

100-6858

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NOVA^e® SERIES

HIGH-SPEED SURFACE AREA & PORE SIZE ANALYZERS



100-6858

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Quantachrome
INSTRUMENTS

A brand of Anton Paar

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

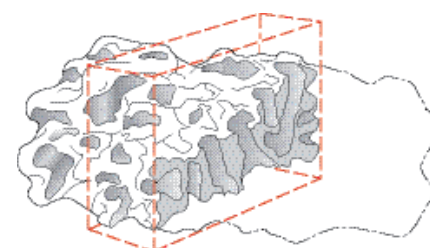
Before performing gas sorption experiments, solid surfaces must be freed from contaminants such as water and oils. Surface cleaning (degassing) is most often carried out by placing a sample of the solid in a glass cell and heating it under vacuum or flowing gas. **Figure 1** illustrates how a solid particle 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.

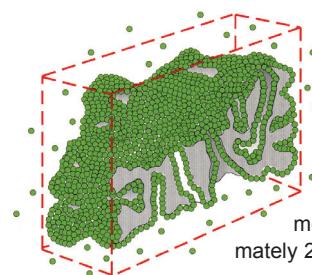
Continued addition of gas molecules beyond monolayer formation leads to the gradual stacking of multiple layers (or multi-layers). The formation occurs in parallel to capillary condensation (see **Figure 3**). The latter process is approximated by the Kelvin equation, which quantifies the proportionality 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.

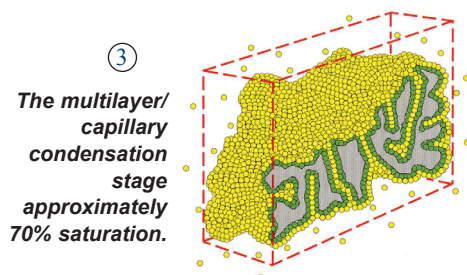
As the equilibrium adsorbate pressures approach saturation, the pores become completely filled with adsorbate (see **Figure 4**).



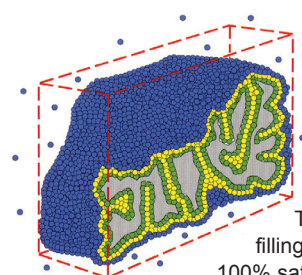
① **A section of one greatly enlarged particle of a solid.**



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.
- PC option—use Windows-based software or run stand-alone.

NOVA 2200^e—rapid two-sample surface area and pore size analyzer.

- Perform fully automated multi-point B.E.T. analysis in as little as eight minutes (per sample).
- 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.
- Usable with most non-corrosive adsorbate gases such as argon, CO₂ and light hydrocarbons over a wide range of temperatures.
- Provides higher laboratory efficiency and productivity.
- Flexible operation—analysis type independent for each station (BET and /or pore size measurement).

NOVA 4200^e—measures up to four samples simultaneously.

- Analyze up to four samples at one time or three plus continuous Po measurement.
- Save space with four on-board sample preparation ports.
- Plus all the capabilities of the NOVA 2200e.

Applications for Quality Control and Research

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

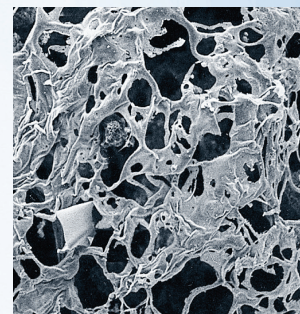
Catalysts for the automotive, fertilizer, fuel cell and petrochemical industries.

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.

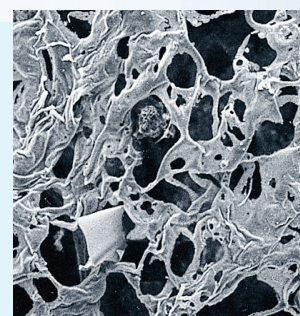
Other applications related to bone, composite materials, fibers, rigid foams, soil, sludge, slurries, suspensions and well cores.



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 included 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.

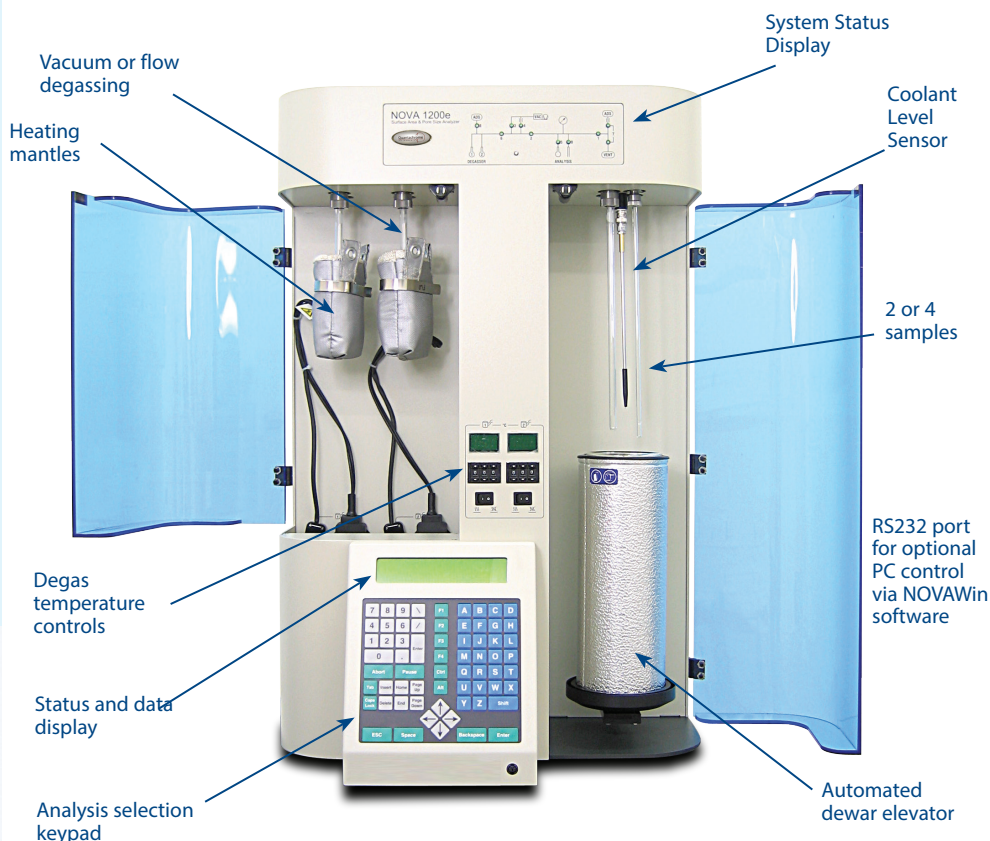
Critical components of highest quality to ensure reliable results

- High-sensitivity pressure transducer with excellent stability.
- 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 HCLS 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 XeriPrep 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 2200e	NOVA 4200e
Surface area analysis	✓	✓
Mesopore size distribution	✓	✓
Standard micropore methods	✓	✓
Analysis stations	2	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 4200e for dramatic increase in productivity.
- Degas 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/Po) points.
- Multiple Po options for speed and accuracy: user entered, calculated from ambient, measured once, or continuously updated throughout analysis
- 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.
- 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.

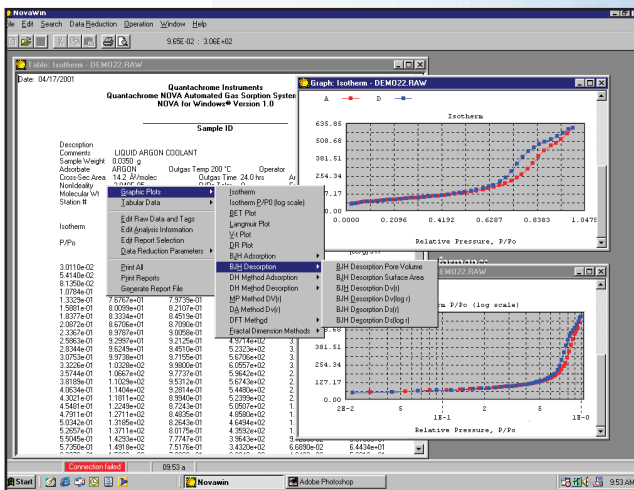
NOVAWin™ - Windows® Based Software for Operation from PC

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.

- PC based initialization and control of NOVA analysis.
- View isotherms in "real-time" during analysis.
- Store analysis configurations for fast recall.
- Compatible with virtually any printer via Windows® operating system.
- Zoom into any part of a graph and perform a linear best fit for any set of data points.

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.

NOVA^e® SERIES SPECIFICATIONS

Performance	Nova 2200e®	Nova 4200e®
Analysis stations:	2	4
Measurement types:	B.E.T., STSA, adsorption isotherm, desorption isotherm	
Surface area range:	0.01 m ² /g to no known upper limit	
Pore size range:	0.35 to >500nm (3.5 to >5000 Å)	
Minimum pore volume:	(liquid) 2.2 x 10 ⁻⁶ ml/g	
Minimum pore volume:	(STP) 0.0001 cc/g	
Adsorbates		
Nitrogen:	✓	✓
Other non-corrosive gases (Ar, CO ₂ , H ₂ , C ₄ H ₁₀ , etc.):	✓	✓
Degassing		
Preparation Ports:	2	4
Methods:	Vacuum and Flow	
Temperature Range:	ambient - 450 °C*, 1° C intervals	
Accuracy:	±5°C	
Pressure Transducers		
Accuracy (% of span):	±0.1	
Pressure (mm Hg) Resolution:	0.016	
Relative Pressure P/P ₀ (N ₂) Resolution:	2 x 10 ⁻⁵	
Physical		
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

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, nonventing 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.

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 may 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.

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.

MasterPrep Degasser

Fully featured preparation unit. Individually heated stations with programmable heating profiles for R&D, commercial labs and multi-user laboratories. Dual modes (vacuum or flow) for further flexibility and optimization. Temperature control and logging via PC software (included). Integral cooling stations provide additional convenience.

Vacuum pump not included.

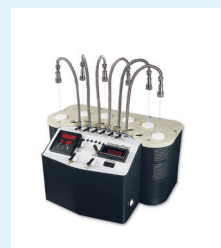
FloVac Degasser

The FloVac provides cost effective vacuum degassing. Complete with single-zone heater (to 400°C), digital temperature controller and built-in digital vacuum gauge. Each sample station has its own adjustable evacuation/backfill rate control. Flow degassing is also possible and can be advantageous in removing large quantities of moisture prior to vacuum degassing. Individual cooling stations.

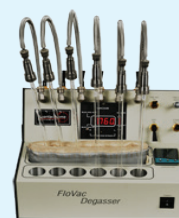
Vacuum pump not included.



Rotary Micro Riffler



Masterprep



FloVac Degasser



Renowned innovator for today's porous materials community. The quality of Quantachrome's after sales service support is the reason we are proud to maintain life time relationships with our customers.

Field Service

Our global service staff assure you that Quantachrome Instruments will continue to be the reliable engines of material characterization laboratories. We offer you the flexibility of choosing from service contracts tailored to provide you with the response time, service package, and spare parts discounts that best fit your needs.

Spare Parts

Quantachrome spare parts are certified to work with our instruments. We provide rapid response spare parts orders, and keep large inventories of replacement parts and hardware available.

Application Lab

Our fully equipped, state-of-the-art powder characterization laboratory (email: application.qt@anton-paar.com), provides the option of contracting for expert testing services. Laboratory services are also available to validate the applicability of our products prior to your purchase using your actual samples.

Lifetime Application Support

We view the field support of our instruments as an essential component of our business strategy. Our expert scientists are always available to answer questions on applications, or the use of our instruments. We do this as a standard service regardless of whether you have a service contract with us or not.

Partners in Science

Quantachrome has a scientific research department consisting of world renowned experts in material characterization. Our staff, led by team conducts collaborative research projects with leading material research labs around the world. They regularly publish articles in leading peer reviewed journals, and speak at technical symposiums around the world.

For almost half a century 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. We have an unwavering commitment to providing state of the art technology, along with superior and unparalleled customer service and support.

Our commitment to customers is to support you before, during, and after the sale throughout the lifetime of our instruments. This is a big commitment because our products are so robust and reliable that we regularly find many still in use for decades.

Corporate Headquarters-USA
Quantachrome Instruments
a brand of **Anton-Paar**
1900 Corporate Drive
Boynton Beach, FL 33426

www.quantachrome.com

Serving Porous
Materials and Powder
Characterization Needs
Since 1968



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