BELSORP-max

High performance gas and vapor adsorption instrument
–Surface area and porosity analysis–

Up to 3 independent samples measured simultaneously

Precise low pressure measurement

High accuracy (AFSM™)

BEL

BEL JAPAN, INC.

Specialist in Adsorption

OVERVIEW

To obtain useful information about micropore, it is important to measure adsorption isotherm from low relative pressure with accuracy. The BELSORP-max is designed to measure wide range adsorption isotherm for surface area and pore size distribution analysis. It can measure adsorption isotherms from relative pressure as low as 1×10^{-8} (N_2 at 77K, Ar at 87K), using a 13.3Pa pressure transducer. Also AFSM™, the new method for free space measurement, is applied and adsorption isotherm can be measured with high accuracy. In addition to gas adsorption measurement, vapor adsorption measurement can be performed and chemisorption option enables unattended chemisorption analysis to perform the process from pretreatment to isotherm measurements.
The BELSORP-max is a high-end adsorption instrument which provides all the researchers in any fields and industries with useful information for surface characterization.

FEATURES

■ Accurate wide range pressure measurement – from extremely low pressure to 133kPa

13.3Pa (0.1mmHg) sensor and enhanced 24bit A/D converter make it possible for the BELSORP-max to measure isotherms from extremely low pressure ($p/p_0=1 \times 10^{-8}$, N_2 at 77K and Ar at 87K) with high accuracy.
Seal material for the valves applied to BELSORP-max is metal which remarkably reduces the effect of gas emission compares to rubber seal which adsorb moisture and gases easily, and emits them under vacuum to have negative effect on low pressure measurement. Not only low pressure measurement, totally 8 transducers measure pressure of each part precisely.

■ Multi sample measurement

The BELSORP-max is equipped with 3 independent analysis ports and a dedicated port for saturation vapor pressure measurement. Each port has pressure sensors enabling up to 3 simultaneous and independent sample measurements. There are three modes for operation:

Standard mode ($p/p_0=10^{-4}$ – 0.997) : Three analysis ports are used for sample measurement and the fourth port is used for measurement of the saturated vapor pressure. The change in the free space is calculated from a calibration based on a prior measurement. Standard mode is used to achieve higher sample throughput and is ideal for QC applications.

High accuracy mode ($p/p_0=10^{-4}$ – 0.997) : Two analysis ports are used for samples and the other two ports are used for measurement of the saturated vapor pressure and the free space of the sample cell. The high accuracy mode is used for samples with very small surface areas or whenever the most accurate data is required.

High accuracy and low pressure mode ($p/p_0=10^{-8}$ – 0.997) : Among three analysis ports, one port is equipped with low pressure sensor. This port is used for isotherm measurement from extremely low relative pressure as low as 1×10^{-8} (N_2 at 77K, Ar at 87K), using a 13.3Pa pressure transducer to analyze microporous material such as active carbon and zeolite. One more low pressure port can be added as an optional. It is effective for high-throughput measurement for micropore analysis.

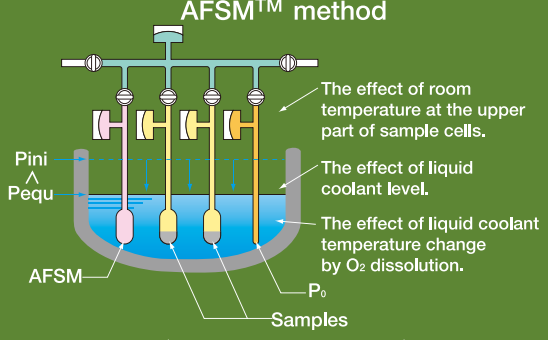
■ Multipurpose

A variety of gases and vapors can be used as adsorptives.

- Nitrogen and argon adsorption for specific surface area and pore size distribution.
- Non-corrosive gas such as hydrogen, oxygen, CO_2, CH_4, etc...
- Chemisorption gas such as H_2, CO, NH_3, etc...
- Kr adsorption. (For low surface area material.)
- Water vapor adsorption. (Useful especially for food and pharmaceutical industry.)
- Alcohol, benzene and other VOC vapor adsorption.

■ AFSM™ - A new method for free space measurement

BEL has developed a unique method, AFSM™ (Advanced Free Space Measurement) to compensate for free space change in the sample cell. This new method was applied to the BELSORP-mini and enjoys a high reputation for its accuracy and reproducibility.
Most conventional instruments require controlling liquid coolant level to keep free space in the sample cell constant. But AFSM™ does not require the coolant level control. With the AFSM™, the free space change with the coolant level lowering can be compensated by measuring the pressure change of separate sample cell. Conventional methods cannot cancel the free space change caused by other reason than liquid coolant level drop, such as temperature fluctuation at the upper part of sample cell, the change of the liquid coolant temperature caused by dissolution of oxygen, etc. But AFSM™ can eliminate all the factors. We adopted AFSM™ for the BELSORP-max and high quality measurements can be performed.



< High accuracy mode >

■ Chemisorption option

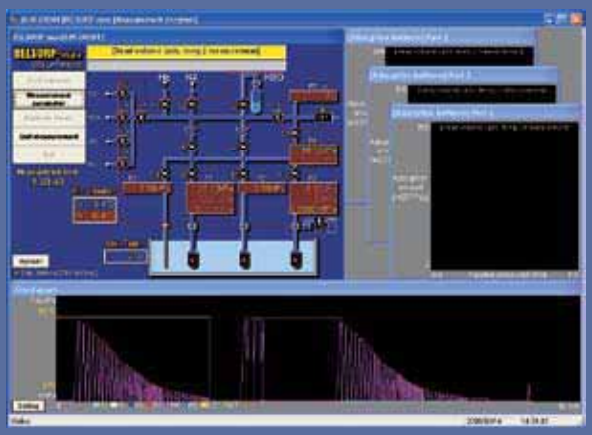
H_2 and CO chemisorption measurement is useful for determining active site of rare metal such as Pt and Pd.
This option allows automatic sample pretreatment in gas flows, oxidation and reduction, etc...
Pretreatment temperatures and procedures can be set up to 1100℃ on the measurement software and that enables unattended chemisorption analysis to perform the process from pretreatment to repeat measurement.

■ Thermostatic air oven

Pressure transducers and valves are installed in the temperature controlled air oven, which makes the pressure gauge outputs stable.When using optional water bath, the temperature at an upper part of the sample cell can be kept constant to prevent condensation of liquid adsorptives, which allows vapor adsorption.

SOFTWARE

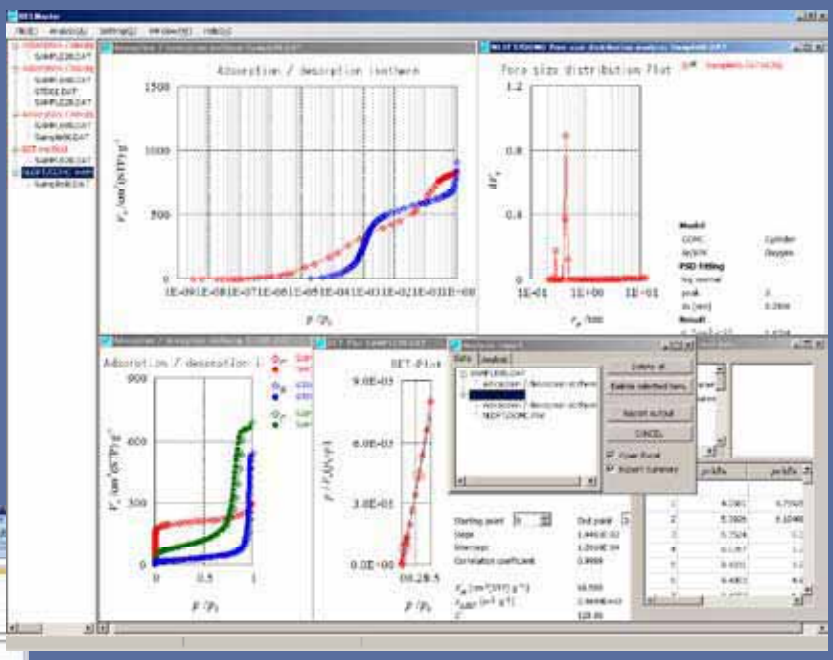
■ Measurement software

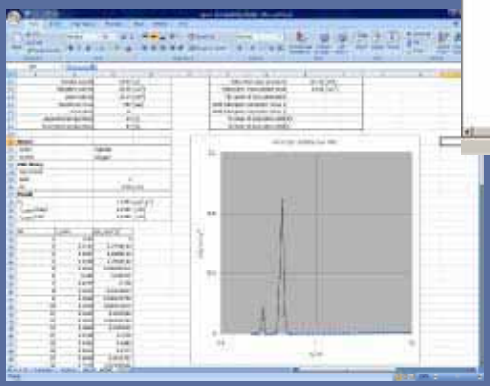


- High throughput measurement sequence control.
- Display of instrument status, trend chart and real-time isotherm.
- Measurement parameters can be altered during sample measurement.
- System check program for instrument status and diagnostics.
- Guidance message makes the operation easy.
- Interactive instrument schematic for control of valves. Simply click the appropriate symbol on the schematic.

■ Analysis software-BELMaster™

- Multilanguage
- Simple drag and drop data manipulation.
- Support of data overlays for comparing different samples.
- Analyzed result is can be transferred to Excel* spreadsheet and plotting programs using CSV data file format.
- Set preferred analysis options using the Routine Analysis Function.
- User can create custom reference isotherms for t-curve and αs analysis.
- BELSim™ the latest powerful pore size evaluation method (NLDFT/GCMC) is included as standard configurations.
- Analysis Options:
  - Adsorption/Desorption isotherm
  - PCT curve
  - BET method
  - Langmuir method
  - BJH/CI/DH/INNES method
  - αs plot
  - t plot
  - MP method
  - Horvath-Kawazoe method
  - Saito-Foly method
  - Dubinin-Astakhov method
  - Difference of adsorption isotherms
  - Molecular probe method
  - BELSim™ (GCMC and NLDFT analysis)





*Microsoft Excel is the trademark of Microsoft Corporation.

OPTIONS

■ Low pressure transducers for port 1 (010-10013-0-0)

In extremely low pressure range, it takes too long time to attain equilibrium. With this option, two analysis ports can be used for low pressure measurement. It is effective for high-throughput low pressure measurement.

■ Chemisorption (010-10012-1-5)

This option enables unattended chemisorption measurement of gases such as CO and H_2 which allows catalysis evaluation such as metal dispersion, active metal surface and average particle size of supported metal by volumetric method.

*Including items for this option:
010-10004-0-0, 010-20008-0-0, 010-210001-0-0

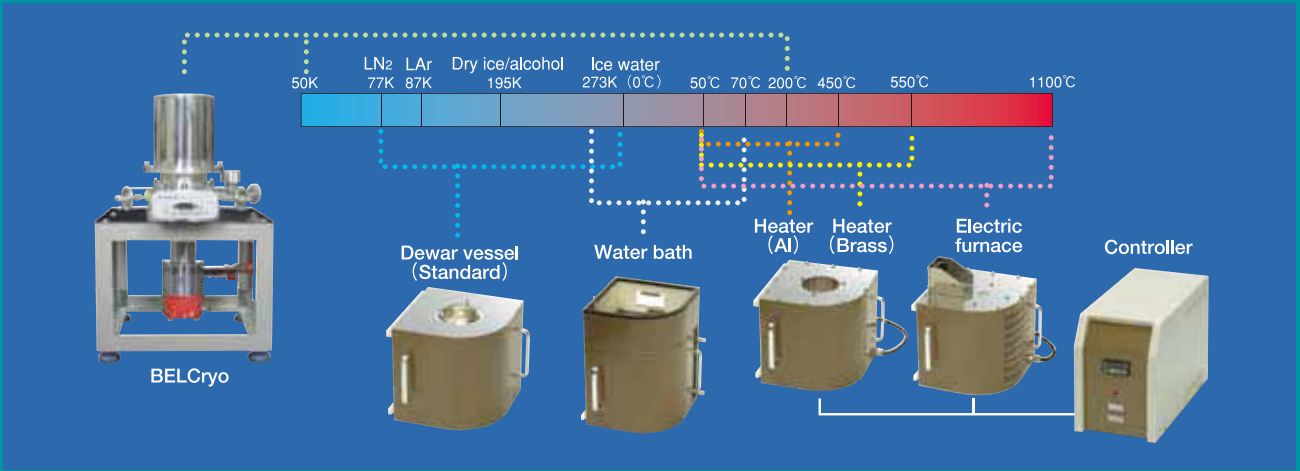
■ TPDpro (010-10017-0-x*1)

With this option, BELSORP-max can perform various essential analyses for catalyst evaluation such as TPD, TPR, TPO and pulse chemisorption. Highly sensitive TCD sensor detects concentration in the gas stream and adsorbed amount can be calculated from the concentration change by dynamic method.

■ 4-port gas selector (010-10004-0-0)

4 additional gas connection ports. Adsorption gas can be selevted by the measurement software.

■ Measurement temperature control



Model number	Name	Specifications		Standard	Option
010-10011-0-0	Dewar vessel	LN_2 : -196℃(77K), -78℃(195K), 0℃(273K)		○	
010-10010-0-0	Water bath*2	-10℃～70℃, closed bath			○
010-10006-0-x*1	Block heater (Al)	50 ～ 450℃, 110 or 220VAC			○
010-10005-0-x*1	Block heater (Brass)	50 ～ 550℃, 110 or 220VAC			○
010-10007-0-x*1	Electric furnace	50 ～ 1100℃, 110 or 220VAC			○
010-10008-0-5	Controller	100V-240V, 600W			○
010-10019-0-1	BELCryo	-223℃(50K)～200℃(473K) (Accuracy:±2mK at 77K)	1-measurement Port		○
010-10020-0-1			2-measurement Port		○

*1 x is the code for the power voltage. 1: 110VAC, 2 : 220VAC
*2 A refrigerated/heating circulator would be be provided at the customer's side.

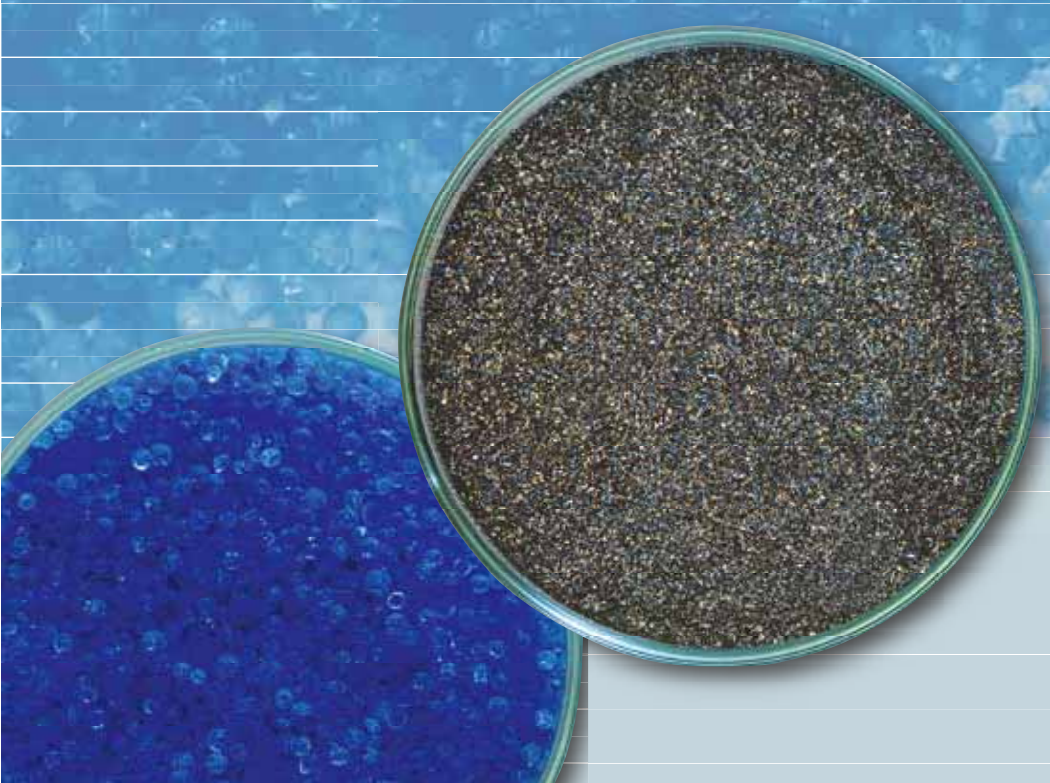
■ Sample cells

Model number	Name	Descriptions	Qt/SET	Standard	Option
010-20000-0-0	Sample cell	Standard sample cell (Max. 500℃, 1.8cm^3)	3/SET	○3SET	
010-20002-0-0	Sample cell	Small sample cell (Max. 500℃, 0.5cm^3)	3/SET		○
010-20004-0-0	Sample cell	Large sample cell (Max. 500℃, 5cm^3)	3/SET		○
010-20008-0-0	Sample cell	Chemisorption sample cell (Max. 1100℃, 1.0 cm^3)	3/SET		○
010-21000-0-0	Filler rod	Glass rod (for 010-20000-0-0, 010-20002-0-0)	3/SET	○2SET	
010-21002-0-0	Filler rod	Glass rod (for 010-20004-0-0)	3/SET		○
010-21001-0-0	Filler rod	Glass rod (for 010-20008-0-0, Max. 1100℃)	3/SET		○

SPECIFICATIONS

Measurement principle	Volumetric adsorption method+AFSM™	
Adsorptive	N_2, Ar, Kr, NH_3, CO_2, H_2, CO, O_2, CH_4 and other non-corrosive gases H_2O, MeOH, EtOH, C_6H_6 and other non-corrosive vapors	
Analysis port	STD mode ($p/p_0=10^{-4}$ −0.997) : 3 ports High accuracy mode ($p/p_0=10^{-4}$ −0.997) : 2 ports High accuracy mode ($p/p_0=10^{-8}$ −0.997) : 1 port (OP : 2 ports)	
Specific surface area	0.01m^2/g and above (N_2/77K, Ar/87K) 0.0005m^2/g and above (Kr/77K)	
Pore size distribution	0.35 - 500 nm in pore diameter	
Pressure transducer	133kPa (1000mmHg) ±0.25% of F.S. x 5 units 1.33kPa (10mmHg) ±0.5% of R. x 2 units (OP : 3 units) 0.0133kPa (0.1mmHg) ±0.15% of R. x 1 unit (OP : 2 units)	
Minimum resolvable pressuure	1.6 x 10^{-6}Pa ($p/p_0=1.6 \times 10^{-11}$,$N_2$ at 77K, Ar at 87K) -24bit A/D converter	
Thermostatic air oven	40℃	
Dewar vessel	Volume 2.6L Holding time 60H	
Sample cell	Standard: Approx. 1.8cm^3 Option: 0.5, 5cm^3	
Vacuum pump	Turbo molecular drag pump + Fore vacuum pump(OP) Ultimate vacuum: 6.7 x 10^{-7} Pa and below	
Vacuum gauge	Pirani + Cold cathode gauge (ATM −5 x 10^{-7} Pa)	
Physical	W565 x H850 x D580 mm, 84 kg (Vacuum pump and computer are excluded)	
Requirements	Computer	CPU: Intel Pentium 4 / Celeron (>1.6GHz), 256MB main memory, 1GB free space in hard disk, 2 x USB(2.0) ports, 1024 x 768 screen resolution Windows 7 / Vista / XP / 2000 (32bit)
	Vacuum pump	Ultimate vacuum : 1800Pa and below Volume displacement : 30L/min or more Connection port to main unit : NW16 or G1/4"male
Utility	Gas	He, Adsorptive gas : pres. 1±0.2 bar (Gauge) (1/8" Swagelok joint) Compressed air : pres. 4∼5 bar (Gauge) (quick connect for 1/4" plastic(teflon)tube)
	Power	Single phase: AC100-120V or 200-240V / 1500VA (400VA is for vacuum pump)

- Due to our policy of continuous product improvement, the specifications are subject to change without notice.
- Windows 2000 / XP are the trademark of Microsoft Corporation.
- AFSM, BELMaster and BELSim are the trademarks of BEL JAPAN, INC.

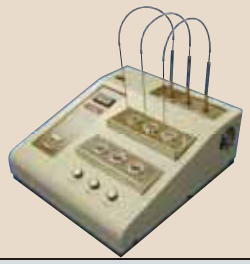


CONSUMABLE PARTS

Model number	Name	Descriptions	Qt	Standard	Option
010-22002-0-0	P_0 tube	Stainless tube	1	○	
010-22000-0-0	Funnel	Sampling glass funnel	3/SET	○	
010-22001-0-0	Liq. bottle	Glass bottle for liquid adsorptive.	1	○	
900-00011-0-0	Filter	Sample cell brass filter with Viton O-ring	6/SET	○	
900-00025-0-0	Filter	Sample cell SUS filter with Viton O-ring	6/SET		○
900-00016-0-0	Cap	Sample cell cap	10/SET	○	
900-00003-0-0	Viton O-ring	Viton O-ring for connecting sample cell	12/SET	○	
900-00004-0-0	Perfluoro O-ring	Perfluoro O-ring for connecting sample cell	6/SET		○
010-22003-0-0	Dewar vessel cover	Dewar vessel top cover	1	○	
900-00017-0-0	Sleeve	Thermal insulation sleeve for sample cell	3/SET	○	

SAMPLE PREPARATION

The BELPREP sample pretreatment systems for the BELSORP-max feature 3 sample ports and continuous display of pretreatment temperature. Sample can be degassed by vacuum or under dry gas flow while heating up to 430˚C.

		BELPREP-flowⅡ	BELPREP-vacⅡ
			
Flow/heat degassing		○	○
Vacuum/heat degassing		—	○
Ultimate pressure		—	1Pa and below
Pretreatment ports		3	
Temperature range		RT-430℃	
Temperature accuracy		±5℃	
Physical		W321xH363xD122mm 11kg	W321xH363xD122mm 15kg
Utility	Gas	N_2 gas 1±0.2bar	
	Power	AC100-120V or AC200-240V	
		515W	530W (Without vacuum pump)

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