Gemini™ VII Series

Surface Area Analyzers

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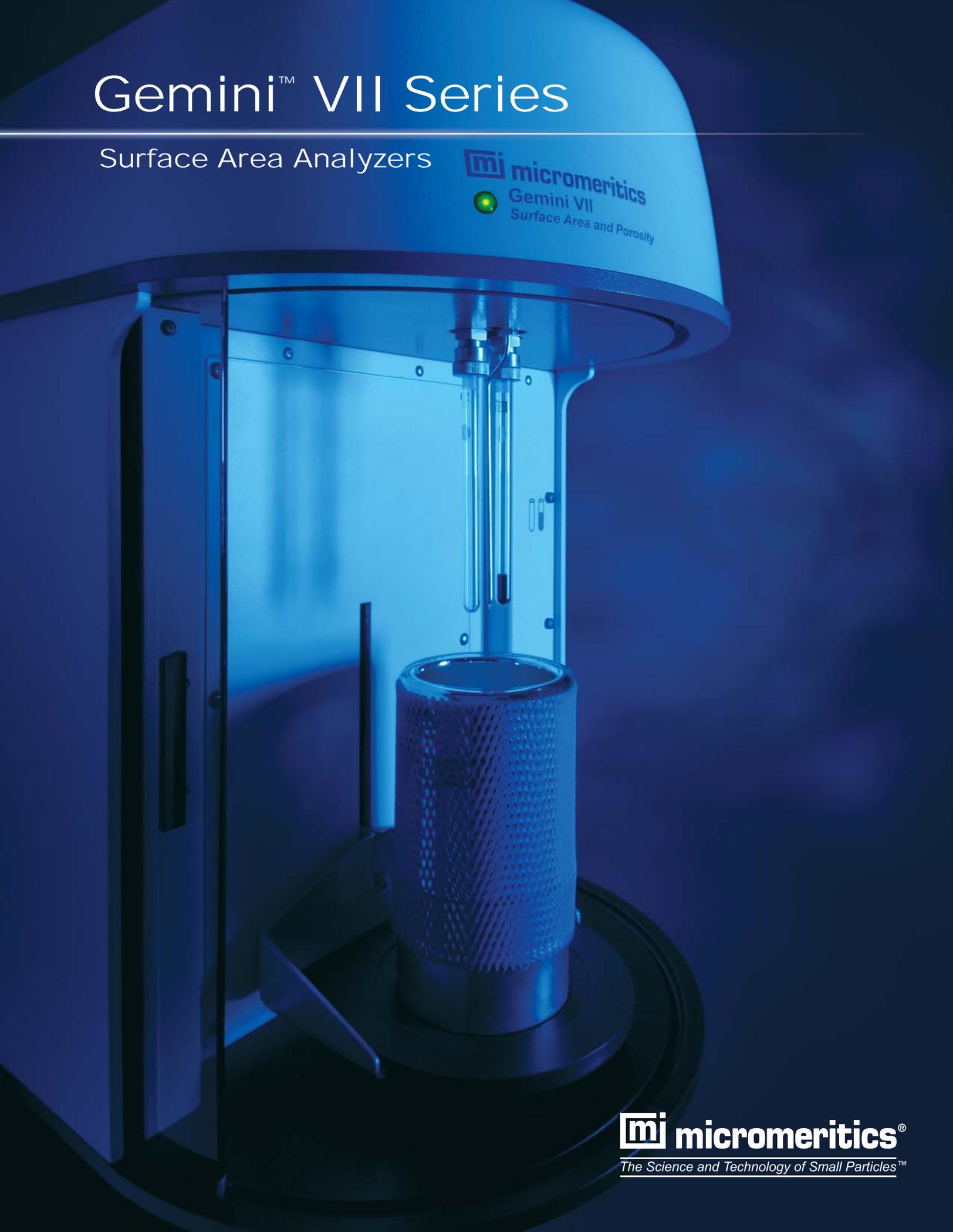
The Science and Technology of Small Particles™

Superior Results with Unique Features

Gemini VII 2390 Series *Surface Area Analyzers*

Rapid and Precise Surface Area Analyses

Surface area and porosity are important physical properties that influence the quality and utility of many materials and products. Therefore it is critically important that these characteristics be accurately determined and controlled. Likewise, knowledge of surface area and especially porosity often is an important key in understanding the formation, structure, and potential application of many natural materials. Micromeritics' Gemini VII 2390 Series of surface area analyzers rapidly and reliably produces accurate and repeatable surface area and porosity results. Their low cost, speed, simplicity of use, reliability, and ruggedness have earned the Gemini a place in laboratories worldwide as an essential tool in research and quality control environments.

Unique Features

The secret of Gemini's unique capabilities lies in the innovative use of sample and balance tubes. These tubes are identical in every aspect, including their thermal environment. The sample and reference reservoirs, like their associated tubes, are physically identical and are initially charged to the same pressure. During an analysis, differential pressure between reservoirs is monitored. This common mode technique assures that any differential pressure is solely due to adsorption by the sample and not to factors that lead to variations in free space during an analysis.

- The Windows® version includes easy-to-follow **installation videos** and **system verification tests** to ensure optimum performance and reliability. **How-to videos** provide on-screen instruction on instrument operation.

- The patented twin-tube design **negates free-space errors** introduced by thermal gradient variations or by initial mismeasurement of free space.

- **Permits low surface area measurements without requiring krypton** by essentially eliminating free-space error, the limiting factor in typical static volumetric systems.

- **Accelerates delivery of the analysis gas** because sample uptake controls the rate at which the gas is delivered to the sample. This results in a surface area analyzer that is as fast as the physics of adsorption allows.

- The use of a servo valve to control the rate of gas flow into the sample tube **assures accurate attainment of target pressures without pressure overshoot**.

- **Three choices of software control**: embedded software with a keypad enabling the Gemini VII to be operated without an external PC, Windows XP or Vista operating system, or the Gemini VII confirm™ 21 CFR Part 11 option.

Three Model Options

Gemini VII 2390*a*
Ideal for rapid and accurate surface area determinations by single-point and multipoint BET and Langmuir methods. In addition, provides standard methods for total pore volume, micropore analysis by the t-method, and much more. Included is the capability to determine statistical thickness surface area (STSA) of carbon blacks. (Refer to ASTM D 6556, ASTM D 3765, ISO/DIS 18852.2, or ISO/CD 4652-2/3.)

Gemini VII 2390*p*
Provides additional precision with the addition of a saturation pressure (P_0) tube that allows the system to monitor the saturation pressure of the adsorptive on a continuous basis during an analysis. This design feature permits a rapid measurement of the adsorption isotherm to near-saturation, as well as determination of pore size distribution.

Gemini VII 2390*t*
Has all the ability of the 2390*p,* including a P_0 tube, with the addition of a larger Dewar and longer sample tubes for extended analyses. This provides the additional capability to measure the total adsorption-desorption process. With this data set, one can perform a BJH or Dollimore-Heal pore size distribution using up to 1000 data points.

Typical Gemini Applications

Pharmaceuticals – Surface area and porosity play major roles in the purification, processing, blending, tableting, and packaging of pharmaceutical products as well as the drug's useful shelf life, its dissolution rate, and bioavailability.

Ceramics – Surface area and porosity affect the curing and bonding of greenware and influence strength, texture, appearance, and density of finished goods. The surface area of glazes and glass frits affects shrinkage, crazing, and crawling.

Adsorbents – Knowledge of surface area, total pore volume, and pore size distribution is important for quality control of industrial adsorbents and in the development of separation processes. Surface area and porosity characteristics affect the selectivity of an adsorbent.

Activated Carbons – Surface area and porosity must be optimized within narrow ranges to accomplish gasoline vapor recovery in automobiles, solvent recovery in painting operations, or pollution controls in wastewater management.

Carbon Black – The wear lifetimes, traction, and performance of tires are related to the surface area of carbon blacks used in their production.

Catalyst – The active surface area and pore structure of catalysts influence production rates. Limiting the pore size allows only molecules of desired sizes to enter and exit, creating a selective catalyst that will produce primarily the desired product.

Paints and Coatings – The surface area of a pigment or filler influences the gloss, texture, color, color saturation, brightness, solids content, and film adhesion properties. The porosity of a print media coating is important in offset printing where it affects blistering, ink receptivity, and ink holdout.

Projectile Propellant – The burn rate of propellants is a function of surface area. Too high a rate can be dangerous; too low a rate can cause malfunctions and inaccuracy.

Medical Implants – Controlling the porosity of artificial bone allows a better imitation of real bone that is more acceptable to the body for tissue growth.

Electronics – By selecting high surface area material with carefully designed pore networks, manufacturers of super-capacitors can minimize the use of costly raw materials while providing more exposed surface area for storage of charge.

Cosmetics – Surface area is often used by cosmetic manufacturers as a predictor of particle size when agglomeration tendencies of the fine powders make analysis with a particle-sizing instrument difficult.

Aerospace – Surface area and porosity of heat shields and insulating materials affect weight and function.

Fuel Cells – Fuel cell electrodes require high surface area with controlled porosity to produce adequate power density.
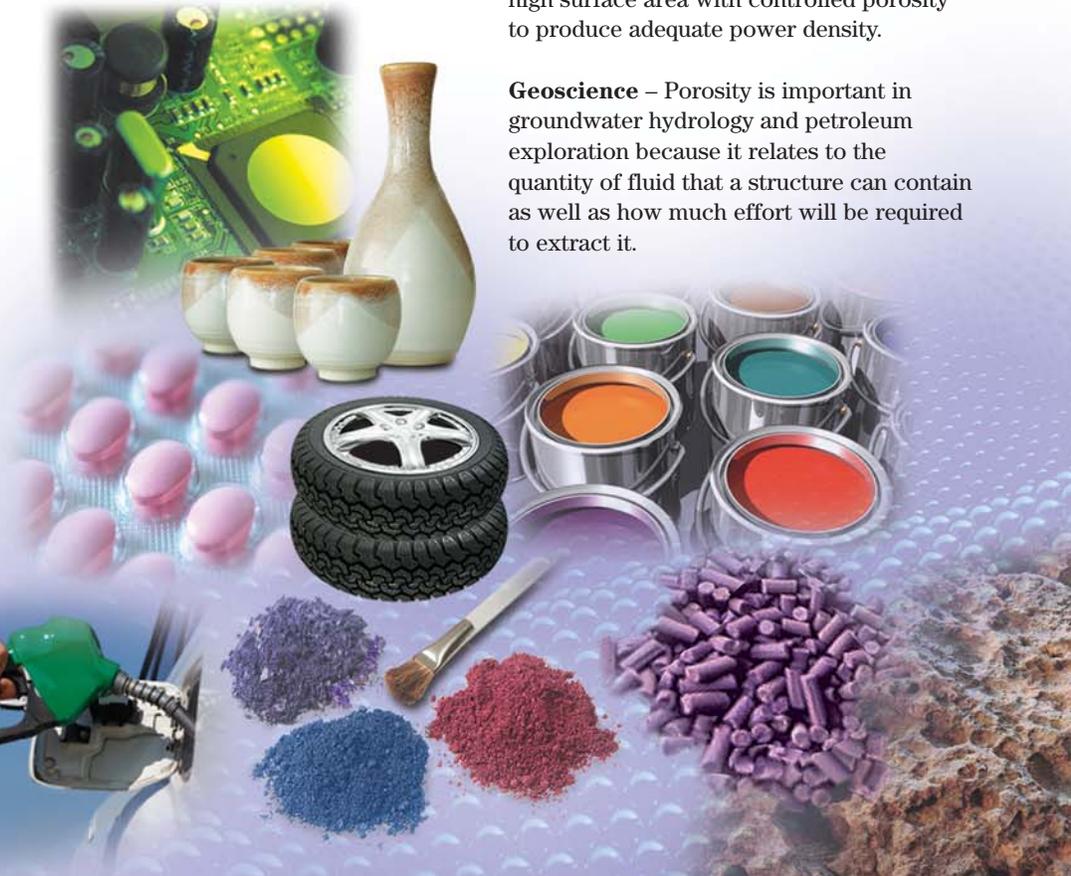
Geoscience – Porosity is important in groundwater hydrology and petroleum exploration because it relates to the quantity of fluid that a structure can contain as well as how much effort will be required to extract it.

Superior Data Presentation Capability

Operating Software

Gemini analyzers can be operated from a keypad by way of embedded software or from a computer using the more-powerful and versatile Gemini Windows optional software.

The embedded software includes:
- System verification tests
- Single- and Multipoint BET (Brunauer, Emmett, and Teller) surface area
- Langmuir surface area
- Total pore volume
- Total micropore volume and area by the t-Plot method using Halsey, Harkins-Jura, or Carbon Black STSA thickness curves
- Horvath-Kawazoe for micropore distribution
- BJH pore size distribution using adsorption isotherm (Gemini 2390p and 2390t only)
- BJH adsorption and desorption isotherm, 1000 data points (Gemini 2390t only)

Optional Gemini Windows Software

The easy-to-use Gemini Windows XP or Vista interface enhances the capabilities to plan, launch, and control the analysis. You can collect, organize, archive and reduce raw data, and store standardized sample information and analysis conditions for easy access during later applications. Finished reports may be generated to screen, paper, or to files in various formats. Features include cut-and-paste graphics and tables, scalable-and-editable graphs, and customizable report formats. Using computer control, you can operate up to four Gemini analyzers simultaneously from a single computer.

Gemini Windows Features

Gemini Windows software provides additional features not included with the embedded software. As examples:
- Installation and how-to videos
- Reduction of user-entered data
- Automatically generated pressure tables with user-selected endpoints
- User-defined pressure table
- Summary report
- Sample log
- Isotherm plot overlays
- Autoscaling x- and y-axes
- Cut-and-paste graphics and tables
- Data export to ASCII and spreadsheet formats
- User-defined thickness curve (manually entered or from data file)
- Fixed pore size tables
- Linear and log plots (isotherm, pore volume, pore area)
- Cumulative and differential data
- Broekhoff-de Boer thickness curve

21 CFR Part 11 Option

Also available is confirm™ software, which addresses the many requirements specified by 21 CFR Part 11 validation, security, audit trails, reporting, and more.

Micromeritics Gas Adsorption Reports

Windows software with all Micromeritics' gas adsorption instruments contains the following reports:

Isotherm Reports:
- tabular
- graphical
- pressure composition isotherm

Isotherm modeling and surface area:
- BET
- Langmuir
- Temkin
- Freundlich

Standard isotherm models:
- t-plot – micropore volume, micropore area, external surface area
- alpha-s method
- f-ratio method

Classic models for mesopore volume, area, and distribution:
- BJH*
- Dollimore-Heal*

Classic models for micropore distribution:
- Dubinin-Radushkevich and Astakhov
- Horvath-Kawazoe
- Saito-Foley
- Cheng-Yang
- MP method

Density Functional Theory for pore size modeling:
- Slit-shaped pores using N_2, Ar, or CO_2
- Cylindrical pores for alkaline-exchanged zeolites using N_2 or Ar
- Cylindrical pores for hydrogen- or ammonium-exchanged zeolites using N_2 or Ar
- Windows-shaped model for pillared clay

Density Functional Theory for surface energy:
- Surface area and energy distributions using nitrogen at 77 K
- Surface area and energy distributions using argon at 87 K

*BJH and Dollimore-Heal require the Gemini VII 2390t to take full advantage of pore size reports based upon the desorption isotherm.
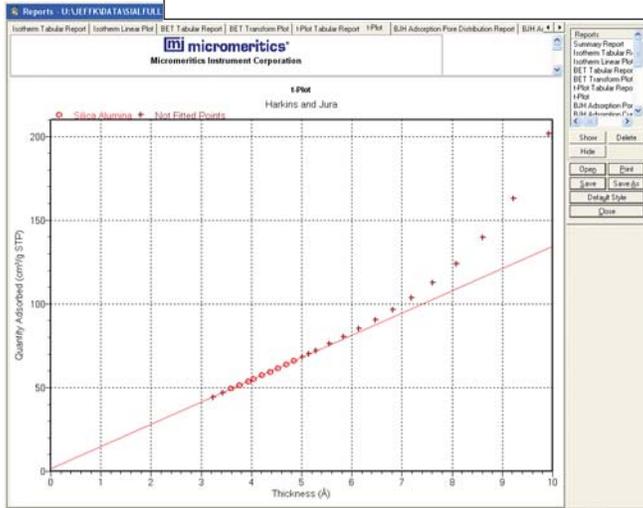
BET Surface Area Report

BET Surface Area: 214.6224 ± 0.3291 m²/g
Slope: 0.020097 ± 0.000031 g/cm³ STP
Y-Intercept: 0.000186 ± 0.000005 g/cm³ STP
C: 108.976671
Qm: 49.3022 cm³/g STP
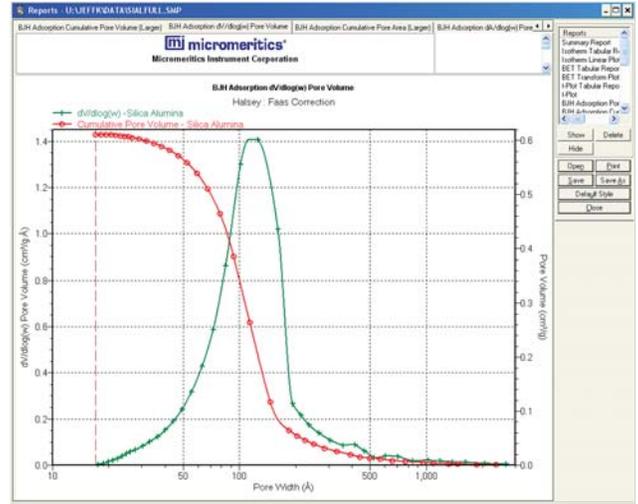Correlation Coefficient: 0.9999907
Molecular Cross-Sectional Area: 0.1620 nm²

t-Plot Report

Micropore Volume: 0.002373 cm³/g
Micropore Area: 9.0674 m²/g
External Surface Area: 205.5550 m²/g
Slope: 13.289049 ± 0.038487 cm³/g·Å STP
Y-Intercept: 1.534435 ± 0.163081 cm³/g STP
Correlation Coefficient: 0.999971
Surface Area Correction Factor: 1.000
Density Conversion Factor: 0.0015468
Total Surface Area (BET): 214.6224 m²/g
Thickness Range: 3.5000 Å to 5.0000 Å
Thickness Equation: Harkins and Jura

The Gemini VII 2390p includes a dedicated transducer for continuously monitoring the saturation pressure of the cryogenic bath. This allows the Gemini VII 2390p to rapidly measure adsorption isotherms and determine the pore volume, area, and size distribution of mesoporous materials.
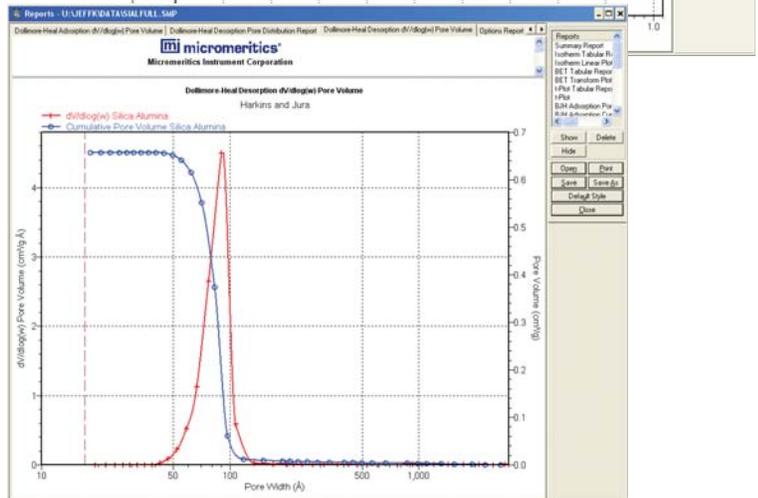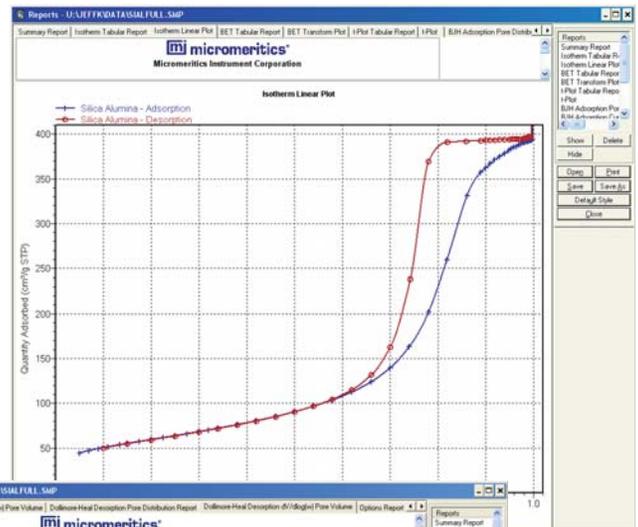

The Gemini VII 2390 Series analyzers provide rapid surface area analysis. The unique balanced design allows BET surface area to be measured using nitrogen for a broad range of materials. The Gemini offers precise measurements of low surface area materials using nitrogen. The determination of micropore volume, micropore surface area, and external surface area is available on all Gemini models using the standard t-plot calculations.

The Gemini VII 2390t features extended operation to facilitate the determination of the total isotherm. Both adsorption and desorption measurements may be obtained; this allows users the capability to determine the pore volume, area, and size distributions using BJH or Dollimore-Heal reports.
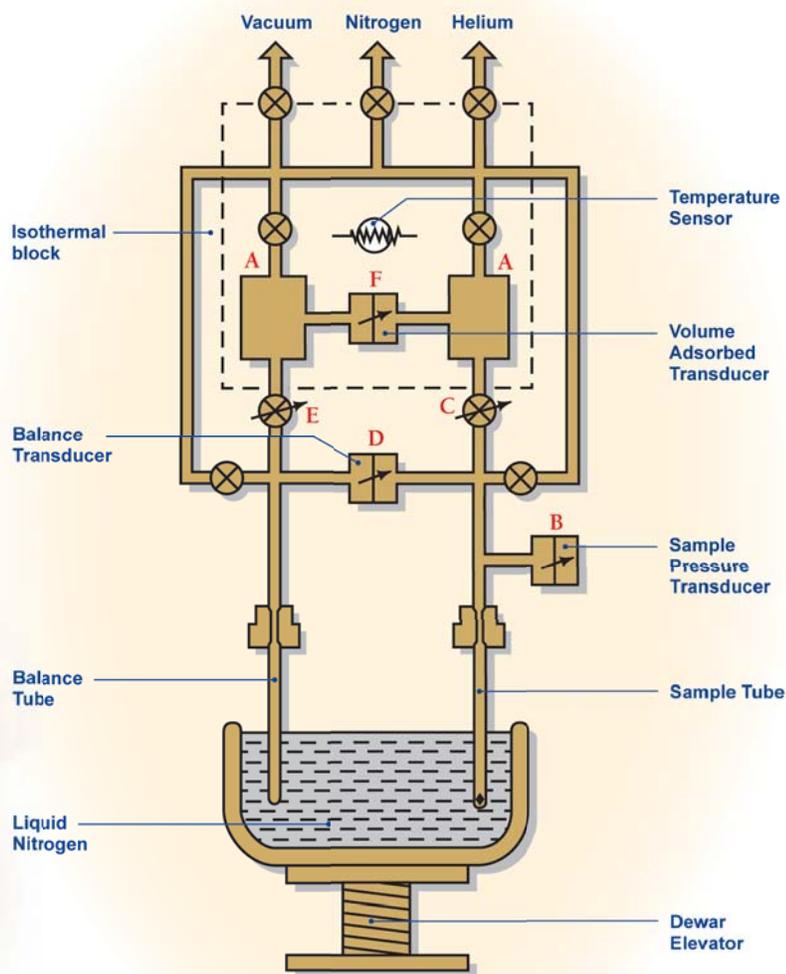
Unique Design

The Gemini Technique

Micromeritics' Gemini utilizes an adaptive rate, static volumetric technique. It is the first gas sorption method that adapts the rate at which gas is delivered to the sample to the rate at which it is adsorbed. Each pressure point is allowed to equilibrate before the next point is taken. The Gemini has, as illustrated below, two gas reservoirs (A) which are filled with equal volumes of the desired adsorptive, usually nitrogen. From the reservoirs, gas is metered into the sample and balance tubes by way of a servo valve that reacts to the rate of adsorption. A transducer (B) monitors pressure within the sample tube. In a typical dose-and-wait analytical system, pressure within the sample tube decreases after each dose as the sample adsorbs gas. This is not the case with the Gemini. Transducer (B) causes a fast response servo valve (C) to increase or restrict the flow of gas to the sample tube as necessary to maintain a constant equilibrium pressure within the sample tube as adsorption occurs. Transducer

(D) located between the sample and balance tubes detects any pressure difference between the two tubes and causes another servo valve (E) to adjust the pressure within the balance tube to negate any pressure differential. A third pressure transducer (F) monitors the pressure between the two reservoirs to determine the differential quantity of gas, the difference being the quantity that is adsorbed on the sample. These methods of dosing and differential quantity detection enable the Gemini to accurately determine adsorption characteristics at a speed and sensitivity level unsurpassed by other static volumetric instruments.

Vacuum   Nitrogen   Helium

Temperature Sensor

Isothermal block

Volume Adsorbed Transducer

Balance Transducer

Sample Pressure Transducer

Balance Tube

Sample Tube

Liquid Nitrogen

Dewar Elevator

Accessories

Sample Preparation Devices

Micromeritics' sample preparation devices prepare batches of samples for surface area and pore volume analysis. They combine flowing gas and/or vacuum with heat to remove atmospheric contaminants, such as water vapor and adsorbed gas, from the surface and pores of the sample. The quality of the data produced by surface area and pore volume analyses depends greatly on the cleanliness of the sample surface. All Micromeritics' sample preparation devices accept He, N_2, Ar, and other non-corrosive gases.

The **SmartPrep™ 065** is a flowing-gas degassing unit which removes adsorbed contaminants from the surface and pores of your sample in preparation for analysis. It contains six sample ports, each one independently temperature-controlled for greater flexibility. It contains two serial ports, one for connecting to the computer and the other available for connection of an additional SmartPrep. The temperature, ramp rates, and soak times of each sample are individually controlled by the computer. Up to five ramps and soaks are allowed. All degas information is integrated into the sample data file for easy reference in the future.

The **FlowPrep™ 060** applies both heat and a stream of inert gas to the sample. The heat causes contaminants to desorb from the surface and the stream of inert gas sweeps them out of the sample tube. It lets you choose the temperature, gas, and flow rate best suited for your sample material and application. Needle valves allow you to introduce the flowing gas slowly to prevent fluidization of samples.

SmartPrep 065

VacPrep 061

The **VacPrep™ 061** offers two methods for removing contaminants. In addition to flowing gas, it enables vacuum to be applied to prepare samples by heating and evacuation. This combination allows you to choose the preparation method that is best suited to your material or application. The VacPrep features six degassing stations, and a choice of vacuum or gas flow preparation on each of the six stations. Needle valves are also provided allowing you to introduce slowly the flowing gas or vacuum to prevent fluidization of samples.

Model 021 LN$_2$ Transfer System

The Model 021 LN$_2$ Transfer System allows you to transfer liquid nitrogen or liquid argon from a nonpressurized storage Dewar into smaller containers used in laboratory experiments.

The system was specifically developed for conveniently filling Dewars for gas adsorption instruments but also can be used for other cryogen applications. The Model 021 can discharge cryogens at adjustable rates up to 3 liters/min. The roller base makes it easy to move the 021 System to the location where the cryogen is needed. The insulated, flexible hose enables convenient filling and refilling of analysis Dewars. The system can hold liquid nitrogen or liquid argon up to 30 days allowing cost-efficient use of your cryogen.

Additional accessories are available for special applications. Contact Micromeritics Sales Department for details. For more comprehensive information on the Gemini VII Series, visit our web site at **www.micromeritics.com**.

To request a quote or additional product information, visit Micromeritics web site at www.micromeritics.com or contact your local Micromeritics sales representative.

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The Science and Technology of Small Particles™

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