

# POROMETER 3G™ SERIES — *through-pore size analyzer*

Filters  
Papers  
Textiles  
Membranes  
Ceramics  
Sintered Metals

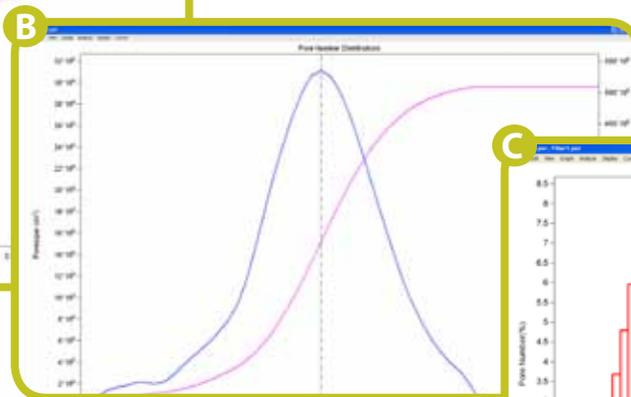
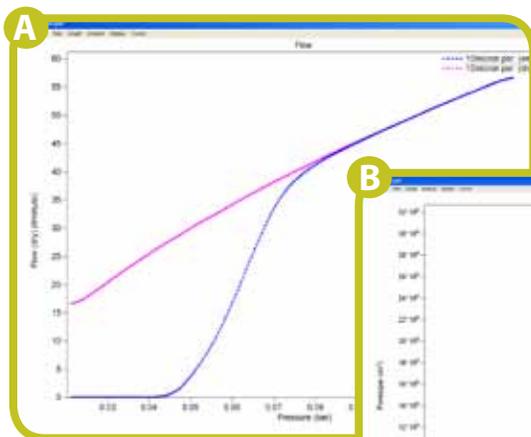


Characterizing Powders & Porous Materials

## CAPILLARY FLOW POROMETRY

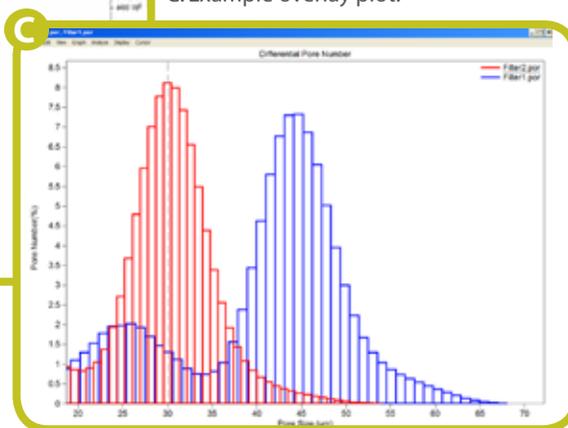
Capillary flow porometry, or just Porometry (also known as the liquid expulsion technique), uses the simple principle of gas pressure to force a wetting liquid out of through-pores in a sample. Through-pores are simply those that connect from one side of the sample to the other. The pressure at which pores empty is inversely proportional to the pore size, larger pores require a lower pressure than do smaller pores. The resulting volumetric flow of gas through emptied pores is also measured.

Pore size is calculated using the Washburn equation. The largest pore to be emptied (at the lowest pressure at which flow is sensed) defines the so-called “bubble point”. After all pores have been emptied (up to the highest pressure achievable) during the “wet” run, a second “dry” run is performed on the same sample. From the complete data set, various flow-related pore size parameters, pore size distributions and gas permeability can be calculated.



The Washburn Equation: 
$$d = \frac{4\gamma \cos \theta}{P}$$

A. Flow rates versus pressure plot.  
B. Differential and cumulative pore size.  
C. Example overlay plot.



## THE 3G SERIES

Quantachrome’s 3G porometers represent state-of-the-art in capillary flow porometry: exceptional performance in a compact bench-top unit, controlled by powerful PC-based software. The four models offered, representing different pressure (i.e. pore size) and flow rate ranges, allow the best match between material properties and instrument per-

formance (sensitivity, accuracy, reproducibility) for a wide variety of applications. Each Porometer 3G is a complete measuring system consisting of pressure control, pressure and flow sensing, sample holder, control and data acquisition software, even a built-in coalescing particle filter, and a comprehensive accessory parts kit.

### 3G micro

The Porometer 3G micro is our entry level capillary flow porometer with small-to-medium pore size capability, and customizable flow rate options. Choose from 100psi or 150 psi maximum pressure, and flow rates of 20, 100 or 200L/min. The 3G micro is especially suitable for a wide variety of woven and non-woven materials having narrower pore size distributions.

### 3G macro

The Porometer 3G macro is the preferred capillary flow porometer for large pore sizes because of its low pressure and high flow rate capabilities. Low pressure control and sensing allows for high resolution pore size measurements up to 500  $\mu\text{m}$  (and larger) to be made, perfect for a wide variety of woven and non-woven materials like diapers, wipes, coarse cleaner and air filters, etc.

### 3G z

The Porometer 3G z is a compact, automatic, broad size range capillary flow porometer, customizable with a wide range of available flow rates sensors. The 3G z is therefore the ideal porometer for samples of controlled geometric size and through-porosity since these parameters, not just pore size, significantly control absolute gas flow through the sample.

### 3G zh

The flagship porometer has the widest pore size measurement range in the series, with both low and high flow rate sensing capability as standard. The pressure capability of up to 500 psi allows for pore sizes from 500  $\mu\text{m}$  down to as small as 18nm to be measured quickly and reproducibly. Its measurement flexibility means that the 3G zh is appropriate for research applications.

## THE 3G BENEFITS

### Operator convenience

The Porometer 3G requires minimal hands-on. The sample holder is totally accessible, mounted in a small, repositionable stand, right on the bench top. The control unit can be placed alongside, or under the bench for even greater space-saving.

### Technical excellence

Proper sensing of pressure at the sample is essential for accurate pore sizing, and this is where the Porometer 3G excels. The "breakthrough" pressure is measured using precision sensors independent of the pressure controllers – each part of the pressure system optimized for their discrete functions. High resolution mass flow sensors (<0.05% f.s.), ensure accurate pore analyses, a necessity at very low flow rates when the pressure exceeds the bubble point and the sample begins to allow through-flow of gas.

### Flexibility

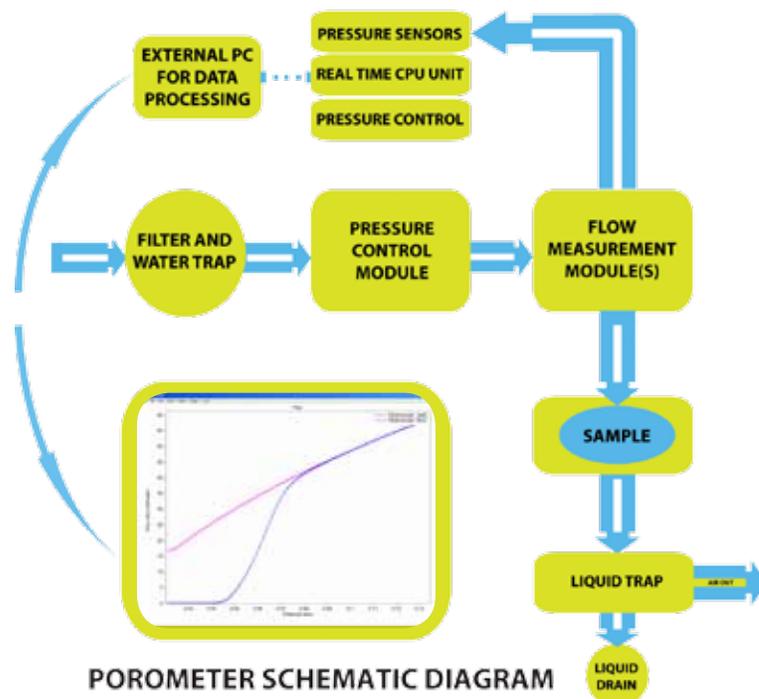
Different sample holders to accommodate samples of different diameter and thickness are available to simplify mounting samples and to ensure proper sealing of a wide variety of materials (polymeric, cellulosic, woven / non-woven, metal, ceramic). There's even a universal sample holder that can be reconfigured for even the most demanding research environment.

### Software

Operating under Windows,<sup>®</sup> the 3GWin™ program offers a familiar look and feel, while offering high-resolution real-time data presentation, statistical calculations, overlay of multiple graphical data sets.

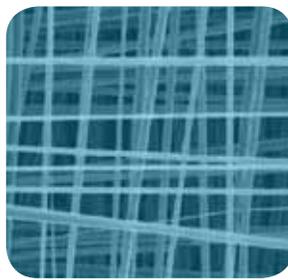
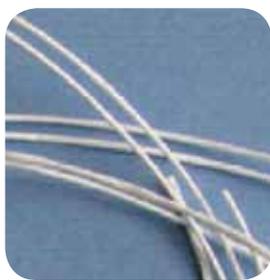
### Expansion

The capability of any 3G porometer can be expanded by using one of the available options such as the Liquid Permeability Accessory, the In-Plane Pore Size & Permeability Accessory and the External Sample Manifold.



POROMETER SCHEMATIC DIAGRAM

## APPLICATIONS



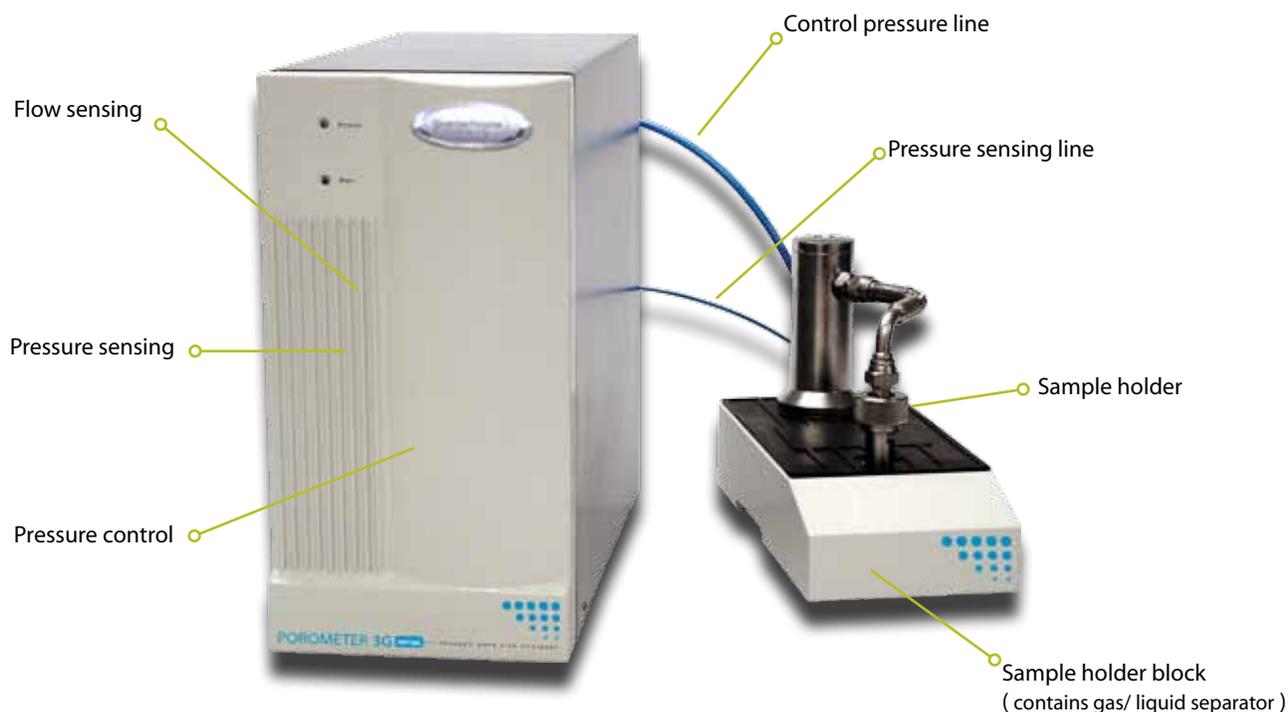
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## INSTRUMENT FEATURES



## MODEL CONFIGURATIONS

	3G micro	3G macro	3G z	3G zh
<b>Pore Size minimum</b>	0.09 $\mu\text{m}$	0.09 $\mu\text{m}$	<0.04 $\mu\text{m}$	<0.02 $\mu\text{m}$
<b>Pore Size Maximum</b>	100 $\mu\text{m}$	>500 $\mu\text{m}$	500 $\mu\text{m}$	500 $\mu\text{m}$
<b>Pressure Controllers</b>	1	2	2	2
Controller #1	0-100 psi	0-5 psi	0-30 psi	0-30 psi
Controller #2	n/a	0-100 psi	0-300 psi	0-500 psi
<b>Pressure Sensors</b>	2	2	3	3
Sensor #1	0-5 psi	0-5 psi	0-5 psi	0-5 psi
Sensor #2	0-100 psi	0-100 psi	0-100 psi	0-100 psi
Sensor #3	n/a	n/a	0-250 psi	0-500 psi
<b>Flow Sensors</b>	1	1	1 or 2	2
Sensor #1	0-100 L/min	0-200 L/min	0-100 L/min	0-10 L/min
Sensor #2	n/a	n/a	Optional 0-200 L/min	0-200 L/min
<b>Flow Sensor Switching</b>	n/a	n/a	manual	auto

Table shows standard configurations. Different pressure and flow rate ranges are available for some models. See performance specifications on page 5.

### Technical Specifications

Pressure sensing accuracy: +/- 0.05% f.s.

Pressure resolution: 16 bit A/D equivalent

Flow sensor type: Precision thermal mass flow

Flow sensor settling time: < 2 secs

Flow sensor temperature coeff.: <0.05%/degC (15-45degC)

### General Specifications

Mains power: 90 - 240 Volts AC, 50/60 Hz

Main control unit dims.: 40cm(H) x 45cm(D) x 19cm(W)

Sample holder block dims.: 24cm(H) x 32 cm(D) x 15cm(W)



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### **Pore Size Methodology:**

All 3G porometers employ the same technique of expelling a wetting liquid from through-pores in the sample. Gas pressure is automatically applied to one side of the sample and as pores empty the resulting gas flow through the open pores is accurately measured by the on-board microprocessor. The actual pressure at the sample is measured independently of the pressure control circuit to ensure the highest quality data. The preferred liquid, Quantachrome Porofil wetting fluid™, has been selected because of its special physical properties (see Wetting Liquid).

### **Permeability Methodology:**

All 3G porometers can also measure permeability. Without modification they can acquire gas permeability data at a single desired pressure, with stabilization defined by pressure or flow, and across a range of pressures at chosen stabilization times. Liquid permeabilities can also be determined using an optional accessory.

### **Pore Size Range:**

The pore size measuring capability of a porometer is dependent on its pressure range capability (see Pressure Control and Measurement). The 3G series offers a sufficiently wide pressure range to be able to analyze from less than 20 nm to more than 0.5mm! The 3G zh has the widest pore size range from < 0.02 microns up to 500 microns. The 3G z can measure much of the same range as the 3G zh, but for the smallest pores. The 3G macro is recommended for applications involving only larger pores, from 0.09 to more than 500 microns with enhanced resolution. The 3G micro specializes in measuring over narrow pore size ranges within an overall range of 60 nm to 90 µm.

### **Pressure Control and Measurement:**

Optimal performance for very different pore size applications requires different pressure ranges, hence the four models of the Porometer 3G series. All 3G models but for the 3G micro are equipped with two controllers covering the appropriate pressure ranges. The 3G zh has no less than three pressure sensors, 0-5psi, 0-100psi and 0-500psi. The 3G has a similar configuration, but is limited to 250 psi. The standard 3G micro and 3G macro have the same low and medium pressure sensing range as the z and zh, i.e 0-5psi, and 0-100 psi, but the 3G micro is also offered with an alternative medium pressure range of 0-150psi.

### **Flow Rate:**

Pressure is just one aspect of porometry. The other is flow rate. As the pressure is increased to empty smaller and smaller pores of the wetting fluid, gas flow continues through previously opened pores, and must be continuously and accurately measured. A small number of pores results in a low flow, a larger number of pores results in a larger flow. The same number of large pores as small pores also results in a higher flow rate. The wide range 3G zh therefore has two flow sensors (0-10 and 0-200 L/min) with automatic switching between the two. The standard 3G z is offered with one flow sensor (100 L/min) but can be optionally fitted with a second sensor (5, 50 or 200 L/min) to encompass more applications. The 3G macro, specializing in large pore applications, therefore features a high-flow rate sensor (0-200L/min), while the 3G micro is offered with a 0-100L/min sensor as standard, or one may choose to substitute a lower flow (0-20 L/min) or a higher flow (0-200 L/min) sensor for specific (e.g. quality control) applications.

### **Sample Holders:**

Different applications don't just mean different pore sizes (pressures) and flow rates, but also different sample sizes. Samples come in different diameters and thicknesses. And so to comfortably accommodate your samples, all 3G porometers come with an exchangeable sample holder: most popular is the 25mm diameter and is available as standard on all models. Other single diameter holders available are 18mm, 37mm and 47mm, or you may prefer the universal 10-50mm holder if you work with very many different sample types. Loading and unloading samples is facilitated by the sample holder being freely accessible.

### **Wetting Liquid:**

While in theory any wetting liquid could be used, in practice useful porometry work requires a liquid with predictable performance and desirable physical properties. Quantachrome Porofil wetting fluid™, a fluorocarbon, is such a liquid. It has a very low surface tension (just 16 dynes/cm), will even wet polytetrafluoroethylene (PTFE), is chemically inert, and will not swell materials like water and alcohol can.

### **Accessories:**

Certain applications require more than just regular capillary flow porometry measurements, so a number of optional accessories are available. The Liquid Permeability Accessory includes a 3 liter vessel for direct transfer of liquid of choice through your sample by controlled application of air pressure. An optional External Sample Manifold facilitates work with non sheet-like materials such as hollow fibers and cartridges. An "In-Plane" Accessory is also offered.





Quantachrome Instruments' corporate headquarters in Boynton Beach, Florida.

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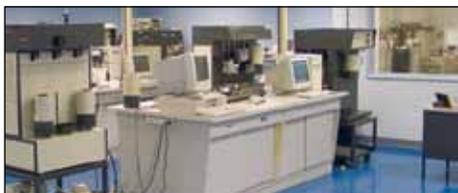
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- Surface Area Measurement
- Pore Size Distribution
- Chemisorption Studies
- Water Vapor Sorption
- Mercury Porosimetry
- Through-Pore Size & Bubble Point
- True Solid Density
- Tapped Density
- Zeta Potential

Not only are Quantachrome products the instruments of choice in academia, but the technology conceived and developed by our expert staff is applied in industrial laboratories worldwide, where research and engineering of new and improved porous materials is ongoing. Manufacturers also rely on porous materials characterization technology to more precisely specify bulk materials, to control quality, and to isolate the source of production problems with greater efficiency.

Quantachrome is also recognized as an excellent resource for authoritative analysis of your samples in our fully equipped, state-of-the-art powder characterization laboratory.



Quantachrome Instruments LabQMC

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