

NOVA[®] *e* SERIES

HIGH-SPEED SURFACE AREA & PORE SIZE ANALYZERS



QUANTACHROME



THE GAS SORPTION PROCESS

Industries Served

Particle characterization technology serves a wide variety of industries, including:

Aerospace
Agriculture
Automotive
Aviation
Batteries
Building Materials
Ceramics
Chemicals
Communications
Equipment
Construction
Consumer Goods
Cosmetics
Electrical & Electronics
Environmental Services
Foods
Food Processing
Fuel Cells
Manufacturing
Marine
Medical Devices
Metals
Mining & Minerals
Munitions
Oil Exploration
Optics
Paints & Coatings
Paper & Packaging
Petrochemicals
Pharmaceuticals
Plastics
Rubber
Textiles
Water Treatment



▲ For laboratory research and development.



▲ For industrial QA/QC and analytical services.

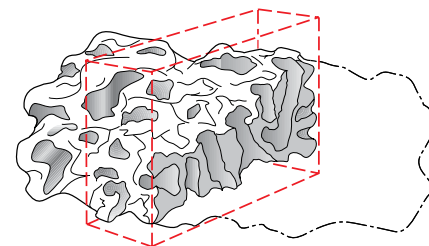
Before performing gas sorption experiments, solid surfaces must be freed from contaminants such as water and oils. Surface cleaning (degassing) is most often carried out by placing a sample of the solid in a glass cell and heating it under vacuum or flowing gas. Figure 1 illustrates how a solid particle containing cracks and orifices (pores) of different sizes and shapes may look after its pretreatment.

Once clean, the sample is brought to a constant temperature by means of an external bath. Then, small amounts of a gas (the adsorbate) are admitted in steps into the evacuated sample chamber. Gas molecules that stick to the surface of the solid (adsorbent) are said to be adsorbed and tend to form a thin layer that covers the entire adsorbent surface. Based on the well-known Brunauer, Emmett and Teller (B.E.T.) theory, one can estimate the number of molecules required to cover the adsorbent surface with a monolayer of adsorbed molecules, N_m (see Figure 2). Multiplying N_m by the cross-sectional area of an adsorbate molecule yields the sample's surface area.

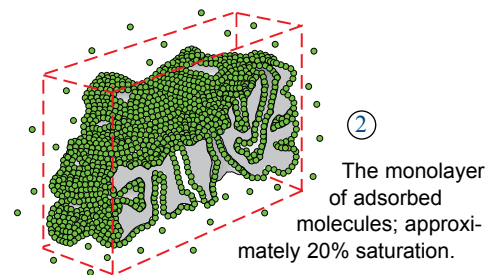
Continued addition of gas molecules beyond monolayer formation leads to the gradual stacking of multiple layers (or multilayers). The formation occurs in parallel to capillary condensation (see Figure 3). The latter process is approximated by the Kelvin equation, which quantifies the proportionality between residual (or equilibrium) gas pressure and the size of capillaries capable of condensing gas within them.

Methods such as the classical one by Barrett, Joyner and Halenda (B.J.H.) or the more accurate Density Functional Theory (DFT) models, allow the computation of pore sizes from equilibrium gas pressures. Experimental isotherms of adsorbed gas volumes relative versus pressures (at equilibrium), are converted to cumulative or differential pore size distributions.

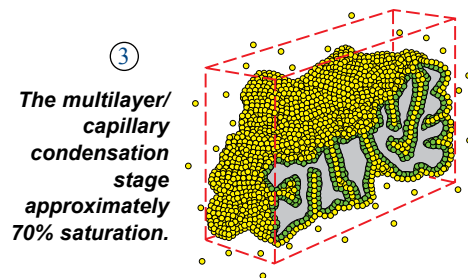
As the equilibrium adsorbate pressures approach saturation, the pores become completely filled with adsorbate (see Figure 4).



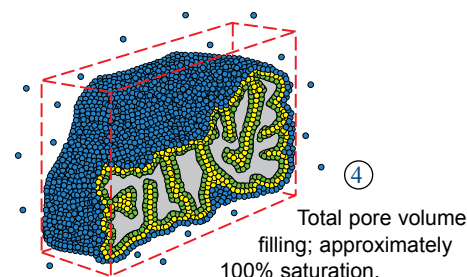
① **A section of one greatly enlarged particle of a solid.**



② **The monolayer of adsorbed molecules; approximately 20% saturation.**



③ **The multilayer/capillary condensation stage approximately 70% saturation.**



④ **Total pore volume filling; approximately 100% saturation.**

Knowing the density of the adsorbate, one can calculate the volume it occupies and, consequently, the total pore volume of the sample. If at this stage the adsorption process is reversed by withdrawing known amounts of gas from the system in steps, one generates desorption isotherms. The resulting hysteresis leads to isotherm shapes that can be related to those expected from particular pore-shapes.

NOVA[®] e SERIES OVERVIEW

Quantachrome's patented NOVA e series offers a full line of high-quality, high-performance Surface Area and Pore Size Analyzers, with eight fully automatic models to meet the needs of any research or quality assurance laboratory.

The NOVA^e Series—designed for today's laboratory.

- **Affordably-priced**—perfect for any laboratory.
- **Space saving**—each unit takes up less bench space than an open 3-ring binder.
- **Versatile**—a wide range of characterization techniques for powdered and porous materials.
- **Upgradeable**—can adapt to meet your expanding or changing laboratory needs.
- **PC option**—use Windows-based software or run stand-alone.

NOVA 1000^e—rapid single-sample surface area and pore size analyzer.

- Perform fully automated multi-point B.E.T. analysis in as little as eight minutes.
- Eliminate the need for helium with patented NO Void Analysis™ (NOVA) technology.
- Analyze up to 200 data points (100 adsorption points and 100 desorption points).
- Prepare two samples by vacuum or flow methods simultaneously with sample analysis—at different temperatures if required.
- Access degasser during analysis to start/stop flow or vacuum degassing with Analysis Interrupt.
- Get data "on the fly" by uploading data to a PC from current analysis.
- Eliminate cell calibration with classical helium-void-volume mode.
- Transfer data via RS232 or printer port.
- Enhance performance with Windows®-compatible software.
- Verify performance with rapid calibration check.

NOVA 1200^e—the "Any Gas" surface area and micropore size analyzer.

- Enhanced single-sample analyzer suitable for a variety of applications.
- Useable with most non-corrosive adsorbate gases such as argon, CO₂ and light hydrocarbons over a wide range of temperatures.
- Plus all the features of the NOVA 1000e.

NOVA 2000^e—measures two samples simultaneously.

- Get all the capabilities of the NOVA 1000e in a two-station instrument.
- Provides higher laboratory efficiency and productivity.
- Flexible operation—analysis type independent for each station (BET and/or pore size measurement).

NOVA 2200^e—features "Any Gas" capability for dual-sample analysis.

- Combines the qualities of the NOVA 1200e and the NOVA 2000e.
- Meets the special needs of the busy research laboratory.

NOVA 3000^e—measures up to three samples simultaneously.

- Analyze up to three samples at one time or two plus continuous Po measurement.
- Save space with four on-board sample preparation ports.
- Plus all the capabilities of the NOVA 1000e and NOVA 2000e.

NOVA 3200^e—features "Any Gas" capability for analysis of up to three samples.

- Combines the qualities of the NOVA 1200e and the NOVA 3000e.

NOVA 4000^e—maximum throughput with four sample stations

- Four samples at one time, or three plus continuous Po measurement.
- Four degas ports.
- See Nova 1000/2000e for other capabilities.

NOVA 4200^e—features "Any Gas" capability for analysis of up to four samples.

- Everything the Nova 4000e can do plus expanded capabilities of using a wide range of analysis gases.

Applications for Quality Control and Research

Carbon for rubber, adsorbents (gas separation and water purification), gas masks, inks, laser printers and copiers.

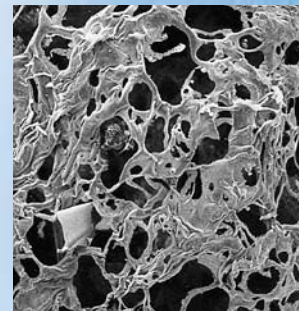
Catalysts for the automotive, fertilizer, fuel cell and petrochemical industries.

Organic materials for adhesives, chromatography, cosmetics, foodstuffs, detergents, explosives, ion exchange resins, pharmaceuticals and plastics.

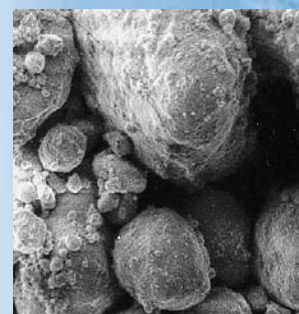
Minerals such as alumina, clays, hydroxyapatite, pigments, phosphates, silicas, zirconia, etc., used for abrasives, adsorbents, biomaterials, ceramics, cements, desiccants, fillers, papers and paints.

Powdered metals and ferrites for batteries, pressure formed/ sintered products, electronics, magnets and magnetic tape.

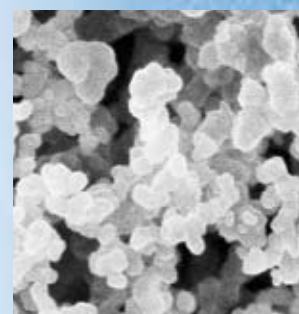
Other applications related to bone, composite materials, fibers, rigid foams, soil, sludge, slurries, suspensions and well cores.



Coal ash ▲



Natural zeolite ▲



Carbon black ▲

NOVA[®] e SERIES

QUALITY CONTROL • RESEARCH

The NOVA Series produces the results you need...

- Single and multi-point B.E.T. surface area with y-intercept, "C" constant, slope and correlation coefficient.
- Up to 100 adsorption and 100 desorption isotherm points.
- B.J.H. pore size distribution calculated from the adsorption or desorption isotherm.
- Total pore volume.
- Average pore radius.

...and with optional NovaWin software

- Dubinin-Radushkevich micropore area, average micropore width and adsorption energy.
- Langmuir surface area with slope, intercept, constant and correlation coefficient.
- Plot of single-point B.E.T. surface area as a function of relative pressure.
- t-method for micropore area and volume (Halsey, deBoer and carbon black methods).
- Density Functional Theory calculations for unified micropore and mesopore size distributions.

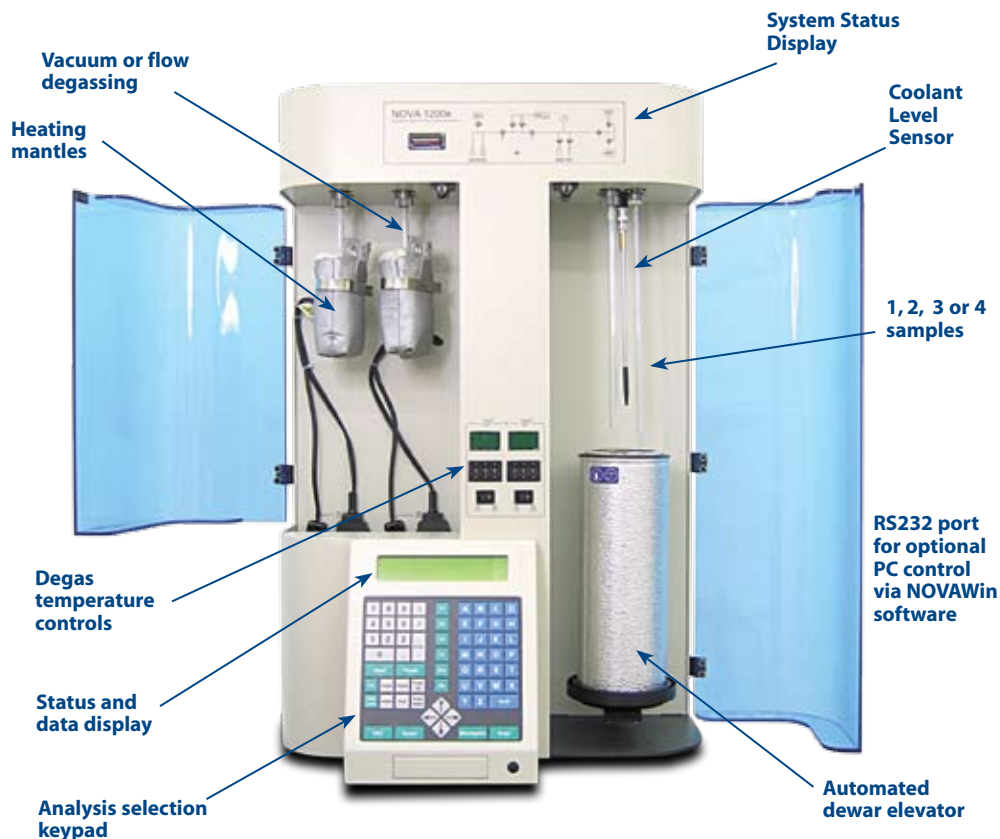
Critical components of highest quality to ensure reliable results

- High-sensitivity pressure transducer with excellent stability.
- High-resolution 16-bit A/D converter.
- Robust dewar elevator for years of trouble-free operation.
- Filter gaskets to prevent vacuum system contamination by powdered samples.
- Reliable solenoid valves and leak-free (10^{-9} cc/sec) dosing manifold.
- Sensitive RTD coolant level sensor

Accurate results require proper sample preparation

- Each station provides sample preparation under vacuum or flow conditions.
- Backfill after vacuum degas with helium or adsorptive.
- Temperature range from ambient to 450°C* with independent selection.
- Flow rate selection for each station.
- Optional, multi-station degassing units for busy laboratories: MasterPrep, FloVac and Flow Degassers.

* 350°C standard with mantles supplied; 450°C with optional quartz heating mantles



Feature highlights of the NOVA^e Series

| Functional Capability by Model | NOVA 1000e | NOVA 1200e | NOVA 2000e | NOVA 2200e | NOVA 3000e | NOVA 3200e | NOVA 4000e | NOVA 4200e |
|--------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|
| Surface area analysis | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Mesopore size distribution | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Standard micropore methods | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Analysis stations | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| "Any Gas" capability | — | ✓ | — | ✓ | — | ✓ | — | ✓ |

ACCESSORIES

Gas Regulator Assembly

Proper Nova functioning is assured when high-quality gas regulators are used. Quantachrome supplies complete assemblies which include two-stage regulators with dual gauges, cylinder connector, isolation valve and 1/8" gas line connector. The regulators feature stainless steel, non-venting diaphragms and the appropriate CGA fitting for specific gases. Different assemblies are available for nitrogen (and other inerts including helium), hydrogen, carbon monoxide, oxidizing gases etc.

Rotary Micro Riffler

Like most powder and porous materials characterization, surface area and pore size studies generally require sub-samples much smaller than the original samples. The Rotary Micro Riffler uses the most accurate way of splitting a powder sample into smaller fractions- spin riffing. The vibrating hopper features adjustable feed rate and the variable-speed collector uses standard or micro test tubes.

NOVA[®] e SERIES BENEFITS

Operational conveniences

- Simultaneous analysis of up to four samples with NOVA 4000/4200e for dramatic increase in productivity.
- Degass up to four samples while analysis is in progress for maximum throughput.
- Automatic analysis, computation, display and printing of results.
- Keyboard selection from unlimited number of analysis types offers fast run initialization.
- Wide variety of sample cells to accommodate any sample.
- Compact, benchtop design to conserve valuable lab space.
- Protective doors for safety.

Meets technical demands

- Full equilibration technology with choice of pressure tolerance, equilibration time and relative pressure (P/P₀) points.
- Multiple P₀ options for speed and accuracy: user entered, calculated from ambient, measured once, or continuously updated throughout analysis (NOVA 2000e through Nova 4200e).
- Upgrades easily as your needs expand; analysis stations can be added up to a maximum of 4.
- Built-in microprocessor guided calibration for optimum performance consistent with ISO-9000 requirements.
- Manual mode diagnostics for performance verification and maintenance.
- Real-time display of analysis status for instant user update of analysis progress.
- Calibration verification is fast. Calibration performed in just a few minutes.

Revolutionary ease-of-use, speed, and accuracy

- Patented NO Void Analysis™ (NOVA) technology eliminates helium, reducing analysis costs.
- Alternatively, use classical helium-void-volume mode to match your existing SOPs.
- RTD coolant level sensor for constant void volume and high accuracy as coolant evaporates.
- MaxiDose™ algorithm reduces analysis time without compromising accuracy.
- Low surface area capabilities with compensation for adsorption on cell walls.
- Access degasser during an analysis to start/stop flow or vacuum degassing with Analysis Interrupt.

- Get data "on the fly" by uploading data to a PC from the current analysis with Nova Software.

Output capabilities

- Front panel display of results upon completion of analysis.
- Automatic report generation on optional printer.
- Communication with PC for analysis set up, data acquisition and reporting.

Analysis Presets

- Allows the user to establish predefined analysis protocols.
- Speed up operation by reducing entries needed to start each run.

System Manager

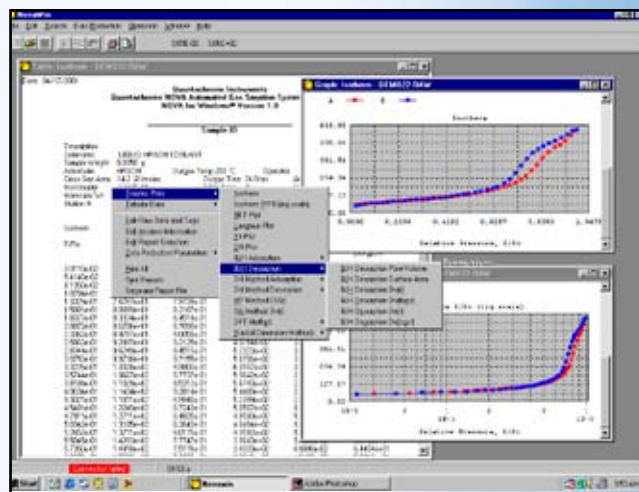
- Exclusive control of key settings such as RS232 settings, critical operation parameters, isotherm measurement, or operation restrictions.

NOVAWin™ - Windows® Based Software for Operation from PC

NOVAWin™ is a PC based program for operation of the NOVA series of instruments utilizing the familiar features of the Microsoft® Windows® operating system. NOVA operators will find this to be a user-friendly, graphical environment to work in.

NOVAWin™ incorporates Quantachrome Instruments' many years of experience in particle analysis through the inclusion of our extensive methods of data reduction and report generation in this versatile software package.

21 CFR Part 11 compliant version available.



Choose from many methods of data reduction.

- Adsorption and desorption isotherms (linear and logarithmic scales)
- BET surface area
- Langmuir surface area
- Micropore volume and surface area by t-plot method (Halsey, deBoer or carbon STSA equations)
- Dubinin Radushkevich micropore surface area
- Dubinin Astakhov micropore area and size distribution
- Mesopore size distribution by BJH method
- Mesopore size distribution by DH method
- Micropore size distribution by MP method
- Density functional theory for unified micropore and mesopore size distribution including library of adsorbates and adsorbent pairs, eg. argon on zeolite, nitrogen on silica, CO₂ on carbon, etc.
- Fractal dimension by NK and FHH methods.

SPECIFICATIONS

| | NOVA 1000e | NOVA 1200e | NOVA 2000e | NOVA 2200e | NOVA 3000e | NOVA 3200e | NOVA 4000e | NOVA 4200e |
|--|--|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Performance | | | | | | | | |
| Analysis stations | 1 | | 2 | | 3 | | 4 | |
| Measurement types: | B.E.T., STSA, adsorption isotherm, desorption isotherm | | | | | | | |
| Surface area range: | 0.01m ² /g to no known upper limit | | | | | | | |
| Pore size range: | 0.35 to >400nm (3.5 to >4000 Å) | | | | | | | |
| Minimum pore volume: | (liquid) 2.2 x 10 ⁻⁶ ml/g | | | | | | | |
| Minimum pore volume: | (STP) 0.0001 cc/g | | | | | | | |
| Gas | | | | | | | | |
| Nitrogen | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Other non-corrosive gases (Ar, CO ₂ , H ₂ , C ₄ H ₁₀ , etc.) | — | ✓ | — | ✓ | — | ✓ | — | ✓ |
| Preparation Ports | 2 | | | | | | 4 | |
| Methods | Vacuum and Flow | | | | | | | |
| Temperature range: | ambient - 450°C*, 1°C intervals | | | | | | | |
| Accuracy | ±5°C | | | | | | | |
| Resolution | | | | | | | | |
| Accuracy (% of span) | ±0.1 | | | | | | | |
| Minimum pressure (mm Hg) resolution | 0.016 | | | | | | | |
| Minimum relative pressure P/Po (N ₂) resolution | 2 x 10 ⁻⁵ | | | | | | | |
| Dimensions (WxDxH) | 51 cm x 51 cm x 79 cm | | | | | | | |
| Weight | 36.29 kg (80 lbs.) | | | | | | | |
| Electrical | 100-240 V, 50/60 Hz | | | | | | | |

*450°C with optional quartz heating mantles.

ADDITIONAL DEGASSING OPTIONS

Sample Preparation

Consistent and reliable surface area results depend upon proper sample preparation procedures.

In terms of B.E.T. analysis, the limiting step in rate of throughput is often sample preparation. The complete degassing of samples can often require several hours, while surface measurements may require as little as 8 minutes.

The NOVAe Series features built-in vacuum or flow sample preparation ports that permit the simultaneous degassing of samples while measurements are in progress.

The Masterprep, FloVac & Flow Degassers

For additional flow and vacuum degassing, Quantachrome offers three valuable complements to



The MasterPrep Degasser set up for vacuum degassing

augment the NOVA's sample preparation facilities: the MasterPrep and the FloVac Degasser for combined flow and vacuum degassing, and the Flow Degasser offering the flow method only.

Each device features six sample stations, each with individual

control valves to allow the addition or removal of individual sample cells without interrupting the other samples in process. A built-in heater provides user-selectable degas temperature to 400°C, in steps of 1°C, monitored continuously on the digital display.

The MasterPrep features individual temperature programming for each of the six sample stations, from the built-in keypad or by PC software (PC not included). In vacuum mode, the MasterPrep's and FloVac's selectable evacuation rates and back-fill gases add convenience and versatility. A selection of fittings are provided to accommodate short and tall glassware as well as three different diameter stems.

In flow mode, all units' needle valves allow careful control of flow rate to avoid elutriation (blowing out) of fine powders. The metal flow tubes for each station provide variable depth

insertion into any sample cell. Cooling stations are provided to hold sample cells after sample preparation.

These degassers provide a virtually continuous supply of properly prepared samples for the NOVAe series of surface area and pore size analyzers.



The Flow Degasser for flow degassing of up to six samples

SERVICES

Application Laboratory

Fee-basis analytical service for a wide range of physical properties: surface area, micropore and mesopores characterization by gas sorption, meso and macropore measurements by mercury intrusion porosimetry, density by gas pycnometry, bulk and tapped powder density, water sorption isotherms, catalyst characterization using reactive gas sorption, TPR/TPD/TPO etc. Staffed by experts; data interpretation by top scientists in their fields, often at no additional charge.



Operator Training Courses

Many users benefit from detailed training classes focusing on instrument operation, report generation and interpretation of results. Get the most out of your investment/equipment budget. Learn about latest advancements in measurement techniques. Try out the latest software versions, taught by our specialists. Classes are held at Quantachrome's headquarters in Boynton Beach, Florida throughout the year. Fully customized classes are available at client's home facility.



Knowledge Transfer Program

Two-day classroom style educational courses. You do not have to be a Quantachrome customer to benefit. Covers theory, application, and results interpretation for the field of porous materials characterization. Courses are customized and presented at your own facility to an unlimited number of attendees.



Service Plans

Every Quantachrome instrument comes with at least a full 12-month warranty. Larger instruments are installed by an expert technician - at no extra charge. To ensure trouble free operation in the years to come, our Service Department offers a variety of maintenance and service contract options. Our service technicians are factory trained and teach instrument operation plus routine maintenance skills to operators. *Refers to USA only. Outside USA, contact your local Quantachrome representative for their offerings. Factory warranty valid worldwide.*



Technical Support

- **Application Notes:** Any or all of our comprehensive listing of notes is available on request. Notes library is continually expanded to feature breakthrough developments in porous materials characterization. Our science staff will assist users with applications for which a note does not already exist.
- **Newsletter:** Quantachrome publishes "Porous Materials Highlights," available electronically. Features application articles, news, events, people and more.

Contributions from users are always welcome.

- **Website www.quantachrome.com:** Provides detailed instrument specifications and brochures, events calendar, course schedules and special announcements. Ask questions to our experts through our feedback form.





Quantachrome Instruments' corporate headquarters in Boynton Beach, Florida.

Quantachrome®

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

For 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:

- Adsorption/Desorption Isotherms
- Surface Area Measurement
- Pore Size Distribution
- Chemisorption Studies
- Water Sorption Behavior
- Mercury Porosimetry
- True Solid Density
- Tapped Density

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 Application Laboratory.

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Quantachrome Instruments' quality management system is certified to be in accordance with ISO9001:2000.

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Quantachrome

INSTRUMENTS

Serving Porous
Materials and Powder
Characterization
Needs Since 1968



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