NG SERIES

MULTI-SAMPLE SORPTION ANALYZERS



RUBOTHERM

MEASURE BEYOND THE LIMITS

RUBOTHERM MULTI-SAMPLE SORPTION ANALYZERS

Porous bulk materials in different forms, for instance powders, pellets, or fibers, are used for different applications in the chemical industry as well as in many products of daily life. The morphology and topology of such materials can be assessed by measuring their adsorption properties.

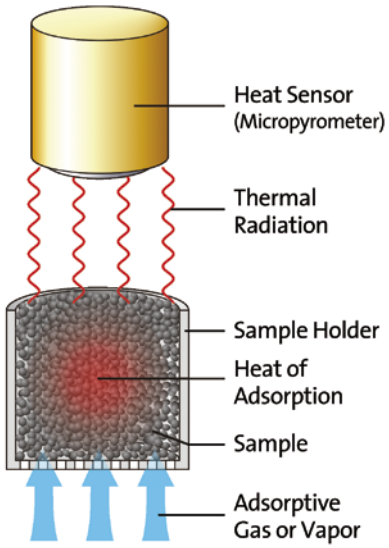
The amount of gas or vapor adsorption is measured with so-called sorption instruments that record this quantity typically at constant temperature and changing pressures. The resulting experimental adsorption isotherm allows the determination of the specific surface area, the total porosity as well as the pore size distribution of the analyzed material. However, such complete isotherm measurements may require a long measuring time, from several hours up to a couple of days.

In order to reduce the time required to characterize materials, Rubotherm has developed the quick test instrument Infra**SORP** for ultra-fast sorption capacity evaluation in quality control and material science.

For analysis that requires the highest accuracy we offer a series of multi-sample isotherm measuring instruments. Many samples can be measured in parallel with high accuracy.

The **BEL**-series of sorption analyzers are designed for measuring physical properties like specific surface area, porosity and chemical reactivity. Parallel for up to three samples with high accuraracy.

Rubotherm's Iso**SORP**®-manometric is the first commercial multi-sample instrument for measuring gas adsorption isotherms in an application relevant, high pressure range. Data measured by this instrument can be used for determining physical properties as well as application relevant sorption data at high pressures.



Measuring principle Infra**SORP**



BEL-series



INFRA**SORP**

INSTRUMENT FOR QUICK-TEST OF POROUS MATERIALS

The Infra**SORP** is designed for users with a high throughput of samples who want to judge their samples by high and low uptake capacity as an indication for the surface area and porosity in a short period of time. The Infra**SORP** is a quick-test instrument that can measure the uptake capacity of up to twelve materials simultaneously in just one measurement taking a maximum time of five minutes.

The Infra**SORP** is the ideal instrument for quality control applications and in material sciences for measurement of specific surface area and butane working capacity with reduced accuracy requirements or where materials with unknown properties can be compared against a benchmark material.

*The Infra**SORP** was developed by Rubotherm in cooperation with the Fraunhofer Institute for Material and Beam Technology (IWS) in Dresden (Germany).*

A test gas (for instance butane, carbon dioxide, ...) is passed through the sample materials and adsorbs on the surface and in the pores of the material. This exothermal adsorption leads to a temperature increase of the sample material. The Infra**SORP** software records the temperature of all samples. The degree of temperature rise is an indicator for the total adsorption capacity. The shape of the temperature profile is characteristic for the kinetics of adsorption.

Distinct correlations between recorded temperature profiles and the specific surface area and butane working capacity with an accuracy level of better than 10% were validated for a variety of different sample materials. The correlations are incorporated in the analysis software allowing for determination of these quantities from the ultra-fast measurement.

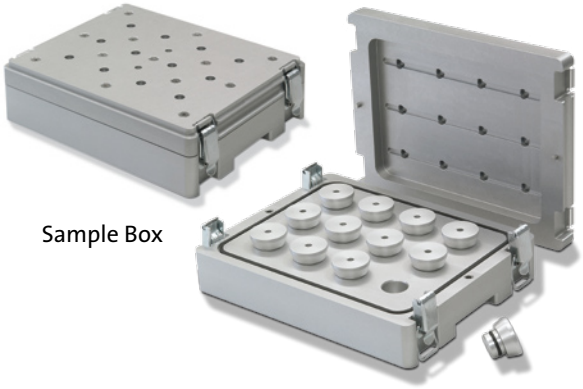
To dry and pretreat the samples the external pretreatment station Infra**PREP** can be used. After the pretreatment samples can be transferred from the Infra**PREP** to the Infra**SORP** in an isolated manner in a sample box guaranteeing no contact between the samples and the external environment.

Technical specification InfraSORP

Measuring method:	contact free and reactionless infrared heat detectors
Measuring gas:	CO_2, butane or other non-corrosive gases
Number of samples:	12
Pressure range:	atmospheric pressure
Measuring temperature:	room temperature
Sample pretreatment:	The sample box with 12 samples can be removed for external pretreatment in a pretreatment station (see picture below) or in an external heating cabinet

Technical specification InfraPREP

Pretreatment method:	heating under inert gas flow or vacuum
Number of samples:	12
Pressure range:	vacuum or atmospheric pressure
Temperature range:	200 °C (300 °C optional)
Special feature:	Isolated transfer of pretreated samples from the Infra**PREP** to the Infra**SORP** without contact to the ambient atmosphere in closed sample box



Sample Box



Iso**SORP**® MANOMETRIC

AUTOMATIC MULTI-SAMPLE HIGH PRESSURE SORPTION ANALYZER

The Iso**SORP**® Manometric instrument measures gas ad- and desorption of up to five samples using the static volumetric method.
Gas is dosed stepwise from a calibrated manifold volume into the six sample cells. The dosing manifold is located in a stainless steel block and completely thermostated to a constant temperature for highest accuracy. Pneumatically operated high pressure valves in the thermostated zone provide lowest possible leak rates and best vacuum.

Two pressure sensors with different full scales are applied to measure the pressure in the manifold. Each sample port is equipped with its own accurate pressure sensor. After a dosing step the sample cell is isolated from the manifold and equilibration of the sorption process is monitored by the pressure sensor in the sample cell. During this equilibration the manifold can be used to dose gas into other sample ports. The firmware of the instrument optimizes the gas dosing sequence in such a way, that the highest possible number of data points is generated.

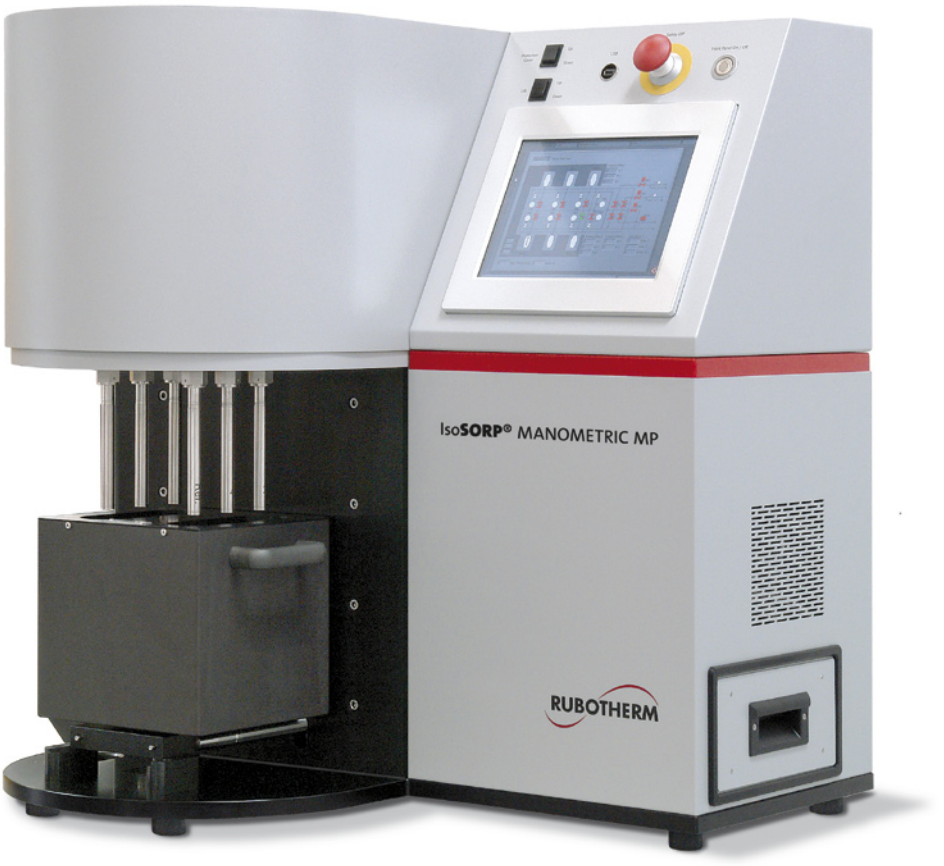
The sixth sample cell is used as permanent blank measurement port "ContiBlank™" for inline measurement of the compressibility factor of the gas atmosphere. Additionally the temperature in this sample cell is recorded. This feature increases the accuracy of the results since no thermal equation of state has to be used for calculating the gas phase's material balances.

The resulting isotherms are calculated from the measured data automatically by the software.

Summary of technical data:

Number of sample ports:
5 sample ports, 1 ContiBlank™ port for on-line measuring the adsorptive gas compressibility factor
Pressure range (dosing manifold):
Vacuum ... 100 bar
Pressure range (sample ports):
Vacuum ... 50 bar
Number of pressure sensors:
8 (6 in sample ports and 2 in the manifold)
Accuracy of pressure sensors:
≤ 0.08%
Temperature sensor:
1 Pt100 in blank sample cell, 2 Pt100 in the manifold
Sample temperature ranges:
LN_2 / LAr cooling: 77 K / 87 K
Coldgas cooling: 120 K ... 290 K
Liquid circulator: 290 K ... 430 K
Electrical heater: 370 K ... 700 K
Gas connections:
2 (reference gas & measuring gas)
Gases:
He, N_2, H_2, O_2, CO, CO_2, CH_4, other gases and vapors with dew points up to 50°C

Iso**SORP**®
MANOMETRIC



BEL SERIES

VOLUMETRIC SORPTION FOR PHYSI- AND CHEMISORPTION AT AMBIENT PRESSURE

BEL**SORP**-MINI

The sorption measuring instrument BEL**SORP**-mini can analyze specific surfaces of > 0.01 m^2/g and pore size distributions in the range 0.35 to 200 nm of solids (powder, pellets, etc.).
The measuring principle is static volumetric with a patented dead volume correction. The problems associated with the falling liquid nitrogen level during a measurement can be determined by this way.
The equipment allows the simultaneous measurement of up to three samples, each one having its own highly accurate pressure sensor.



BEL**SORP** MINI

BEL**SORP**-MAX

The BEL**SORP**-max is a static-volumetric sorption measuring instrument for the measurement of physisorption, vapor and chemisorption. It can be used for the measurement of smallest micropores up to macropores (0.35 nm ... 500 nm) because of its very wide relative pressure range.
The measurement of water vapor sorption is integrated in the standard version, the chemisorption analysis can be integrated as an option.
Measurements of very small specific surfaces (>0.0005 m^2/g) are possible by Kr-adsorption. The equipment has the highest accuracy available due to the patented continuous correction of the dead volume.
In addition to standard analysis as BET, BJH, HK etc. more complex procedures like Density Functional Theory can be also performed.
In combination with the TPDPro function the BEL**SORP**-max is able to perform dynamic flow chemisorption measurements (TPx- and pulse adsorption measurements).



BEL**SORP** MAX

BEL**CAT**

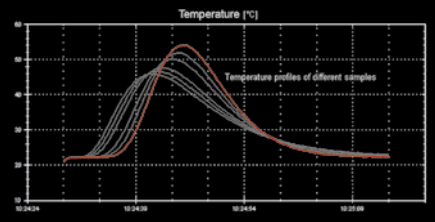
The BELCAT is a chemisorption measuring instrument using the dynamic gas flow method for measuring among other things the active centers in catalysts (metal dispersion), the execution of pulse chemisorption measurements, as well as TPD, TPO and TPR analysis (temperature programming desorption, - oxidation and - reduction).
The equipment has a high temperature furnace for the preparation of samples and to keep it at a moderate temperature. The temperature range is from room temperature up to 1100°C. The sample can also be cooled with liquid nitrogen at 77 K in order to measure specific surfaces with the BET-1-Punkt method. The measurement takes place via new, highly accurate heat conductivity detectors (TCD), which are characterized by an outstanding long-term stability. Optionally the BEL**CAT** can be equipped with a cryo-system that enables to measure from -100°C to 1000°C contineously.
The coupling of a mass spectrometer is possible for simultaneous gas analysis. An extensive range of gases and vapors can be used for chemisorption measurements due to the corrosion resistance of the system. The analysis software can perform the following analyses:
Metal dispersion · Peak integration (manual and automatic) · TPD, TPO, TPR evaluations · Chemisorption · Physisorption · BET analysis (1-point)



BEL**CAT**

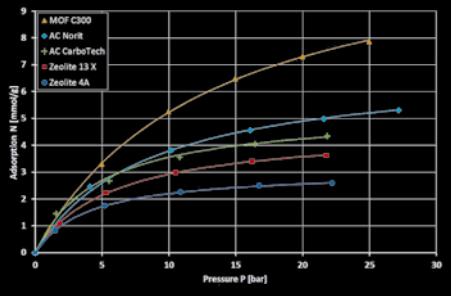
NG Series Application Examples

Selected experimental results measured with the **NG** series in our customers' laboratories are shown below.



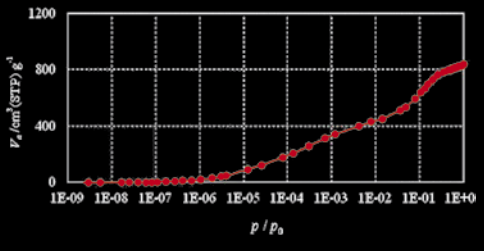
INFRA**SORP**

Infra**SORP** data recording during simultaneous sorption capacity test on six differnet samples with butane. The sample with the highest temperature increase is the material with the highest sorption capacity. From the integrated area under the temperature recording the butane working capacity and the BET surface area of each sample can be determined within an accuracy level of typically <10%.



Iso**SORP**® MANOMETRIC

Simultaneous measurement of CH_4 adsorption on five samples in one experiment with the Iso**SORP**® MANOMETRIC. Materials used were a metal organic framework (MOF), two activated carbons (AC), and two zeolites. The MOF material exhibits the highest capacity for CH_4 followed by the ACs.



BEL SERIES

Ultra-low pressure measurement with the BEL**SORP**-MAX instrument of the **BEL** Series. The diagram shows a N_2 adsorption isotherm on an activated carbon at 77 K with a very low starting relative pressure (P/Po) of 3E-08. Such ultra-low pressures can be realized in the **BEL**SORP-max due to the all SS-valve manifold with pneumatic valves. Reliable measurements in this pressure range allow assessing micropore size distributions down to the molecular diameter range.

ADSORPTION ISOTHERMS & KINETICS +++ SURFACE AREA & POROSITY +++ ABSORPTION & SOLUBILITIES +++ GAS STORAGE +++ DIFFUSION & PERMEATION +++ SEPARATIONS +++ WETTING & DRYING PROCESSES +++ CORROSION STUDIES +++ FILTER MATERIAL TESTING +++ CATALYST TESTING

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