ISO 9277

The classical pore size distributions (PSD) are the INNES method (slit shape) and BJH, DH, CI methods (cylinder shape), which evaluate mesopores based on the capillary condensation theory. HK (slit), SF (cylinder), and CY (cage) methods can also be used to evaluate micropores based on the adsorption potential theory. The DA method and DR method are also commonly used for pore volume evaluation as pore structure evaluation. The new included, novel PSD evaluation methods, NLDFT and GCMC, are described in ISO 15901-2.

The adsorption isotherm is known as the relationship between the adsorbed amount on the adsorbent and the equilibrium pressure of a gas / vapour at constant temperature. The adsorbed amount is shown on the vertical axis and is usually related to the mass of the adsorbent, while the horizontal axis represents the relative pressure (p/p_0 ; p = equilibrium pressure and p_0 = saturation vapour pressure). In general, the sorption isotherm delivers information about the specific surface area, pore size distribution and pore volume.



Classical BJH pore size distributions of silica materials based on nitrogen adsorption isotherms at 77.4 K

BELSORP MINI X

FURTHER OPTIONS & ACCESSORIES



SAFETY COVER

| The safety cover for the BELSORP series increases the already high safety during measurements.

IoT: The Internet of Things for our BELSORP product line

- ▶ Measurement status and results remotely via e-mail notification system
 - | sorption isotherms of all ports at a glance
 - | detailed sample information
 - | BELMASTER (Ver. 7) measurement files
 - | plotted graphs
- ▶ Notifications can be sent to multiple recipients at once
- ▶ Labor productivity improvement
- ▶ Seamless measurement procedure
- ▶ Faster troubleshooting through automatic alerts



HEATER & CONTROLLER

| Pretreatment of the sample from 50°C up to 450°C.



WATER BATH

| Water bath for measurement temperature ranging from -10°C to 80°C. A refrigerated / heated circulator is required for usage.




GAS SELECTORS

| The gas selector enables the connection of up to 4 adsorptives simultaneously (1 x Helium + 4 x adsorptive).

TECHNICAL DETAILS



SPECIFICATIONS AT A GLANCE

System	BELSORP MINI X (4 Ports)	BELSORP MINI X (3 Ports)
Measurement principle	Volumetric / manometric method + AFSM™ (Advanced Free Space Measurement)	
Adsorption gas	N ₂ , Ar, CO ₂ , H ₂ , CH ₄ , butane, and various other non-corrosive gases	
Number of measurements (high accuracy mode)	Max. 4 ports simultaneously (3)	Max. 3 ports simultaneously (2)
Specific surface area	~0.01 m ² /g (N ₂) (depending on sample density)	
Pore size distribution (ø)	0.7~500 nm (optional: from 0.35 nm by molecular probe method)	
Low pressure isotherm	P/P ₀ = ~10 ⁻⁴ (N ₂ @ 77K, Ar @ 87K)	
Pressure transducer	133 kPa (1000 Torr)	
Gas ports	6	5
CE certificate	2 ports * (optional: 5)	
		

¹ 0.35 ~ 500 nm possible by molecular probe method

07/2023 Subject to technical modifications and errors

System	Pore size distribution	Micropore	Mesopore	Macropore	Isotherm	Single point BET	Multi point BET	Vapor adsorption	Chemisorption	True density
BELSORP MINI X	+	+	+	+	+	+	+	-	-	+

 suitable  suitable to a limited extent  not suitable

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VERDER



**ENABLING
PROGRESS**

Verder is composed of leading laboratory equipment companies active in sample preparation and analysis for quality control as well as research & development purposes.

As trusted solution partner, Verder Scientific enables thousands of companies to ensure economic, technological and environmental progress by mastering their scientific applications. Together, we make the world a healthier, safer and more sustainable place.

