

# Pore Size Analysis

By Gas Sorption, Mercury Porosimetry and Flow Porometry



## Pore Size Analyzers

- Filters • Membranes • Textiles
- Non-Woven • Ceramics • Paper
- Adsorbents • Catalysts • Batteries



### AUTOSORB® iQ Series

Premier, high performance, 1-to-3 port extended-range pore size and surface area analyzer. Detailed micropore size analysis is made possible by virtue of a patented high-vacuum, oil-free turbomolecular system and high precision low-pressure transducers, with each sample being served by its own set of dedicated pressure transducers. Metal O-rings and gaskets in critical measurement zones assure ultra-low pressure capability. Extremely long cryogen holding time extends operator-free cryogen usage to almost four days. Up to four built-in preparation (degassing) ports are served by the turbo vacuum system via a design free from potential cross-contamination including a dedicated vapor cold-trap. Available with one or two sample stations, and as a standard (but upgradeable) surface area/ mesopore size analyzer with non-turbo vacuum system. Alternatively supplied without built-in degassers for use with external sample preparation systems. Vapor sorption, chemisorption, temperature programming, and **CryoSync™** options create a unique all-in-one porous materials characterization system.

Visit [www.quantachrome.com](http://www.quantachrome.com) for more detailed instrument specifications and downloadable brochures.



### AUTOSORB® 6iSA

This is the workhorse of industrial laboratories using the gas sorption technique to characterize their porous materials. This surface area and pore size analyzer can work around the clock thanks to its six, totally independent analysis stations. Each station, comprised of its own sample cell, saturation pressure ( $P_0$ ) cell and large capacity coolant Dewar, can be started while any number of the other stations are still running. The AS6iSA is designed to be operated as a bench-top or floor-standing unit for maximum flexibility, giving it a place in any lab. Combine it with one or more matching degassing (sample preparation) units to complete your high-throughput system.



### QUADRASORB™-evo- MP/Kr

This 2-to-4 port surface area and pore size analyzer assures sample independence with individual transducers and coolant baths, unique analysis types and even different start-times. Additional versatility is due to its remarkable ability to operate both in classical mode (requiring helium) or Quantachrome's patented helium-free mode. Micropore range and krypton capability (for very low surface area materials) are possible by virtue of a high-vacuum turbo pump system, precision low-pressure transducer, and metal-to-metal seals where appropriate. Available with 2, 3 or 4 analysis stations, and as a regular vacuum model (without micropore and krypton capabilities). As with the Autosorb 6iSA, a range of accessory sample preparation units are available to match your individual lab needs.



### CryoSync™

It is now well established (IUPAC-2015) that argon adsorption at 87 K presents clear advantages over nitrogen at 77 K for pore size analyses by gas sorption. Quantachrome's **CryoSync™** (patent pending) enables highly precise and cost-effective gas sorption analyses at 87 K but using liquid nitrogen as the cryogen.

For details visit: <http://www.quantachrome.com/whatsnew/cryosync.html>.



### NOVAtouch™ Series

The NOVAtouch™ series provides next-generation performance in high speed and throughput gas sorption analysis, featuring table-top, multi-sample, combined preparation/analysis instruments. Pore size analyses gain increased speed from new dosing routines and extra pressure transducers. Models with dedicated  $P_0$  stations enable continuous  $P_0$  measurements to improve measurement precision and resolution for enhanced pore size measurements. The larger single Dewar provides the longer duration required for more detailed mesopore size analyses. Models with built-in sample flow/vacuum degassing capabilities include full PC control and programming of multiple ramp rates and hold times. The full-color, multilingual touchscreen provides real time data displays and gives easy access to all instrument functions, operating simultaneously with its PC software. Each model is available in 1-to-4 analysis station versions, and includes four built-in degassing ports, along with optional 21 CFR part 11 compatibility. Additional standard features include multiple analysis gas inputs for even more flexibility, ethernet connectivity, and advanced proprietary algorithms designed to minimize analysis times without sacrificing accuracy.

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### NOVA®e Series

High speed and throughput surface area and pore size analyzers. Compact, 1-to-4 analysis station units include both standard mesopore analysis and sample preparation capabilities. Sample preparation and physisorption analyses can operate in parallel to promote high throughput requirements. Degassing can be carried out via flow or vacuum methods at user-selectable sample temperatures. Pore size and surface area analysis operates in classical mode (using helium) or in Quantachrome's patented and cost-effective helium-free mode, making the NOVAe suitable for both university and industrial applications alike. The single Dewar design, compact and rapid, nevertheless retains the capability to analyze up to four samples, each with different settings and individually targeted data points at user-programmable relative pressure ( $P/P_0$ ) values.



### POREMASTER®/POREMASTER GT

Automatic pore size and pore volume distribution analyzers using the classical mercury intrusion / extrusion technique. Pore size range measured safely and quietly from 1000  $\mu\text{m}$  to less than 3.5 nm in the 60,000 psi capable units, and 6.5 nm in the 33,000 psi models. Both versions have two built-in low pressure analysis ports (for pore sizes above 4  $\mu\text{m}$ ) which also automatically evacuate and correctly fill sample cells with mercury and enable mercury density and porosity determinations. The high pressure cavity, for pore sizes smaller than 4  $\mu\text{m}$ , holds one sample cell in the standard unit, and two cells in the GT model for greater throughput. Designed to enhance operator safety and comfort, both models include cold traps, provisions for venting, and automatic mercury transfer from a closed reservoir to the low pressure ports.

### POROMETER 3G™ Series



The Porometer 3G series of capillary flow porometers includes three models to best fit the widest range of through-pore size and bubble point applications. Automatic measurements of filters, membranes, woven, and non-woven textiles, papers, etc., in a compact yet powerful table-top unit. Pressure capabilities of 0.015 to 500 psi represent a pore size range extending from over 500  $\mu\text{m}$  to 0.02  $\mu\text{m}$  and lower. Available options include liquid permeability, in-plane porometry, and more.

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## Comparison of Pore Size Analyzers at a Glance

Instrument Model	Analysis Stations	Built-in Sample Preparation Stations	Pore Size Range <sup>b</sup> [nm]		Significant Features/ Capabilities <sup>c</sup>						
			Lower Bound	Upper Bound	Micro-Porosity	Meso-Porosity	Macro-Porosity	Fluid Intrusion	Flow-Through	H <sub>2</sub> O-Filled Pores	Chemisorption <sup>f</sup>
<b>Autosorb-iQ</b>	1- to-3	2 or 4	0.3	500	√	√	√	--	--	--	√
<b>Autosorb 6iSA</b>	6	--	0.3	500	d	√	√	--	--	--	--
<b>Quadrasorb evo</b>	2- to-4	--	0.3	500	√	√	√	--	--	--	--
<b>NOVAtouch<sup>e</sup>/NOVAe</b>	1- to-4	2 or 4	0.3 <sup>d</sup>	500	d	√	√	--	--	--	--
<b>PoreMaster GT</b>	1 or 2	2	3	10 <sup>6</sup>	--	√	√	√	--	--	--
<b>Porometer 3G</b>	1	a	20	5x10 <sup>5</sup>	--	√	√	--	√	--	--

<sup>a</sup> Sample preparation performed in-situ.

<sup>b</sup> Measured values often exceed stated limits.

<sup>c</sup> By IUPAC convention, micropores <2 nm; mesopores: 2-50 nm; macropores: >50 nm.

<sup>d</sup> Detailed pore size distribution by CO<sub>2</sub> adsorption at non-cryogenic temperatures and modern NLDFT/GCMC statistical mechanics methods.

<sup>e</sup> Includes advanced algorithms for speed enhancements and operator access to real-time data and functions via a touch-sensitive color screen.

<sup>f</sup> Optional.

## Selected International Standards Applicable to Pore Size Analysis

### ASTM UOP964-11

Surface Area, Pore Volume, Average Pore Diameter, and Pore Size Distribution of Porous Materials by Nitrogen Adsorption.

### ASTM D4404-10

Standard Test Method for Determination of Pore Volume and Pore Volume Distribution of Soil and Rock by Mercury Intrusion Porosimetry.

### ASTM UOP578 - 11

Automated Pore Volume and Pore Size Distribution of Porous Substances by Mercury Porosimetry.

### ASTM F316-03(2011)

Standard Test Methods for Pore Size Characteristics of Membrane Filters by Bubble Point and Mean Flow Pore Test.

### ASTM D4284-12

Standard Test Method for Determining Pore Volume Distribution of Catalysts and Catalyst Carriers by Mercury Intrusion Porosimetry.

### ASTM D4641-12

Standard Practice for Calculation of Pore Size Distributions of Catalysts and Catalyst Carriers from Nitrogen Desorption Isotherms.

### ASTM UOP874 - 88

Pore Size Distribution of Porous Substances by Nitrogen Adsorption Using a Quantachrome Analyzer.

### ASTM D4222-08

Standard Test Method for Determination of Nitrogen Adsorption and Desorption Isotherms of Catalysts and Catalyst Carriers by Static Volumetric Measurements.