Quantachrome
INSTRUMENTS

autosorb iQ

automated gas sorption analyzer

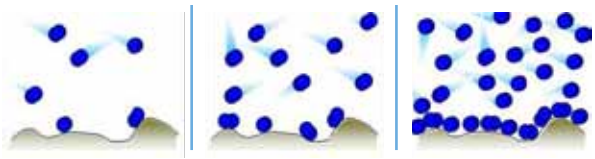
surface area, pore size, chemisorption

autosorb iQ

intelligent design

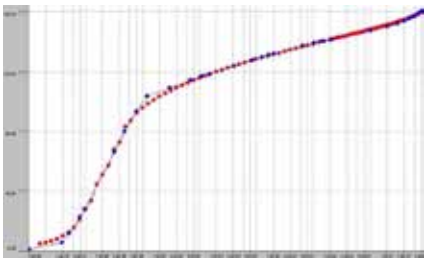
Gas Sorption

Physisorption, or physical adsorption, is the process by which gas and vapor atoms and molecules are adsorbed onto the surface of a solid and which relies on weak attractive forces, usually measured at cryogenic temperatures. It is also the experimental means by which one can quantify the surface area of a solid, its pore size and pore volume distribution. Chemisorption, or chemical adsorption, is the process of gas sorption to specific sites through the formation of chemical bonds. It is the experimental means by which one measures active metal area, and related properties, of catalysts, usually at much higher temperatures than physisorption measurements.



Measurement Sensitivity

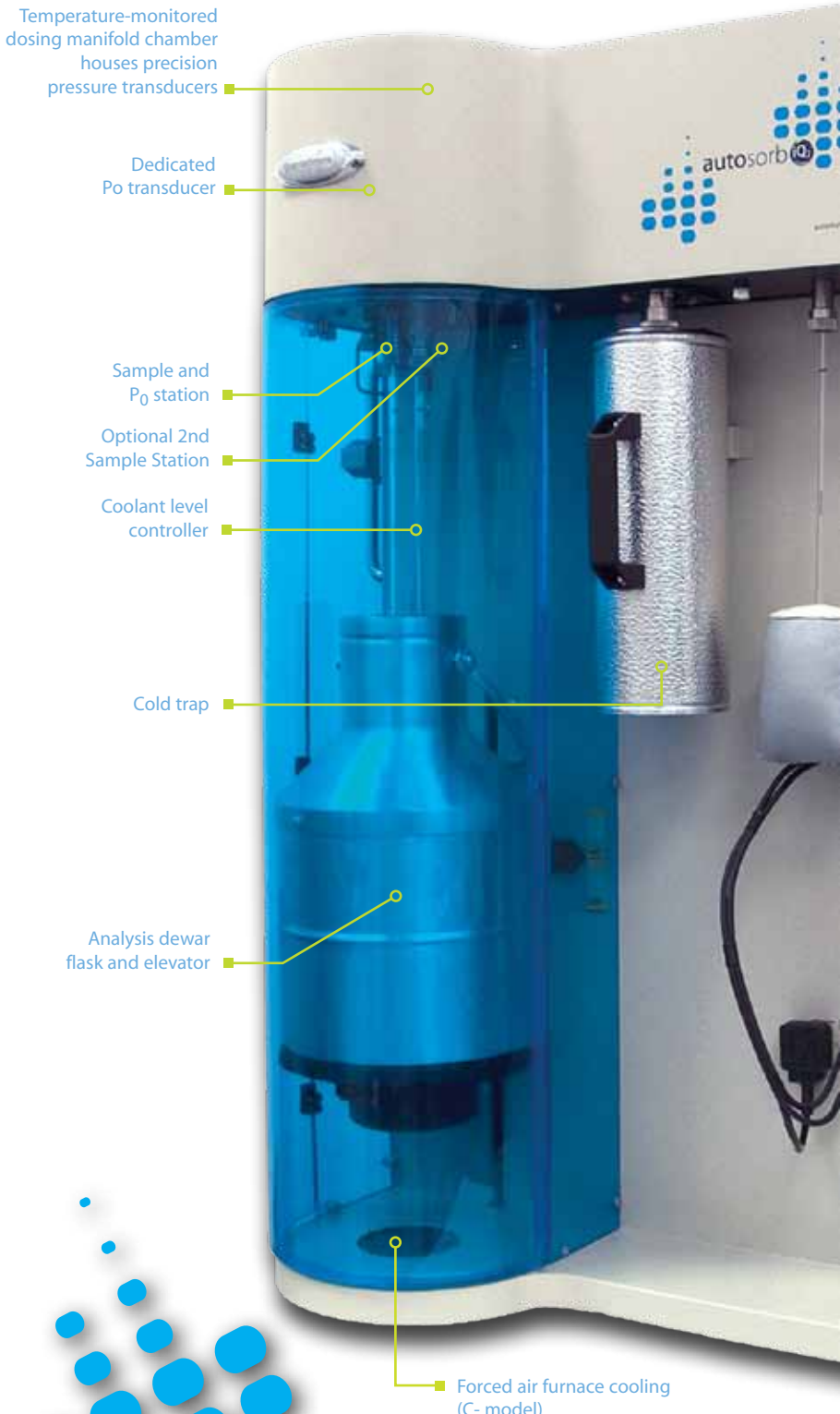
The sensitivity of a physisorption analysis using the manometric technique, relying on pressure changes in the sample cell to define the sorbed amounts, is higher when the volume around the sample, the so called free-space or void volume, is as small as is practicably possible - most importantly the cold free space/void volume since volume for volume it contains more (unadsorbed) gas molecules than the equivalent warm space. That is ensured by accurately controlling the level of cryogenic coolant around the sample cell so as to immerse as little as is necessary. The highest quality chemisorption measurements are no less demanding, yet are achieved by intelligent hardware integration.



N_2 isotherm of microporous zeolite, starting below 1 x 10^{-7} P/Po shows excellent agreement with DFT model.

State-of-the-Art

Building on the reputation of the Autosorb name, the **iQ** represents a major leap forward in gas sorption measurement technology providing materials science researchers with a highly sophisticated platform to tackle any pore size, surface area or catalyst characterization problem.



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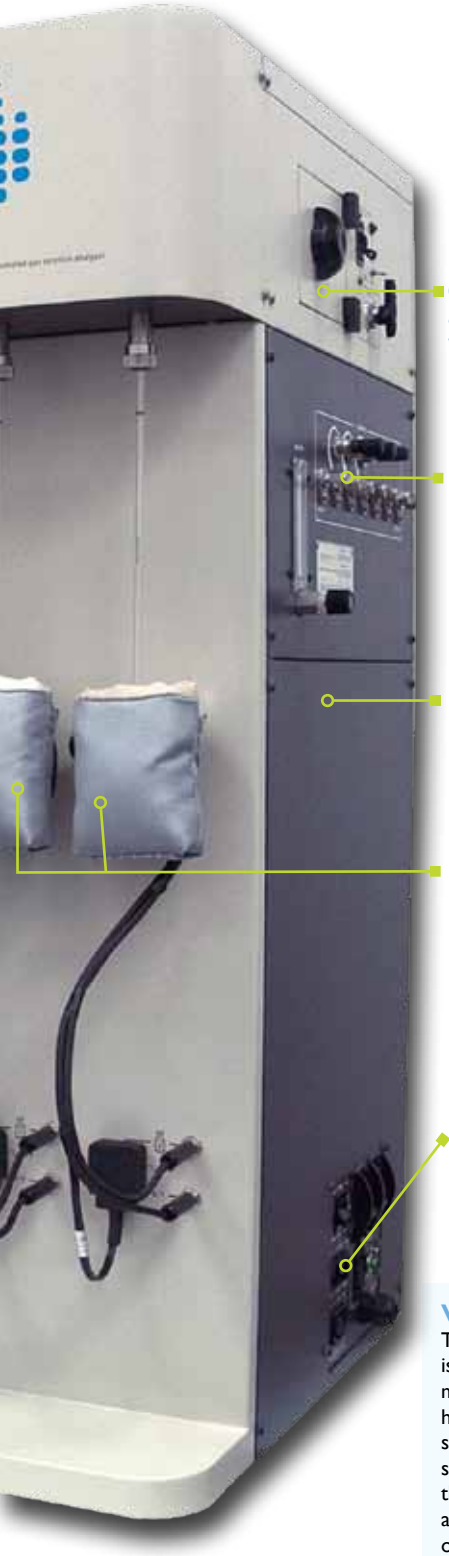
Visit *www.quantachrome.com* for more detailed instrument specifications and downloadable brochures.

autosorb iQ

precise • fast • versatile



Autosorb-iQ-AG

Ideal for surface area and meso-pore analysis, the iQ-AG is available in one- or two-station versions and provides an easy upgrade path to high vacuum, low pressure and chemisorption capabilities should your needs change. Usable with nitrogen, argon, carbon dioxide and a host of other gases, even ammonia, this instrument has instant appeal for a wide range of applications.

applications

Perfect for mesoporous materials like aluminas, silicas and other oxides including M41S materials (eg MCM-41), PMOs, KITs and many SBAs; academic research programs and industrial applications.

Autosorb-iQ-MP

The gold-standard in micropore analyzers. Patented, dry high-vacuum system, ultra-stable transducers, three pressure ranges seamlessly overlap. Optional second, MP station. Turbo-level degassing perfectly complements low starting pressures for true micropore analysis. This is also the model for analyses using low pressure krypton.

applications

Detailed and accurate studies of microporous materials including zeolites, carbons, MOFs, hierarchical pore structures (e.g. micro-mesoporous carbons like CMK, and micro-mesoporous zeolites), H_2 storage, heats of adsorption. Kr capability ideally suited for APIs, thin films, nanosized metal and ceramic powders.

Autosorb-iQ-C

When bench space is at a premium and maximum capability is essential. The only combined chemisorption-physisorption manometric analyzer that features built-in degassing stations and an optional second physisorption port. Built-in flow options puts this model even further ahead of the field. This analyzer is unrivalled in catalyst characterization capability: one moment it's a rapid surface area and pore size analyzer, the next it is measuring active metal area and dispersion, even tempera ture programmed analyses.

applications

Characterization of heterogeneous catalysts and support materials; transition and precious metals, dissociative and non-dissociative type adsorption, acidic and basic sites of oxides.

Standard features makes these analyzers stand out from the crowd... low leak-rate metal seals, stainless steel manifold, dedicated Po transducer, built-in programmable degassing, multiple gas inputs.

options / accessories

Vapor Option

The vapor generator is housed within the manifold chamber... heated and thermostatically controlled; a solenoid valve opens the pump (ballast) for all important venting of condensible vapors. The option is available on all models, AG, MP and C, one- and two-station, and can be added at a later date.

TCD

A thermal conductivity detector is yet another built-in option... not an external hook-up. It adds TPR/TPD/TPO capability to the C (chemisorption model) for extensive catalyst characterization. A cold trap (with bypass valve) is included. An automatic loop injection valve can be added for pulse titration of active sites.

Mass-Spec

Uniquely close-coupled, this option requires no second turbopump vacuum system. The gas is sampled from the cell vent and introduced via a differentially pumped, valved port. Can be supplied as the hardware interface alone for use with you own quadrupole mass spectrometer. Available only on the C model.

Calorimeter Interface

Measure heats of adsorption directly at the sample cell using this attachment to interface with commercially available third party calorimeter.

Cryostat

Exclusive gas sorption cryostat. For isotherms at any temperature between 78K and 200K using only LN_2 as coolant. Fits all models.

Mass Flow Controller

A popular upgrade for the C model. Programmed from the PC it controls the flow rate of any attached gas during chemi-pretreatment or TCD-based analysis.

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autosorb iQ

benefits

The **Autosorb-iQ** has been designed to produce comprehensive data of the highest quality, both quickly and reliably.

Operator Convenience

All instrument operations are accessed through the Windows®-based software program. Fully customizable analysis parameters can be set up ahead of time and recalled as often as one likes. So too can degassing protocols. Reconfiguring the instrument, between physisorption and chemisorption modes, takes mere seconds. The unit is sized to comfortably fit on a standard laboratory bench with all electrical and gas connections to the side, rather than to the rear, for easier access. An optional rolling cart is available if greater mobility is desired or bench space is limited.

Technical Excellence

Electronic pressure transducers form the core of the instrument; ceramic diaphragm capacitance type offer superior stability at lower pressures. The high vacuum system of the micropore and chemisorption models is mounted internally and features a 90,000rpm turbo-molecular pump backed by a dry diaphragm pump for oil free analysis. A constant, small cold zone (physisorption mode) is achieved by using the proven RTD coolant level sensing system. Interruptions to the analysis are minimized by virtue of a dedicated Po (saturation pressure) transducer on the Po cell. Metal-to-metal seals for critical fittings in the measurement zones ensure best possible vacuum performance.

Analysis Flexibility

No two applications are the same and so a variety of physisorption measurement types are included to optimize data point spacing in the measured isotherm according to pore size and pore volume. And since some users prefer the classical helium void volume method and others helium-free analyses, both techniques are at the disposal of the operator. Advanced analytical techniques that require scanning the isotherm hysteresis loop, or pore size distribution of thin films using krypton gas, or the largest library of density function theory (DFT) calculations, are accommodated as standard features.

Higher Throughput

By offering an optional second station, the Autosorb-iQ offers a huge improvement in sample throughput. This is most evident when properly analyzing microporous materials in detail. These notoriously slow measurements (because of restricted diffusion of gases at the necessarily very low pressures) have, in the past, been the cause of many a laboratory bottleneck. Simultaneous analysis of two such samples, each using their own dedicated sets of pressure transducers clearly offers a tangible solution without sacrificing the quality of results. Routine surface area and mesopore analyses are similarly improved in terms of throughput, important for busy labs and industrial users. Even the chemisorption model can be equipped with a second physisorption station.

Intelligent Preparation

Quality data come from properly prepared samples. Two built-in degassing stations offer the user flexible programming of automatic ramp, hold and test protocols, including a pressure-rise limit method to minimize elutriation and steaming damage to susceptible samples. Chemisorption mode offers completely hands-free operation from in-situ preparation including gas switching, furnace control (heating and cooling), flow rate control (optional MFC) to isotherm acquisition without operator intervention.

Additional Flow Methods

While the Autosorb-iQ is a state-of-the-art manometric (also called vacuum volumetric) gas sorption analyzer, the chemisorption model is also available with optional flow-based methods of analysis: temperature programmed reduction, oxidation and desorption (TPR, TPO, TPD) and pulse titration (automatic loop injection) using a built-in TCD. A close-coupled mass spectrometer (no separate vacuum required) is also offered for detailed catalyst characterization involving identification of gaseous species.

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Contact your local representative or call 1.800.989.2476 (in USA/Canada) to request pricing information.

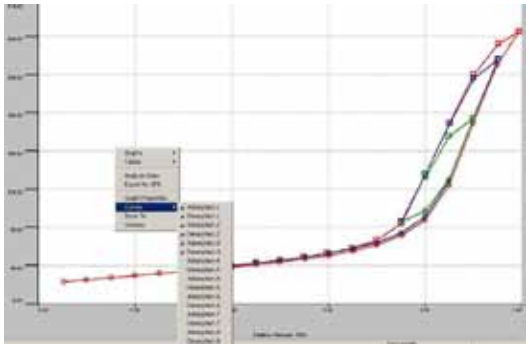
iQ Win software

autosorb iQ specifications

The Windows®-based comprehensive control, acquisition, calculation and reporting software communicates with the analyzer via Ethernet; directly or via a LAN.

A typical physisorption analysis starts with degassing the sample. The desired protocol of heating rates, hold times and automatic testing are loaded, then the iQ takes over. After completing the timed protocol, or sooner if residual pressure rise passes the user-defined test limit, the iQ shuts down the degasser, backfilling the sample cell or leaving it under vacuum if preferred.

Analysis parameters can be recalled from a saved set, or freshly created, and can import the degassing details. You always have a choice of analyzing using the classical helium or, He-free void volume methods. Request data at targeted relative pressure points, automatically supplemented during the run by additional "maximum delta volume sorbed" points (in regions of the isotherm that show steep up-take or desorption) or let them be acquired according to a fixed volume dosing algorithm called VectorDose. When sorption takes place in large amounts and quickly, the popular Maxidose feature minimizes total analysis time. Hysteresis in physisorption isotherms can be "scanned", that is multiple ad/desorption cycles over desired P/Po ranges can be programmed.



Comprehensive physisorption calculations include specific surface area (single and multi-point B.E.T., Langmuir, STSA, t-plot, alpha-s, DR), pore size (BJH, DH, DA, MP, HK, SF, Monte-Carlo, NLDFT, QSDFT) with their corresponding surface area values, Kr-pore size for thin films, heats of adsorption, plus NK and FHH fractals. The DFT library is the most extensive available commercially; no less than fifteen mathematical models describing different pore shapes, chemical nature of the surface and specific adsorbate and temperature pairs.

Feature	iQ-AG	iQ$_2$-AG	iQ-MP	iQ$_2$-MP	iQ-C
Sample analysis stations	1	2	1	2	1
Optional second AG port	✓	–	✓	–	✓
Optional second MP port	–	–	✓	–	✓
Po station w/ dedicated transducer	✓	✓	✓	✓	✓
BET/mesopore capable (P/Po >1 x 10^{-3})	✓	✓	✓	✓	✓
Low pressure Kr capable	–	–	✓	✓	✓
Micropore capable (P/Po < 1 x 10^{-4})	–	–	✓	✓	✓
Chemisorption capable	–	–	–	–	✓
1000 torr transducers	3	4	3	4	3
10 torr transducers	–	–	1	2	1
1 torr transducers	–	–	1	2	1
Coolant level control method	RTD	RTD	RTD	RTD	RTD
Standard cryogen dewar (90 hours)	3 liter	3 liter	3 liter	3 liter	3 liter
Vacuum pump included	✓	✓	✓	✓	✓
Turbo pump	–	–	✓	✓	✓
Built-in degasser stations	2	2	2	2	2
Degas cold trap	✓	✓	✓	✓	✓
Adsorbate gas input ports	5	5	5	5	5
Dedicated helium input port	✓	✓	✓	✓	✓
Dedicated backfill gas input port	✓	✓	✓	✓	✓
Total number input ports (standard)	7	7	7	7	7
Optional extra adsorbate input ports	7	7	7	7	7
Total gas input ports (standard + optional)	14	14	14	14	14
Optional built-in, heated vapor generator	✓	✓	✓	✓	✓
Available second vacuum system	✓	✓	✓	✓	✓
1100° C furnace with auto lid closing	–	–	–	–	✓
Fan-assisted furnace cooling	–	–	–	–	✓
Built-in auto isolation valve for flow-cell	–	–	–	–	✓
Optional mass flow controller	–	–	–	–	✓
Optional TCD with cold trap	–	–	–	–	✓
Optional auto titration loop	–	–	–	–	✓
Optional built-in mass spectrometer	–	–	–	–	✓
Upgradable to MP model	✓	✓	–	–	–
Upgradable to C model	✓	✓	✓	✓	–

The software program is provided with a site-wide licence and can be freely installed on multiple PC's, not just the one connected to the analyzer. It is also available in a 21 CFR Part 11 compliant version.

Choose chemisorption parameters that include in-situ pretreatment, and a second (reversible) isotherm measurement and combine multiple pre-treatments and isotherm analysis conditions (different gases, different temperatures) into an extensive batch mode. Chemisorption results include metal area, dispersion, nanocluster (crystallite) size, and monolayer capacity by a number of methods: extrapolation, Langmuir, Freundlich and Temkin. Heats of chemisorption are also available using manometric (static isotherm) data. Flow methods of analysis (with the TCD option) expand the range of measurements to include activation energy, quantitative TPR, TPO and TPD, with the ability to deconvolute overlapping TPX peaks.

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Renowned innovator of ideas for today's porous materials community.

For over 40 years, Quantachrome's scientists and engineers have revolutionized measurement techniques and designed instrumentation to enable the accurate, precise, and reliable characterization of powdered and porous materials:

- Gas Sorption Isotherms
- Surface Area Measurement
- Pore Size Distribution
- Chemisorption Studies
- Water Sorption Behavior
- Mercury Porosimetry
- True Solid Density
- Tapped Density
- Zeta Potential

These properties are essential qualities of battery and fuel cell materials, heterogeneous catalysts, pharmaceuticals, ceramics, carbons, zeolites, advanced mesoporous and microporous materials, pigments and foodstuffs, indeed any solid whose performance relies on some interaction with its surroundings through its surface. Quantachrome offers a wide range of fully automated gas, vapor and water sorption analyzers, gas displacement pycnometers, flow chemisorption analyzers and intrusion porosimeters suitable for both research and development, and industrial quality control.

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CE

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Quantachrome Instruments' quality management system is certified to be in accordance with ISO9001:2008.

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