BELCAT

The chemisorption analyzer



TPD/TPR/TPO, Pulse chemisorption

Measurement with fast, precision and easy operation

Powerful data deconvolution software

BEL

BEL JAPAN, INC.

Specialist in Adsorption

OVERVIEW

To investigate physical and chemical property of catalyst surface is essential in catalytic research. For metal supported catalyst, metal dispersion rate, metal surface area and metal particle size decide the cost and performance of the catalyst. For solid acid catalysts, the number of acid sites and acid strength determine the catalysis performance. Catalytic reaction occurs on the catalyst surface. So the specific surface area is an important factor for the catalysis evaluation.
Various methods are used for the purpose and here are the representative examples;

i). TPD measurement
ii). TPO / TPReduction, TPReaction measurement
iii). Pulse chemisorption measurement
iv). BET single point measurement

The BELCAT-series is designed to provide all these methods can be performed with just one unit. The dynamic flow method is applied. Highly-sensitive TCD detects concentration in the gas stream and adsorbed amount can be calculated from the concentration change. BELCAT-series has three models with a variety of options. You can choose the suitable one for your purpose. Each model offers highly accurate and reproducible data with simple operation.
The BELCAT will provide useful data to all the researches who are involved in the surface chemistry.

TPD measurement

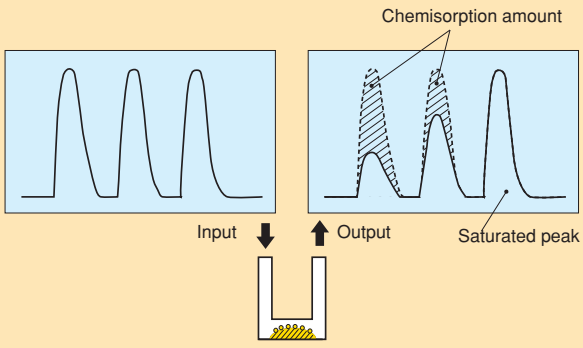
This is known as the method to obtain the information about the characteristics of chemisorption on the solid surface. The TPD spectrum is expressed as a graph with desorption amount of adsorptive on the vertical axis and the temperature on the horizontal axis.
By continually increasing the temperature of solid and measuring desorbed molecules, one can determine the number of the desorption peaks (types of adsorption active site), desorption temperature (activation energy of desorption), and the desorption amount (number of active sites).
By this method, it is easy to obtain the detail information about the active sites of catalyst. Therefore, it is often used to study solid catalyst. (Especially NH3-TPD for acid catalyst)

TPO/TPReduction and TPReaction measurement

This is known as the method to obtain the information about the characteristics of reaction. The spectrum is expressed as a graph with the consumption amount of reaction gas or desorbed amount of reaction products on the vertical axis, and temperature on the horizontal axis.
By continually increasing the temperature of catalyst under the reactive gas flow and measuring the amount of consumed gas or produced/desorbed gas, one can determine the reacted component (detection, qualitative/quantitative analysis), distribution of reacted products, and amount of non-reacted component (reactivity).
It is possible to investigate the characteristics of catalyst reaction during the continual temperature change. Also, it is possible to observe each reaction stage if the gas has a step-by-step reaction.

Pulse chemisorption measurement

Pulse chemisorption is to repeatedly introduce reaction gas to the sample until it is saturated and from the difference in non-saturated and saturated detected peaks, it calculates the amount of chemisorption.
As the application of pulse adsorption, one can calculate the metal dispersion and metal surface area by using the gas molecules that chemisorb on the metal surface (H_2, NO, CO, etc).
Metal dispersion is defined to be the ratio of supported metal atoms and atoms that are exposed on the catalyst surface. This is used as one of the parameters to evaluate supported metal catalyst.
It is also possible to calculate the size of metal particles by assuming the shape of supported metal particles.



Metal dispersion/size of metal particles is reported to significantly affect the reactivity and selectivity of catalyst. They are widely known parameters to evaluate the supported metal catalyst.

BET surface area measurement

BET surface area per unit weight of sample. On a solid catalyst, it significantly affects the reaction efficiency because it is the contact area with the reactant.
In this method, one can cool down the sample to the liquid nitrogen temperature while having the flow of nitrogen gas diluted by helium. Then one can measure the desorption volume of nitrogen while returning to the room temperature, and calculate the specific surface area by using BET 1-point equation.
This is one of the very important methods not only for the evaluation of solid catalyst but also for the general adsorbent powder.

FEATURES

■ BELCAT-M



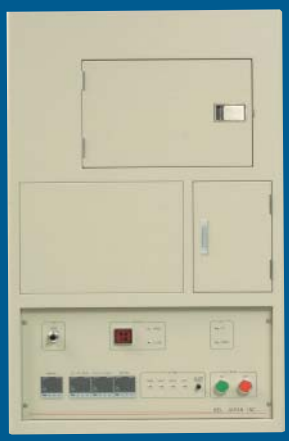
The BELCAT-M is the basic model of BELCAT series.
The BELCAT-M is a compact and an inexpensive instrument, but provides variety of measurement such as pulse chemisorption, TPD, TPO/TPR and single point BET can be performed.
Temperature control and data acquisition can be carried out by an high resolution interface and the measurement software. Valves and other parts are put on the front panel in a straightforward allay and that allows intuitive and easy operation.



■ BELCAT-B

The BELCAT-B is the standard model of BELCAT series.
Temperature control, data acquisition and valve operation can be carried out automatically. Gas flow rates for carrier and pretreatment lines are controlled accurately by MFC. A split-type electric furnace enables quick cooling. BELCAT-B can be customized as the customer's requirement. Measurement can be performed easily by setting the sample cell and entering the parameters and conditions.

■ BELCAT-A



The BELCAT-A is the high-end model of BELCAT series.
In addition to the function of BELCAT-B, vapor dosing such as water, pyridine etc. is available. The vapor concentration can be controlled with an evaporator. Valves and gas plumbing are placed in the temperature controlled air oven to prevent vapor condensation. Combining a vapor condenser with the evaporator, the vapor concentration can be controlled more accurately and in wider range.

SAFETY DESIGN

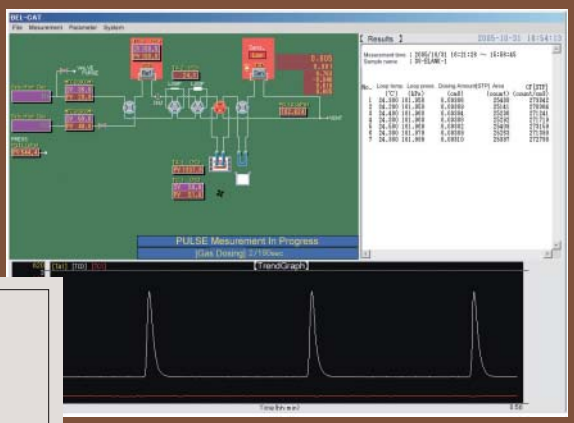
All the BELCAT models are equipped with a various safety measures.

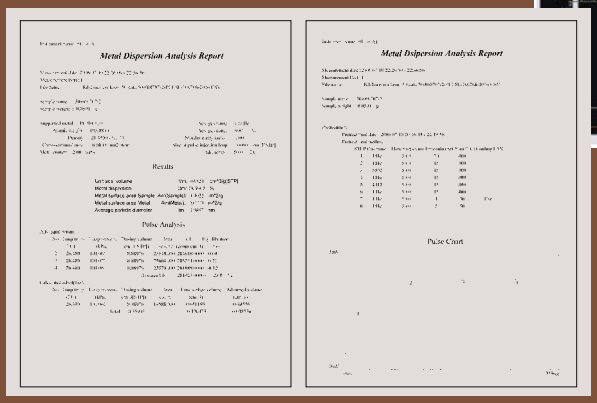
	Description	BELCAT		
		M	B	A
Furnace & Air oven	Measurement area (heating over 50℃) cover is opened accidentally, start alarming and stop hearing simultaneously.	—	✓	✓
	The temperature exceeds the pre-setting value, start alarming, turned off all the valves and stops heating.	✓	✓	✓
	The temperature of air bath exceeds the preset value, stops heating.	—	—	✓
	Incorrect temperature which exceeds maximum temperature cannot be input by software programs.	✓	✓	✓
Gas	Gas alarm sensor can be connected to BELCAT and when activated by gas leakage, starts alarming and turned off all the valves and stops heating.	—	✓	✓
	Even if the gas leakage occurred due to the sample cell breakage, all gases are exhausted by back vent fan.	—	✓	✓
	When the inside pressure exceeds 120kPa, measurement stops and displays the exceed value.	—	✓	✓
	Monitoring the gas flow and detect it as substantially below the setting value, the measurement stops as gas shortage.	—	✓	✓
	Monitoring the compressed air pressure and detect it as substantially below the setting value, the measurement stops as gas shortage.	—	✓	✓
	Some kind of gases, such as H_2 and O_2 etc., are dangerous when mixed. To prevent such condition,different pretreatment gases cannot flow at the same time.	✓	✓	✓
Other	Monitoring the carrier gas and detect it as substantially below the setting value, turned off the power of TCD as the stop of carrier gas flow.	✓	✓	✓
	When the external warning devices such as seismoscope are activated, start alarming and turned off the all valves and stops heating.	✓	✓	✓
	Emergency button (*optional) is easy to stop the instrument.	✓	✓	✓
	When the power failure, the all valves are turned off and stops the gas supply.	✓	✓	✓

SOFTWARE

■ Measurement software : BELCAT-A, -B

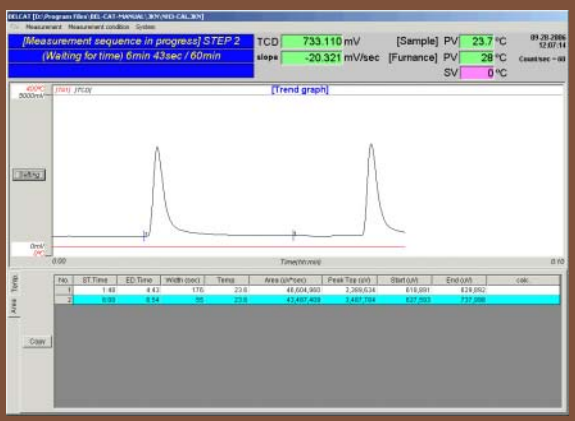
- Valves, MFCs, temperature control and data acquisition can be performed automatically.
- Display of instrument status, trend chart of TCD and temperature.
- Interactive instrument schematic for control of valves. Simply click the appropriate symbol on the schematic.
- For pulse chemisorption and specific surface measurement, the result can be calculated and their report is created automatically.





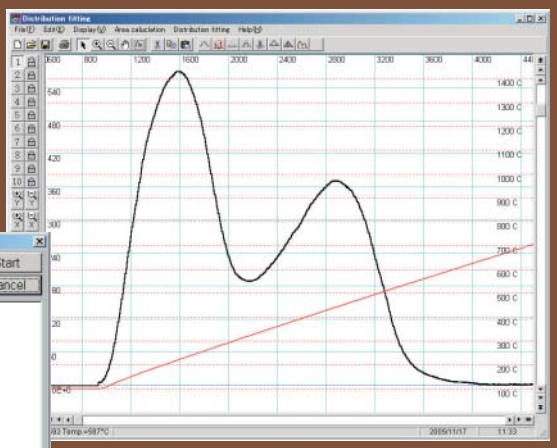
■ Data acquisition software : BELCAT-M

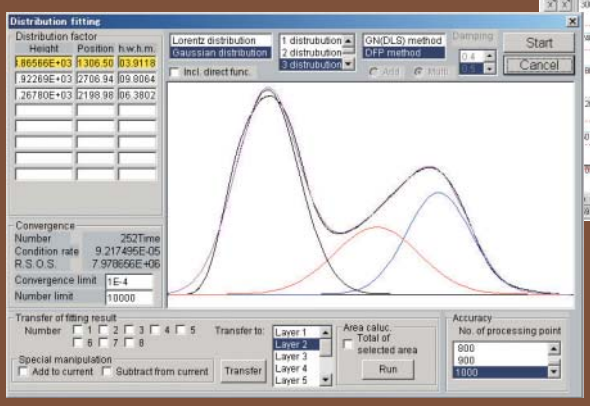
- Temperature control and data acquisition can be performed automatically.
- The software detects peaks and calculates peak areas automatically.

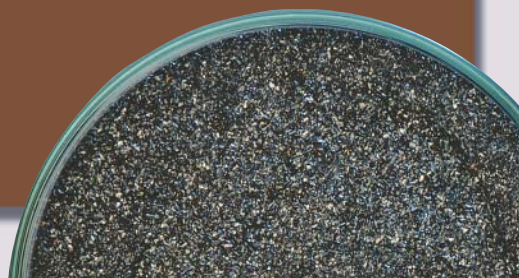


■ Analysis software-Distribution fitting

- Spectrum can be edited and the area can be calculated on this program.
- Full of useful functions, such as "Base line correction", "Spike noise filter", etc. will make accurate chemisorption amount calculation.
- Layer structure allows to compare multiple spectrums on the same screen.
- Peak deconvolution function can divide measured spectrum into multi-peaks so that the number of active sites exist on the catalyst surface.
- As the calculated data are saved in CSV format, data can be edited easily with other spread sheet software.







SPECIFICATIONS

		BELCAT-M	BELCAT-B	BELCAT-A
Measurement principle		Dynamic flow method		
Detector		Thermal Conductivity Detector (W-Re filament)		
Measurement/Pretreatment port		1		
Gas port Carrier / Pretreatment / Pulse Pretreatment / Pulse		2 4	3 4 (Gas ports can be added up to 10.)	
Gas flow control Carrier / Pretreatment / Pulse Pretreatment / Pulse		Needle valve Needle valve	Mass flow controller (non-corrosion resistant) Mass flow controller (corrosion resistant)	
Electric furnace Range Ramp rate [50-500℃] [500-1000℃] Quick cooling		RT—1200℃ 100℃/min —	RT—1200℃ 70℃/min 30℃/min ✓ [1000-100℃] 60min	
Vapor dosing		—	—	✓
Physical		W550×D480×H745 40kg	W600×D700×H720 100kg	W600×D700×H920 130kg
Requirement	Computer	CPU: Intel Pentium 4 / Celeron (>1.6GHz), 256MB main memory, 1GB free space in hard disk, 1024 x 768 screen resolution, Windows 2000 / XP		
	PCI slot	1	—	
	Serial port	1	2	
Utility	Gas	Carrier/Pretreatment/Pulse gas : pres. 0.1-0.2 bar (Gauge) (joint: 1/8" Swagelok) Compressed air : pres. 4.5-5.5 bar (Gauge) (joint: 1/8" Swagelok) -For BELCAT-A,-B		
	Power	Single phase: AC100-120V or 200-240V / 1500VA		
		1100W	1100W	1500W

- 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.

OPTIONS for BELCAT-A, -B

The BELCAT-A and B can be customized as the customer's requirement.

■ Gas port

- It is possible to increase the number of port up to 10.
- The ports can be made to be corrosion resistant. You can pretreat multiple gases at one time and do not need to change the piping in each measurement.

■ Gas mixing

- Gas mixing lines with mass flow controllers can be installed to maximum of 10 ports besides the standard gas ports. As the gas mixing unit can make mixed gas from pure gas cylinders, no need to prepare pre-mixed gas cylinder.
- By producing various kinds of mixed gases, measurement of catalyst activity can be done under the simulation of actual condition.

■ Pulse loop

- One 6-way valve for pulse loop is included in standard configuration. It is possible to add one more loop line for the pulse injection for BELCAT-A and BELCAT-B. These loop lines can be chosen depending on the adsorption volume of the sample.
- By installing double pulse injection loops, it is possible to do the pulse injection measurement with the same gas but different dosing volumes.



■ Gas analyzer

- A gas analyzer such as Q-mass and GC can be connected to the BELCAT. It is possible to detect the reacted products produced in TPD/TPR measurement, which cannot be detected by TCD detector.

■ Condenser for bubbler

- Combining the condenser with the bubbler, the vapor pressure can be controlled more accurately. So this option is useful when measuring pulse chemisorption with using vapor as an adsorptive. This option is only for BELCAT-A.

SAMPLE CELL and SAMPLE CELL ADAPTOR

■ Measurement temperature range

There are two types of sample cell. One is for Pulse chemisorption / BET, and the other is for TPD/TPR/TPO. Pulse chemisorption / BET model has two models, made of pylex (up to 500℃) and made by quartz (up to 1150℃).
A sample cell is installed to an adaptor. And then the adaptor is attached to BELCAT by one-touch operation. Three types of adaptor are prepared.



Adaptor for pulse injection/BET



Adaptor for TPD/TPR/TPO



Adaptor for Q-mass



Sample cell for pulse injection/BET



Sample cell for TPD/TPR/TPO

Model number	Name	Descriptions	Qt	Standard	Option
060-20000-0-0	TPD/TPR sample cell	Quartz, Maximum temperature 1150℃	1	✓	–
060-20001-0-0	Pulse/BET sample cell	Pylex, Maximum temperature 500℃	1	✓	–
060-20002-0-0	Pulse/BET sample cell	Quartz, Maximum temperature 1150℃	1	–	✓
060-20003-0-0	TPD/TPR sample cell adaptor	For 060-20000-0-0	1	✓	–
060-20004-0-0	Pulse/BET sample cell adaptor	For 060-20001-0-0 and 060-20002-0-0	1	✓	–
060-20005-0-0	TPD/TPR sample cell adaptor	For 060-20000-0-0. With Q-mass connection	1	–	✓
060-20006-0-0	TPD/TPR sample cell adaptor	For 060-20000-0-0. Chemraz O-rings.	1	–	✓
060-20007-0-0	Pulse/BET sample cell adaptor	For 060-20001-0-0 and 060-20002-0-0. Chemraz O-rings.	1	–	✓
060-20008-0-0	TPD/TPR sample cell adaptor	For 060-20000-0-0. With Q-mass connection. Chemraz O-rings.	1	–	✓
060-20024-0-0	Filter	SUS, Mesh size 0.5μ	6/SET	✓	–

■ For BELCAT-M

The sample cell for BELCAT-M consists of three tubes. All the three tubes are for TPD/TPR/TPO measurement and the two of them for Pulse/BET measurement.



Model number	Name	Descriptions	Qt	Standard	Option
060-20015-0-0	Sample cell	Quartz, Maximum temperature 1150℃	3	✓	–
060-20022-0-0	Trap cell	Quartz, Maximum temperature 1150℃	1	✓	–
060-20016-0-0	Sample cell adaptor	For TPD/TPR/TPO measurement	1	✓	–
060-20017-0-0	Sample cell adaptor	For Pulse/BET measurement/Trap	1	✓	–
060-20023-0-0	Sample cell adaptor	For TPD/TPR/TPO measurement. With Q-mass connection	1	–	✓

CONSUMABLE PARTS

Model number	Name	Descriptions	Qt	Standard	Option
900-30000-0-0	Glass Wool	Quartz, Maximum temperature 1150˚C,10 g	1	✓	–
900-10006-0-0	Dewer cup	Used for BET single point measurement	1	✓	–
990-00006-0-0	Reference sample	Reference material for TPD measurement, ZSM-5, 1g.	1	✓	–
990-00005-0-0	Reference sample	Reference material for metal dispersion, 2wt%Pt/Al_2O_3, 1g.	1	✓	–
990-00004-0-0	Reference sample	Reference material for specific surface area, Carbon Black, 1g	1	–	✓
990-00010-0-0	Reference sample	Reference material for TPR measurement, CuO, 1g	1	–	✓
060-20013-0-0	Thermocouple	For BELCAT-A	1	✓	–
060-20012-0-0	Thermocouple	For BELCAT-B	1	✓	–
060-20014-0-0	Thermocouple	For BELCAT-M	1	✓	–

insurface®
SORPTION INSTRUMENTS

BEL Japan, Inc.
1-9-1 Haradanaka, Toyonaka-shi,
Osaka 561-0807, Japan
Phone: +81-(0)6-6841-2161 Fax: +81-(0)6-6841-2767
E-mail: international@nippon-bel.co.jp
http://www.nippon-bel.co.jp

CE 2004 BEL Japan, Inc.