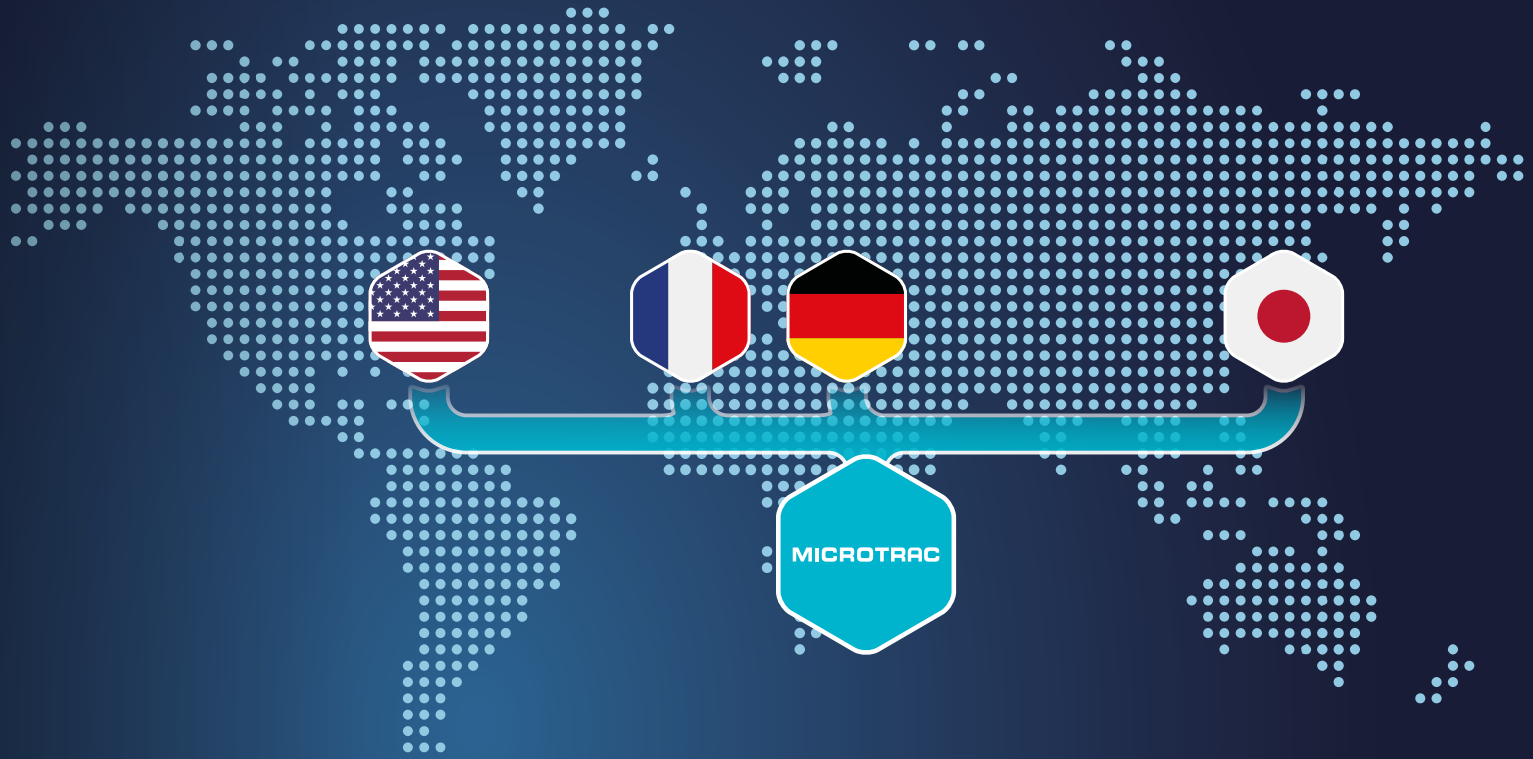
MICROTRAC
a VERDER company

BELSORP MAX G

BET SURFACE AREA AND PORE SIZE DISTRIBUTION ANALYZER

QUICK & EASY CHARACTERIZATION OF MICROPOROUS MATERIALS WITH HIGHEST ACCURACY



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

Size & Distribution

Shape

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 mm, 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

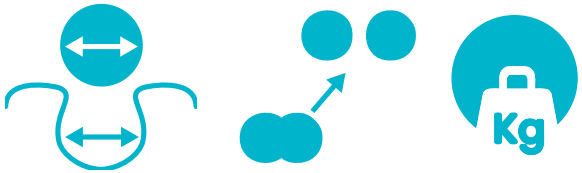
Particle size

Zeta potential

Stability & Shelf-Life

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



Surface Area & Pore size

Catalysis

Density

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 MAX G

HIGH PRECISION GAS ADSORPTION ISOTHERM

- Highly reproducible BET specific surface area and pore size distribution evaluation from extremely low pressure
- Low BET specific surface area by Kr gas measurement at 77.4K
- Porosity from micro- to meso- and macropores by gas adsorption measurement of N_2, Ar, CO_2 and more
- High performance PSD analysis by GCMC & NLDFT with the BELMASTER (Ver. 7) software
- Actual and short-time evaluation for each adsorption point by Gas Dosing Optimization (GDO) function
- Gas and NET adsorption measurement via AFSM™2, without the need for He gas
- Optional vacuum gauge to monitor ultimate vacuum degree
- IoT: Process monitoring via e-mail notification system

BELSORP MAX G Features

- Specific surface area & pore size distribution: evaluation with N_2, Ar, and more through adsorption measurement from extremely low to atmospheric pressure
- Capable of ultra micropore evaluation through CO_2 adsorption
- Low specific surface area measurement via Kr adsorption
- Analysis of H_2, CO_2, O_2, CH_4 and non-corrosive gases
- Measures various adsorption rates

BELSORP MAX G is a new range of powerful, compact and economical models in the BELSORP MAX series by Microtrac. Its special feature is the measurement of gas adsorption isotherms starting from extremely low pressures for the evaluation of micro-, meso- and macroporous materials, as well as non-porous materials. This instrument is equipped with one measurement port, one dedicated port for saturated vapor pressure measurement and one port for free space measurement. Each port is equipped with a dedicated pressure sensor for high-precision measurements.

The BELSORP MAX G surface area & pore size distribution analyzer is capable of measuring various materials such as pellets, molded bodies, substrates, and finely dispersed samples using special-purpose sample tubes. Additionally, it is possible to mount a sample tube with an outer diameter of 9 mm or more on the measurement port. The BELSORP MAX G supports a wide range of adsorbates and measurement conditions.

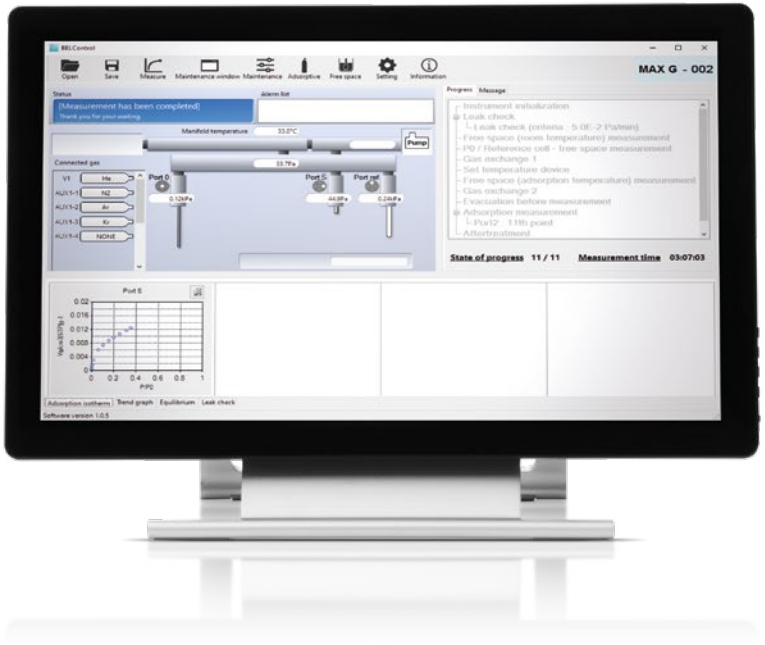
Depending on our customers' needs, we are offering two models, namely the BELSORP MAX G LP (low pressure) and the BELSORP MAX G MP (medium pressure), which are both equipped with different pressure transducers:

	BELSORP MAX G LP	BELSORP MAX G MP
Port 1	133 kPa 1.33 kPa 0.0133 kPa	133 kPa 1.33 kPa 0.133 kPa
Port 2	133 kPa	
Saturation vapor pressure port	133 kPa	
Turbomolecular pump	✓	✓

BELSORP MAX G models and their configurations

BELSORP MAX G

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 adsorptive. 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 measure-ment 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.

LESS THAN 1.8 METERS

I Control up to 5 units 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 measuringw the adsorption / desorption isotherms, while the saturated vapor pressure is constantly monitored with a dedicated port.

I Resolution: 0.01 m^2

I Reproducibility:

Total surface area 1 m^2 → ± 1.2%*

Total surface area 10 m^2 → ± 0.4%

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 in approx. 15 minutes.

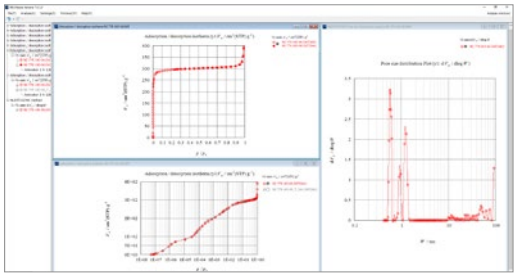
* The total surface area (m^2) is the product of both the specific surface area (m^2/g) and the sample mass.

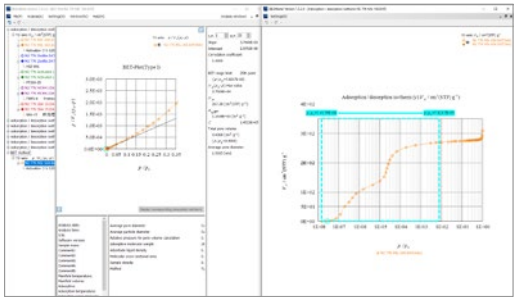
Software Features

- **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**
- **Two sub modes are available:**
  I High-precision mode for R&D
  I Quick BET mode for QC

BELSORP MAX G

BELMASTER EVALUATION SOFTWARE





Software Features

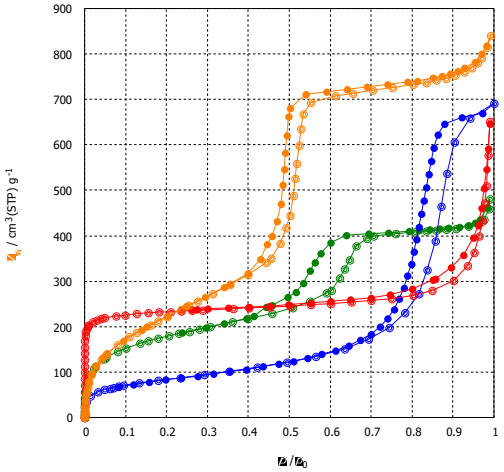
- Analysis data and results can be saved by Drag & Drop (MS Excel format)
- Easy change of chart overwriting, X-Y axis scaling, unit conversion, and more
- Result window can be saved for further analysis after a computer restart
- Routine analysis setting function (useful for repeated analyses)
- Customized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

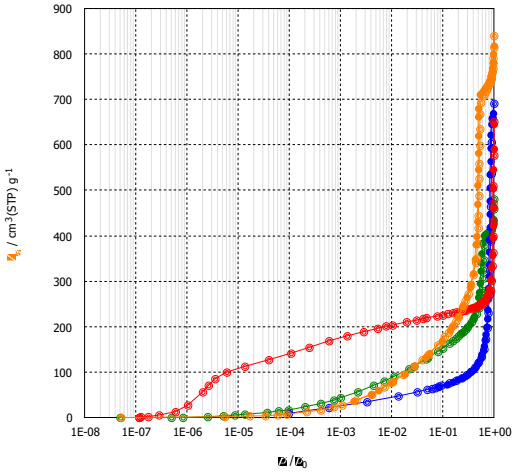
- Adsorption-desorption isotherm / PCT curve
- BET Specific Surface Area, incl. ISO9277 / Rouquerol plot for Type I isotherms
- Langmuir & Freundlich specific surface area
- INNES, BJH DH & CI method (mesopores)
- HK, SF & CY method (micropore distribution, only for BELSORP MAX series)
- t-plot method (micro to mesopore analysis)
- αs plot method (micro to mesopore analysis)
- MP method (micropore distribution)
- Dubinin-Astakhov & Dubinin-Radushkevich method (micropore volume)
- Isosteric heat of adsorption (for MAX series)
- Differential adsorption isotherm
- Fractal dimension
- Molecular Probe Method (ultra micropore)
- Adsorption rate analysis
- BELSim™: NLDFT / GCMC (ISO15901-2) for micro- to- macropore distribution

MEASUREMENT RESULTS

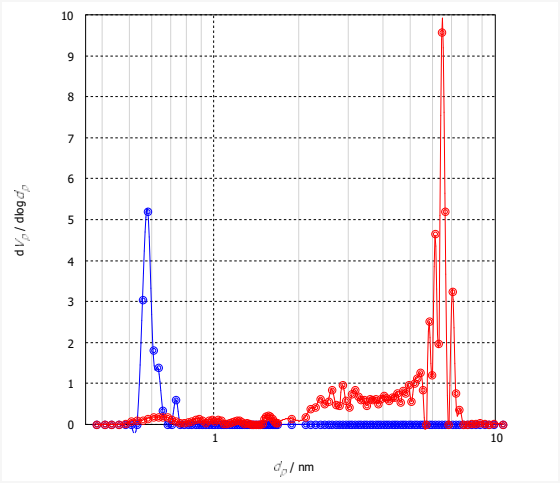
BELSORP MAX G



Gas sorption measurements of meso-/microporous materials: nitrogen sorption isotherms of Aluminum-fumarate (red) and Develosil100 (blue) at 77.4 K and argon sorption isotherms of MCM-41 (orange) and SBA-15 (green) at 87.3 K.



Logarithmic scaled gas sorption measurements of meso-/microporous materials: nitrogen sorption isotherms of Aluminum-fumarate (red) and Develosil100 (blue) at 77.4 K and argon sorption isotherms of MCM-41 (orange) and SBA-15 (green) at 87.3 K.



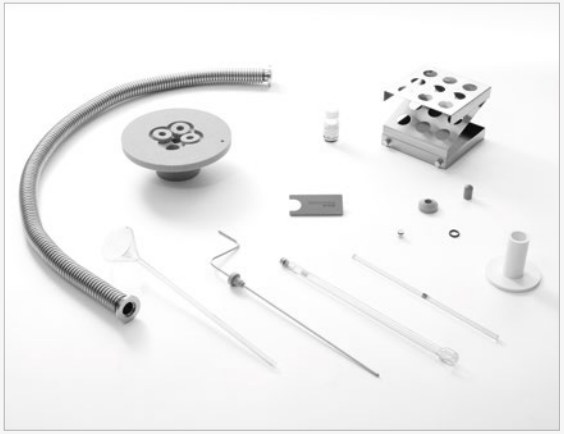
GCMC pore size distributions of SBA-16 (red) and MS-5A (blue) based on argon adsorption isotherms at 87.3 K

NLDFT (Non-localized Density Functional Theory) and GCMC (Grand Canonical Monte Carlo) are methods, which can evaluate micropores to meso- and macropores using a unified theory. For a given pore morphology and pore size, an adsorptive and an adsorbent, and for a given temperature, a theoretical isotherm is calculated for a range of discrete pressures. From a set of such theoretical isotherms for a discrete range of pore sizes, the so-called kernel, an experimental isotherm is fitted and a pore size distribution is obtained as a result.

Microtrac provides evaluation methods which cover a wide range of pore sizes and various adsorbates, such as N_2 (77.4 K), Ar (87.3 K), and CO_2 (298 K). It uses NLDFT / GCMC kernels of slit, cylinder, and cage pore models with carbon and metal oxide surface atoms, resulting in the most appropiate description of porous materials. Our BELMASTER software (Ver. 7) allows for the easy comparison between experimental and simulated isotherms, with the simulated isotherm serving as a basis for the PSD calculation. The similarity between them is an indicator for the correct PSD calculation.

BELSORP MAX G

FURTHER OPTIONS & ACCESSORIES



STANDARD CONSUMABLE GOODS

- Sample cells, filler rods, filters, O-rings, caps & weighing platforms, NSD capsules, various sizes of sample cells, quick seals, and much more.

GAS SELECTORS

- Up to 5 gases (1x He and 4x adsorptive) can be mounted with external gas selectors to accommodate different types of adsorbates.

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.

TECHNICAL DETAILS

SPECIFICATIONS AT A GLANCE

System		BELSORP MAX G MP	BELSORP MAX G LP
Measurement principle		Volumetric method + AFSM™ (Advanced Free Space Measurement)	
Adsorption gas		N_2, Ar, Kr, CO_2, H_2, O_2, CH_4, butane, and various other non-corrosive gases	
Adsorption vapor		-	
Number of measurements (high accuracy mode)		1 sample	
	Specific surface area	~0.01 m^2/g (N_2), ~0.0005m^2/g (Kr) (depending on sample density)	
	Pore size distribution (⌀)	0.35~500 nm (from ~0.25 nm when CO_2 is used)	
	Low pressure isotherm	P/P_0 = ~10^{-8} (N_2 @ 77K, Ar @ 87K)	
	Vapor adsorption	-	
Pressure transducer	133 kPa (1000 Torr)	3	3
	1.33 kPa (10 Torr)	1	1
	0.133 kPa (1 Torr) 0.0133 kPa (0.1 Torr)	1 (0.133 kPa)	1 (0.0133 kPa)
Thermostatic air oven		-	-
Gas ports		2 ports (5 ports max.)	
CE certificate		✓	

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 MAX G	⊕	⊕	⊕	+	⊕	⊕	⊕	-	-	+

⊕ *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.

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