



BET SPECIFIC SURFACE AREA & PORE SIZE ANALYZER

BELSORP MINI X

microtrac.com/ru/products/gas-adsorption-measurement/surface-area-pore-size-distribution/belsorp-mini-x/

BELSORP MINI X

BET SPECIFIC SURFACE AREA & PORE SIZE ANALYZER

For simple, fast and highly accurate characterization of porous materials

Microtrac's BELSORP MINI X's outstanding features result in world class repeatability, with significantly reduced measurement time. The MINI X is equipped with up to 4 sample measurement ports and new high-throughput functions including multi-device control.

The BELSORP MINI X is meticulously designed to measure specific surface area, pore size distribution and pore volume with extreme accuracy. Equipped with dedicated pressure sensors on each sample measuring port and a dedicated port for saturated vapor pressure, it enables completely independent simultaneous measurements.

The new measurement software improves user productivity by streamlining measurement procedures with in-software step-by-step instructions, displaying the measurement progress and sending the measurement results via e-mail. Depending on your sample throughput, a 3-port and 4-port models are offered.

Additionally, the new analysis software (BELMASTER™) enables structural evaluation of a wider range of materials than ever before.



INDEPENDENT MEASUREMENT PORTS

Up to four specimens can be measured simultaneously, enabling the measurement times for multiple samples to be shortened significantly.

BELSORP MINI X

WORLD CLASS LEVELS OF REPRODUCIBILITY

- Up to four independent measurement ports and one dedicated port for saturated vapor pressure measurements
- Smallest & lightest in the world
- Unbeatable reproducibility by patented AFSM™
- Gas adsorption isotherm & NET adsorption measurement through AFSM™2 without the need of He-gas
- Multiple Measurement Methods: High-precision measurements, multi-sample measurement, and quick BET measurement modes to suit your purpose
- Dedicated pressure transducer for each port
- Simultaneous control of up to 20 measurement ports via multi-device control (5 units)
- Short measurement time with GDO
- IoT: Process monitoring via e-mail notification system
- Optional micropore analysis by molecular probe method
- Optional FDA 21 CFR Part 11 compliance

BELSORP MINI X

КЛЮЧЕВАЯ ОСОБЕННОСТЬ

BET specific surface areas from $0.01 \text{ m}^2/\text{g} \sim (\text{N}_2)$ and pore size distribution from $0.7 \sim 500 \text{ nm}$ (option: $0.35 \sim 500 \text{ nm}$ by molecular probe method).

SIMULTANEOUS MEASUREMENT OF MULTIPLE SAMPLES

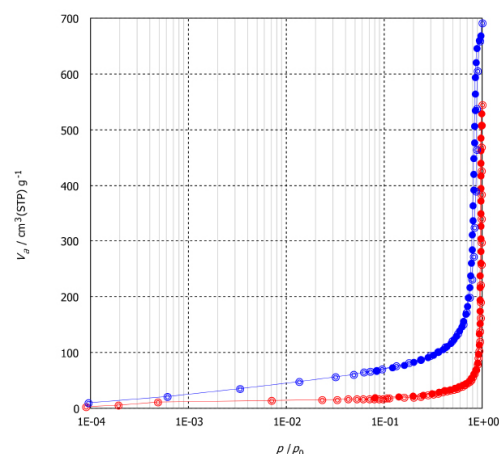
Up to 4 specimens can be measured simultaneously, enabling the measurement times for multiple samples to be shortened significantly.

MULTIPLE MEASUREMENT OPTIONS

This instrument brings together highly accurate measurements with several high throughput modes (e.g. Quick BET mode, Gas Dosing Optimization). It can be used flexibly depending on customer needs.

EASE OF USE: SIMPLE SETTING OF MEASUREMENT SOFTWARE

The BELSORP MINI X is a fully automatic measurement system. Simple Mode allows for accurate measurements with minimal sample information. Detailed configurations can be set in Professional mode.

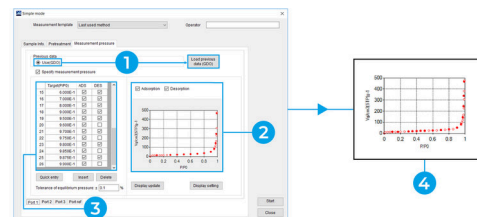


BELSORP MINI X

MEASUREMENT METHODS

GAS DOSING OPTIMIZATION (GDO)

Simple Mode includes the Gas Dosing Optimization (GDO) option, which automatically calculates the optimal gas dosing amount from previous measurement results. With this function, the measurement set points can be reliably obtained and the measurement times can be reduced significantly.



INNOVATIVE FREE SPACE MEASUREMENT FOR HIGHEST ACCURACY (AFSM™)

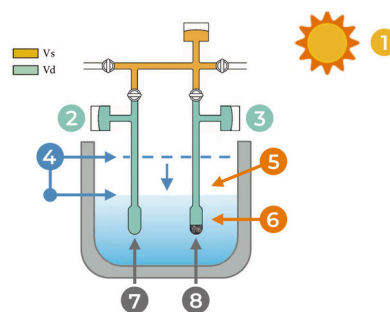
With AFSM™, the level control of liquid coolant (e.g. liquid nitrogen or argon) is not necessary anymore. Instead, we have adopted our groundbreaking, continuous free space measurement method, the patented Advanced Free Space Measurement (AFSM™).

This method has achieved highest reproducibility by using a reference cell (empty sample cell; same type of sample cell used for measurement) to follow second-to-second changes of free space. Since the change of free space is equal in the sample and reference cells under the same environmental conditions, the free space change can be continuously followed by the pressure change of the reference cell.

Free space fluctuations caused by environmental factors can be considered:

- | LN₂ level changes
- | Atmospheric temperature / pressure changes
- | Temperature changes of coolant due to oxygen dissolution

With this technique, environmental factors can be taken into account that were not considered before.

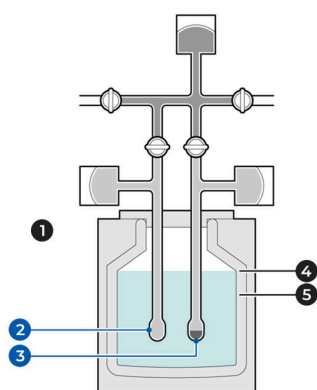


BELSORP MINI X

HELIUM-FREE MEASUREMENT & PRETREATMENT

ADSORPTION MEASUREMENT WITHOUT USING HELIUM GAS (AFSM™2)

First, free space measurement for a blank sample cell and a blank reference cell is performed with the adsorptive gas at the appropriate adsorption temperature. Then adsorption measurement can be achieved by utilizing both cells without helium gas. As free space changes for both cells are the same, measurement results can be obtained in a shorter time, without keeping the coolant level constant between blank and adsorption measurements.



COMPACT & LIGHTWEIGHT

Through complete optimization and rationalization of the materials, we succeeded in reducing the device size and weight.

OPTIONAL PRETREATMENT OF SAMPLES AT MEASUREMENT PORT

For accurate adsorption measurement, samples are usually pretreated by vacuum under heat to remove adsorbed gas and/or water molecules without affecting sample structure. Pretreatment can be performed externally using BELPREP VAC II or VAC III to increase throughput, or directly at the BELSORP MINI X measurement port using a heater. Avoiding transfer is important for sensitive, e.g. hydrophilic, samples.

DATA ANALYSIS

BELMASTER enables display of adsorption / desorption isotherms; BET specific surface areas; pore volumes by t-plot or αS method; mesopore analysis by DH and BJH; micropore analysis by HK or SF; and optional GCMC / NLDFT analysis.

MORE BELCONTROL FEATURES

- | Overlaying adsorption / desorption isotherms and comparing data between ports during measurement
- | Store pressures, temperatures and valve actuations in trend data
- | System check function for diagnosing instrument status
- | E-mail notification of measurement status and results
- | Interactive program in Japanese or English
- | Step-by-step instructions and extensive help functions

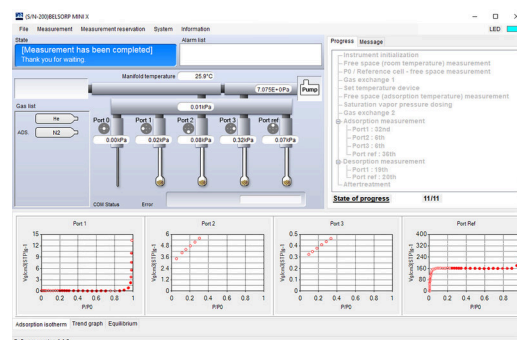
BELSORP MINI X

BELCONTROL: NEW OPERATION SOFTWARE

The versatility of BELSORP equipment is complemented by BELCONTROL, the intuitive, user-friendly operation software. It guides the user step-by-step through setup of analysis conditions, measurements, filling the liquid nitrogen or other bath, replacement of gas cylinders and degassing steps. It is designed to make the instrument accessible to inexperienced users.

For inexperienced users or measurements of unknown samples, BELCONTROL only requires basic sample information (name, mass, etc.), pretreatment conditions (if not performed externally) and measurement range.

Professional Mode permits detailed control of dosing settings, equilibrium criteria, leak-test options and other measurement configurations. Simple Mode reduces setup requirements; when a comparable prior isotherm is available, GDO can shorten measurement time.



BELCONTROL

Quick BET	Да	Multi-point BET surface area in less than 20 minutes
Helium-Free Measurement	Да	AFSM™2 enables He-free measurements with unmatched accuracy
Adsorption Kinetics	опционально	Rate of adsorption measurements for diffusion analysis

OPERATION SOFTWARE

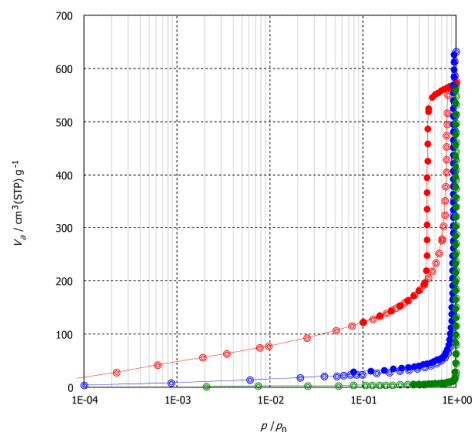
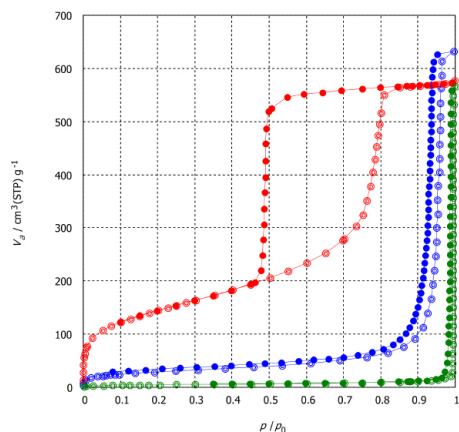
Программное обеспечение имеет наивысший приоритет для упрощения работы и оснащено множеством функций для повышения производительности труда. Наше программное обеспечение поможет Вам шаг за шагом выполнить несколько процедур, например, выполнить измерения, заменить газовый баллон, продуть коллектор и т.д. Эта удобная функция делает прибор доступным даже для неопытных пользователей. Предлагаются два режима: Простой режим и Профессиональный режим.

УЗНАТЬ БОЛЬШЕ → microtrac.com/ru/products/gas-adsorption-measurement/software/belcontrol/

GAS ADSORPTION MEASUREMENTS

EVALUATION SOFTWARE BELMASTER

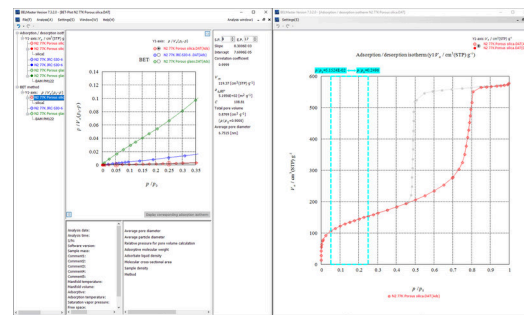
A sorption isotherm is the relationship between the adsorbed amount and the equilibrium pressure of an adsorptive gas at constant temperature. Gas sorption isotherms provide information about specific surface area, pore size distribution and pore volume.



Specific surface area (SSA) refers to a sample's accessible surface area and is important in adsorption and catalytic reactions. It can be calculated according to ISO 9277 with the BET method or by the Langmuir method. Select a pressure range (multi-point BET) or point (single-point BET) and the surface area is calculated automatically; BELMASTER also supports calculation according to ISO 9277 Annex C for microporous materials.

The MINI X measures low-surface-area samples accurately without krypton gas. Its Quick BET Mode obtains three-point BET results from four samples in approx. 15 minutes. BELMASTER derives pore size distributions from 0.7 to 500 nm (optional: 0.35 nm) from measured isotherms.

Microtrac обеспечивает анализ распределения по размеру пор следующего поколения с помощью передовых методов QSDFT, NLDFT и GCMC в диапазоне размеров пор от 0,35 до 500 нм. BELMaster имеет библиотеку из 59 ядер для N₂, Ar и CO₂.



ВЫСОЧАЙШАЯ ТОЧНОСТЬ ПРИ НАИМЕНЬШИХ ПЛОЩАДЯХ ПОВЕРХНОСТИ

AFSM™

Следующие измерения проводятся с использованием нашего запатентованного непрерывного метода измерения свободного пространства Advanced Free Space Measurement (AFSM™). Этот метод достиг наивысшей воспроизводимости за счет использования эталонной ячейки для отслеживания изменений свободного пространства. Для проверки точности используется сертифицированный эталонный материал CRM-170 (непористый альфа-оксид алюминия; сертифицированное значение удельной поверхности азота BET SSA: $1,05 \pm 0,05 \text{ м}^2/\text{г}$). Даже при снижении общей площади поверхности примерно с 2 м^2 до менее $0,4 \text{ м}^2$ значения BET SSA остаются практически идентичными.

ПРЕИМУЩЕСТВА ЗАПАТЕНТОВАННОЙ ТЕХНОЛОГИИ AFSM

- Не нужно поддерживать уровень LN_2
- Улучшает воспроизводимость как по площади поверхности, так и по объему пор
- Обеспечивает изотерму адсорбции материала с низкой площадью поверхности без использования газообразного криптона (общая площадь поверхности до $0,1 \text{ м}^2$)

Образец	добавки	Общая площадь [м²]	Количество [г]	SSA-BET [м²/г]	С-постоянная
BCR-170_1	N ₂	~2	~1.94	1.03	114
BCR-170_2	N ₂	~1	~1.12	1.02	143
BCR-170_3	N ₂	~0.7	~0.75	1.03	101
BCR-170_4	N ₂	~0.4	~0.38	1.02	50

*Коэффициент корреляции 0,9995 или выше

BELSORP MINI X

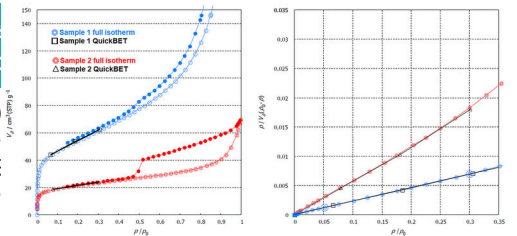
РЕЖИМ БЫСТРОГО BET

The Quick BET Mode can be used to maximize sample throughput: three BET adsorption points of four samples can be measured in approx. 15 minutes (sample density required). A previous free-space measurement file can be reused, or free space measured together with the sample.

Образец	Стандартный многоточечный	Быстрый многоточечный	Стандартный односточечный	Быстрый односточечный
1	189.9	190.5	188.1	190.5
2	75.7	77.4	74.7	75.7

BET-SA в $\text{м}^2/\text{г}$; N_2 ; многоточечный p/p_0 0,05–0,30, односточечный p/p_0 0,20.

Результаты измерений в режиме быстрого BET полностью сопоставимы со стандартным режимом; время измерения значительно сокращается.



BELSORP MINI X

ПРИНЦИП РАБОТЫ

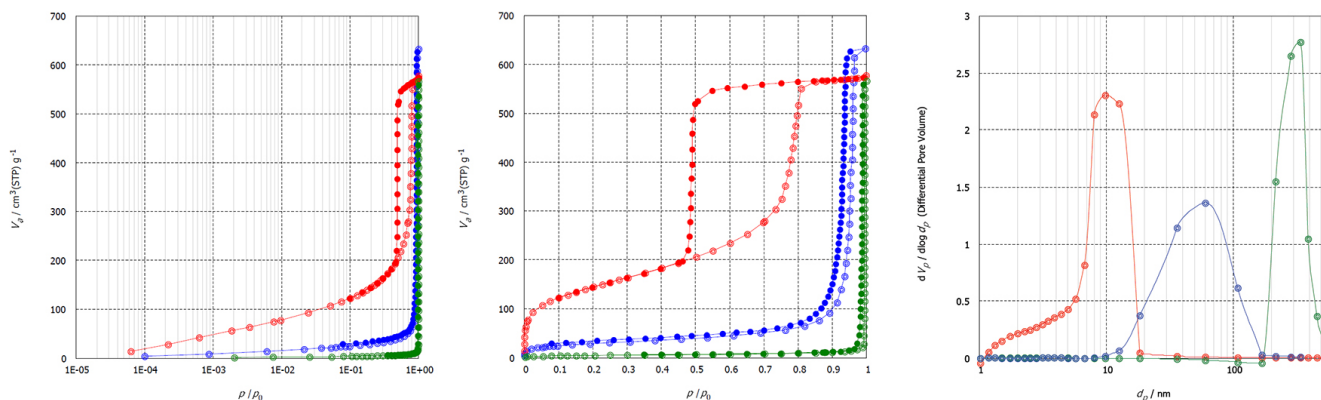
ANALYSIS OF PORE SIZE DISTRIBUTION VIA NLDFT & GCMC METHOD

The classical pore size distributions (PSD) are calculated by INNES method (slit shape) and BJH, DH, CI methods (cylinder shape), which evaluate mesopores based on capillary condensation theory. HK, SF and CY methods evaluate micropores. NLDFT and GCMC (optional for BELSORP MINI X) extend analysis across micro-, meso- and macropores and are specified in ISO 15901-2.

Теория	Interaction Surface and Gas	Adsorbate	Applicable Pore Size Range
BJH, CI, DH, INNES method	Kelvin equation (surface tension and contact angle)	Bulk liquid density	> 2 nm; meso and macropore
HK, SF, CY method	Lennard-Jones potential (interaction and repulsion force)	Bulk liquid density	0.4–2 nm; micropore
NLDFT, GCMC	Statistical thermodynamic model		0.35–500 nm; whole pore range

Microtrac provides evaluation methods for N₂ (77.4 K), Ar (87.3 K) and CO₂ (298 K), using NLDFT / GCMC kernels of slit, cylinder and cage pore models with carbon and metal oxide surface atoms. BELMASTER makes it easy to compare experimental and simulated isotherms, the latter serving as a basis for pore size distribution calculations.

In the following part an example for pore size distribution calculation by BJH method is given:



BELSORP MINI X оснащен датчиками давления 1000 торр; изотерма начинается с $\sim P/P_0 = 1 \times 10^{-4}$. Опция: 0,35 нм методом молекулярного зонда.

BELSORP MINI X

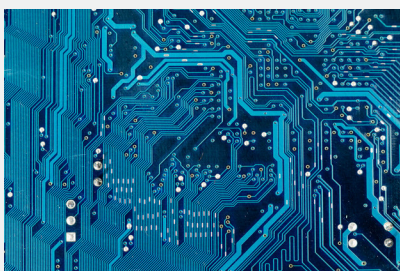
ТИПИЧНЫЕ ПРИМЕРЫ ПРИМЕНЕНИЯ

Microtrac's gas adsorption analyzers are used in a variety of fields. These include catalysts, batteries, fibers, polymer materials, zeolite, fuel cells, chemicals, pigments, cosmetics, MOF / PCP, magnetic powders, separation membranes, filters, toners, cement, ceramics, semi-conductors, and many more.



ЭНЕРГЕТИКА И ПОРИСТЫЕ МАТЕРИАЛЫ

- | материалы аккумуляторов
- | катализаторы
- | цеолит
- | керамика
- | Углерод



ПРОМЫШЛЕННЫЕ МАТЕРИАЛЫ

- | электронные компоненты
- | Топливные элементы
- | Тонер
- | цемент
- | медицина / фармацевтика



СПЕЦИАЛЬНЫЕ МАТЕРИАЛЫ

- | Кварц
- | MOF / PCP
- | пигменты
- | косметика
- | ... и еще много чего!

БАЗА ДАННЫХ ПРИМЕНЕНИЙ

Чтобы найти лучшее решение для вашего применения в определении размера частиц, посетите нашу базу данных применений.

БАЗА ДАННЫХ ПО ПРИМЕНЕНИЮ → microtrac.com/ru/applications/application-database/

АКСЕССУАРЫ И ОПЦИИ



STANDARD CONSUMABLE GOODS

The standard consumables comprise sample cells, filler rods, filters, O-rings, caps and weighing platforms. Various sizes of sample cells, quick seals, and other optional consumables are also available.



WATER BATH

Easily swap the Dewar with a water bath for measurement temperatures ranging from -10°C to 80°C. A refrigerated / heated circulator is required.



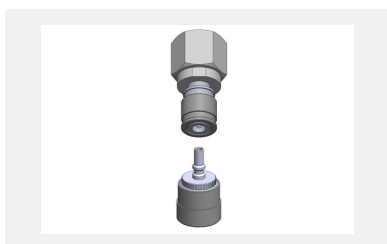
HEATER

In-situ pretreatment of the sample from 50°C to 550°C, directly at the measurement port without transferring the sample cell before analysis. Particularly useful for sensitive samples.



GAS SELECTOR

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



ИЗМЕРИТЕЛЬНАЯ СИСТЕМА AIRGUARD

Система измерений AirGuard обеспечивает точный анализ удельной поверхности по методу BET и распределения по размерам пор на приборах BELSORP, защищая чувствительные образцы от воздействия влаги и кислорода. Благодаря простой установке в один клик AirGuard обеспечивает высокоточные измерения без увеличения времени анализа и может быть установлена на существующие системы BELSORP.

BELSORP MINI X

ХАРАКТЕРИСТИКИ

Принцип измерения	Объемный метод + AFSM™
Адсорбция газа	Азот (N ₂), Аргон (Ar), Метан (CH ₄), Этан (C ₂ H ₆), диоксид углерода (CO ₂), водород (H ₂), н-бутан (n-C ₄ H ₁₀), изобутан (i-C ₄ H ₁₀) и другие некоррозионные газы
Порты газа	2 порта (макс. 5 портов)
Количество измерений (Режим высокой точности)	Макс. 4 порта одновременно (3 порта в режиме высокой точности)
Диапазон измерений (удельная поверхность)	0,01 м ² /г и выше (N ₂), в зависимости от плотности образца
Распределение пор по размерам (Диаметр)	0,7 - 500 нм, опция: возможно 0,35 нм методом молекулярного зонда
Изотерма низкого давления	$p/p_0 = 10^{-4}$ (N ₂ @77K, Ar @87K)
Датчик давления	133 кПа (1000 Torr) x 6 единиц
Вакуумметр / насос	Роторный насос
Пробирка для образца	Стандартная трубка, приблизительно 1,8 см ³ (опционально: 5 см ³)
Сосуд Дьюара	Объем: 2 л; Время выдержки: 30 ч
Подогреватель предварительной обработки	50 - 450°C (4 порта)
Водяная баня	-10 - 80°C (4 порта)
Программное обеспечение для анализа BEL Master° 7	Изотермы адсорбции, BET удельной поверхности области тип I (в соответствии с ISO 9277), BET автоматический анализ, удельная поверхность Ленгмюра, VJH, DH, CI, INNES метод
Аналитическое программное обеспечение BELMaster™ 7 cont.	t-участок, NLDFT / GCMC (OP BELSim™), МР метод, метод Дубинин-Астахова, молекулярный зонд, as-участок
Размеры (Ш x В x Г)	280 x 650 x 465 мм (без учета вакуумного насоса и ПК)
Вес (основной корпус)	38 кг (исключая вакуумный насос и ПК)
Используемый газ	He, N ₂ (99,999% или более высокая чистота), 0,1 ± 0,02 МПа, соединение: 1/8 " Быстросъемное / выпуск: выпускное отверстие роторного насоса, Ø 11 мм
Используемая мощность	Однофазный, переменный ток 100~240 В (50/60 Гц) / 10А (Вкл. R. P.), 50/60 Гц
CE certified	да
Рекомендуется Монитор	Мониторы с разрешением Full HD

BELSORP MINI X

СВЯЖИТЕСЬ С НАМИ →

microtrac.com/ru/contact/contact-form/?prefilltext=contact_form.request&product=602

ЗАПРОС ПРЕДЛОЖЕНИЯ →

microtrac.com/ru/contact-services/quote-request-form/?prefilltext=contact_form.quote_request&product=602



MICROTRAC
a **VERDER** company

microtrac.com/ru/products/gas-adsorption-measurement/surface-area-pore-size-distribution/belsorp-mini-x/

© Microtrac – microtrac.com / Content may be subject to modifications or corrections