

# QUANTACHROME

## NOVA<sup>®</sup> Series *e*

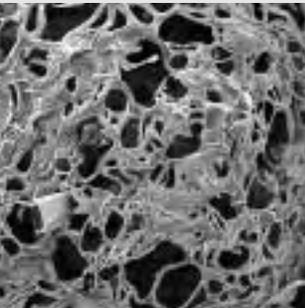


**High-Speed Surface Area &  
Pore Size Analyzer System**

## Industries Served

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

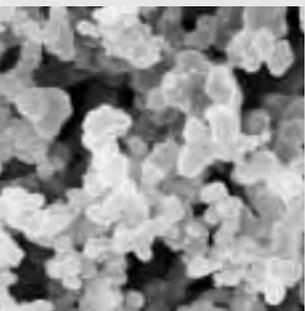
Aerospace  
Agriculture  
Automotive  
Aviation  
Building Materials  
Ceramics  
Chemicals  
Communications Equipment  
Construction  
Consumer Goods  
Cosmetics  
Electrical & Electronics  
Environmental Services  
Foods  
Food Processing  
Manufacturing  
Marine  
Medical Devices  
Metals  
Mining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



Photomicrograph: ▲  
Coal ash



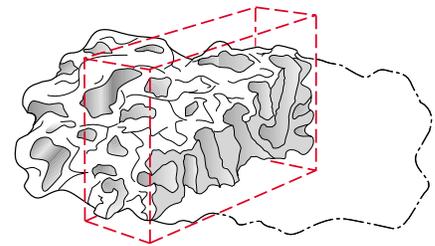
Photomicrograph: ▲  
Natural zeolite



Photomicrograph: ▲  
Carbon black

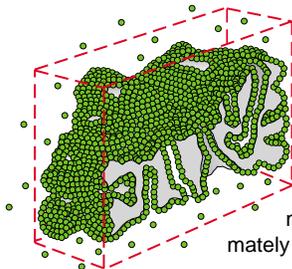
# The Gas Sorption Process

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.



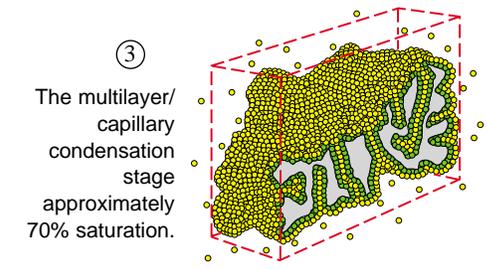
① A section of one greatly enlarged particle of a solid.

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.



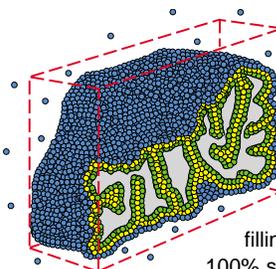
② The monolayer of adsorbed molecules; approximately 20% saturation.

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 adequately described 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.



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

Methods such as DFT or Barrett, Joyner and Halenda (B.J.H.) allow the computation of pore sizes from equilibrium gas pressures. One can therefore generate experimental curves (or isotherms) linking adsorbed gas volumes with relative saturation pressures at equilibrium, and convert them to cumulative or differential pore size distributions.



④ Total pore volume filling; approximately 100% saturation.

As the equilibrium adsorbate pressures approach saturation, the pores become completely filled with adsorbate (see Figure 4). 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 one reverses the adsorption process by withdrawing known amounts of gas from the system in steps, one can also generate desorption isotherms. The resulting hysteresis leads to isotherm shapes that can be mechanistically related to those expected from particular pore shapes.

# NOVA<sup>®</sup> 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 8 fully automatic models to meet the needs of any research or quality assurance laboratory.

## The NOVA e Series—designed for today's demands in particle characterization!

- **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**—run stand-alone or interfaced to a PC.

## NOVA 1000—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.
- Prepare two samples by vacuum or flow methods simultaneously with sample analysis—at different temperatures if required.
- Analyze up to 200 data points (100 adsorption points and 100 desorption points).
- 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 NOVA's straight-walled sample cells.
- Transfer data via built-in 3.5" drive, RS232 or printer port.
- Enhance performance with Windows®-compatible software.
- Verify performance with built-in calibration syringe.

## NOVA 1200—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, CO<sub>2</sub> and light hydrocarbons over a wide range of temperatures.
- Plus all the features of the NOVA 1000.

## NOVA 2000/22000—two samples simultaneously.

- Get all the capabilities of the NOVA 1000/1200 in a 2-station instrument.
- Provides higher laboratory efficiency and productivity.
- Flexible operation—analysis type independent for each station (BET and/or pore size measurement).

## NOVA 3000/3200—features 3 sample capability.

- Additional port can be used for Po.
- Meets the special needs of the busy research laboratory.

## NOVA 4000/4200—measures 4 samples simultaneously

- Save space with four on-board sample preparation ports.
- Plus all the capabilities of the NOVA 1000 through NOVA 3200.
- Large capacity dewar for thermal stability and unattended operation.

## Applications for Quality Control and Research

The list of materials and products employing Quantachrome's particle characterization technology is as diverse as industry itself:

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

**Catalysts** for the automotive, fertilizer 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



▲ For laboratory research and development.



▲ For industrial QA/QC and analytical services.

*optimizing*  
**PARTICLE**  
**PERFORMANCE**

# NOVA<sup>®</sup> SERIES

## 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.

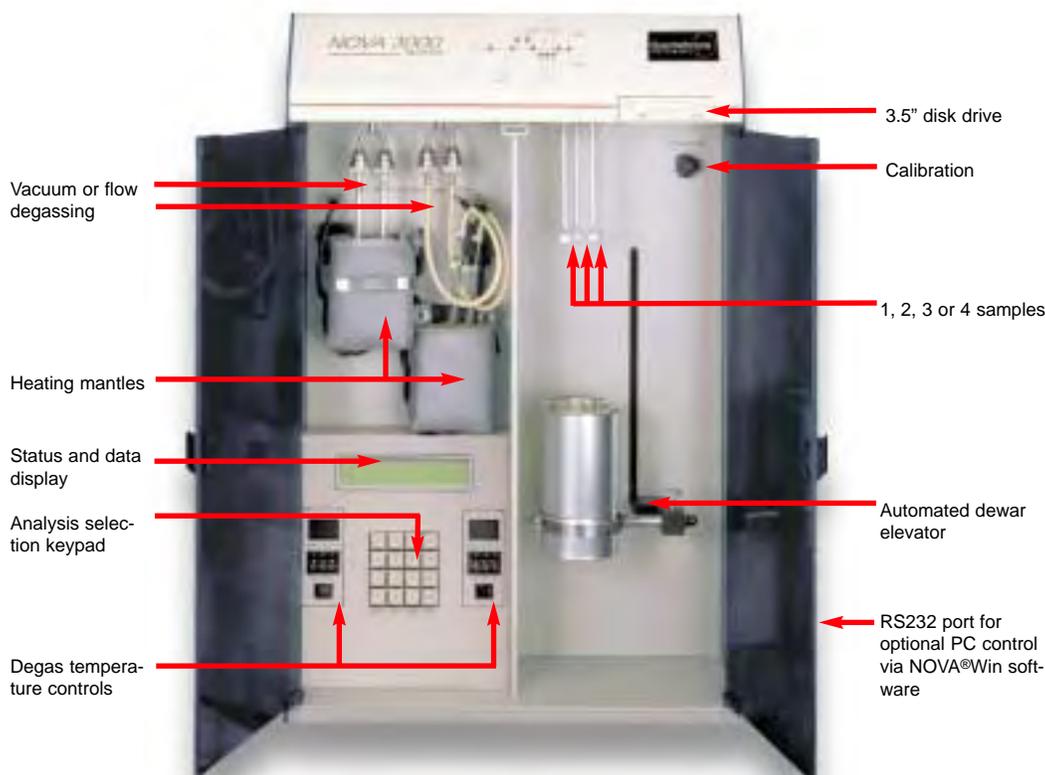
## ...and with optional Windows<sup>®</sup>-based software!

- 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 for unified micropore and mesopore size distribution.

## 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.
- Precision manufactured calibration station.

- See cover photo for new style "e" cabinet

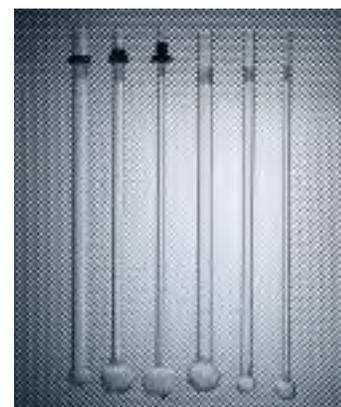


## Feature highlights of the NOVA Series e

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

## Accurate results require proper sample preparation

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



- ▲ Sample cells of 6, 9, or 12 mm may be used with standard cell adaptors.

\* 450°C with optional quartz heating mantles

## NOVA<sup>®</sup> e Series Benefits— Loaded with labor saving features

### Many operational conveniences

- Simultaneous analysis of up to three samples with NOVA 3000/3200 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 the most rigorous 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 (NOVAe 2000/2200, 3000/3200 and 4000/4200).
- Upgrades easily as your needs expand.
- Low Area Option for enhanced low surface area sensitivity.
- 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 with printed report performed in about one minute.

### Revolutionary ease-of-use, speed, and accuracy

- Patented NO Void Analysis<sup>™</sup> (NOVA) Technology eliminates helium, reducing analysis costs.
- Straight-walled sample cells eliminate calibration for most users.
- TempComp<sup>™</sup> (patent pending) algorithm corrects for the effects of liquid nitrogen evaporation during analysis without the need for level-control devices.
- MaxiDose<sup>™</sup> 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 Analysis Interrupt.

### Output capabilities to meet every need

- Front panel display of results upon completion of analysis.
- Automatic report generation on optional printer.
- Upload via RS232 to PC for remote data manipulation.
- Multi-user/multi-product feature. Saves information on 3.5" disk for each NOVAe user or for each type of material analyzed.

### Analysis Presets

- Allows the user to establish pre-defined 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<sup>™</sup> - Windows<sup>®</sup> Based Software for Operation from PC

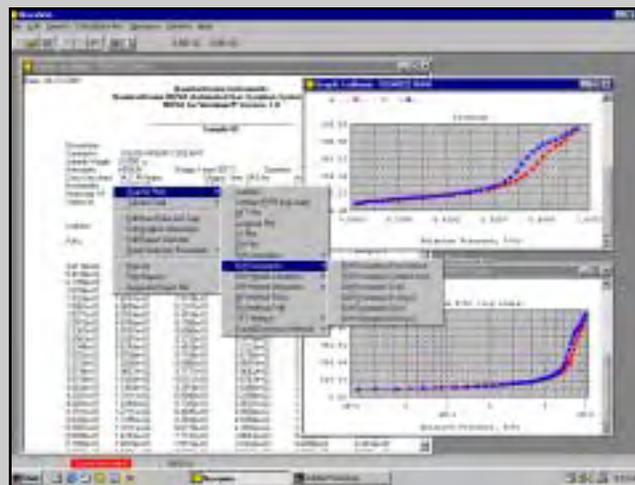
NOVAWin is a PC based program for operation of the NOVA series of instruments utilizing the familiar features of the Microsoft<sup>®</sup> Windows<sup>®</sup> operating system. NOVA operators will find this to be a user-friendly, graphical environment to work in.

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 instrument control

- 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<sup>®</sup> operating system.
- Zoom into any part of a graph and perform a linear best fit for any set of data points.

### Choose from many methods of data reduction



### User friendly pop-out menus provide choices of Graphical and Tabular presentations of:

- 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 "t" 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, CO<sub>2</sub> on carbon, etc.
- Fractal dimension by NK and FHH methods

# SPECIFICATIONS

	NOVAe 1000	NOVAe 1200	NOVAe 2000/2200	NOVAe 3000/3200
	Single sample/with nitrogen analysis	Single sample/ "Any Gas" analysis	Dual sample, N2/ "AnyGas" analysis	Three sample, N2/ "Any Gas" analysis

## Performance

Surface area range: 0.01 - more than 2,000 m <sup>2</sup> /g	yes	yes	yes	yes
Adsorption and desorption isotherm	yes	yes	yes	yes
Pore diameter range: 0.35-200 nm (3.5 - 2,000 Å)	yes	yes	yes	yes
Minimum pore volume: better than 2.2 x 10 <sup>-6</sup> ml	yes	yes	yes	yes
Analysis stations	1	1	2	3

## Adsorbates

Nitrogen	yes	yes	yes	yes
Other non-corrosive gases (Ar, CO <sub>2</sub> , C <sub>4</sub> H <sub>10</sub> , etc.)	no	yes	no	yes

## Degassing

Ports	2	2	2	4
Vacuum and flow	yes	yes	yes	yes
Temperature range: ambient - 450°C*, 1°C intervals	yes	yes	yes	yes
Accuracy	±5°C	±5°C	±5°C	±5°C

## Pressure Transducers

Accuracy (full scale)	0.11%	0.11%	0.11%	0.11%
Reproducibility (full scale)	0.02%	0.02%	0.02%	0.02%
Minimum resolvable pressure (mm Hg)	0.016	0.016	0.016	0.016
Minimum resolvable relative pressure (N <sub>2</sub> )	2 x 10 <sup>-5</sup>			

## Physical

Dimensions (HxDxW)	49.5 cm x 35.6 cm x 76.2 cm
Weight	31 kg (70 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 FloVac Degasser & Flow Degasser

For additional flow and vacuum degassing, Quantachrome offers two valuable compliments to augment the NOVAe's sample preparation facilities: 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 heating mantle provides user-selectable degas temperature to 400°C in steps of 1°C monitored continuously on the digital display.

In vacuum mode, the FloVac's selectable evacuation rates and



The FloVac Degasser set up for vacuum degassing

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, both units' needle valves allow careful control of

## NOVAe 4000

Four sample/with  
nitrogen analysis

## NOVAe 4200

Four sample/  
"Any Gas" analysis

yes	yes
4	4

yes	yes
no	yes

4	4
yes	yes
yes	yes
±5°C	±5°C

0.11%	0.11%
0.02%	0.02%
0.016	0.016
2 x 10 <sup>-5</sup>	2 x 10 <sup>-5</sup>

## Prompt, Dependable Service... Worldwide

At Quantachrome, reliability means more than product performance...it means responsiveness.

You can depend on our staff for on-site installation and service, prompt factory repairs, and telephone troubleshooting support.

The purchase of a Quantachrome product signifies the beginning of a long term relationship, with a goal to ensure the maximum return on your investment.



## Global Network of Distributors

With more than 50 offices worldwide, Quantachrome's distribution network delivers products and support on a global basis...truly a single source for all your particle characterization instruments.

## Other Fine Products from Quantachrome

Quantachrome markets a full range of particle technology characterization instruments, including:

- **AUTOSORB® 6B & 3B** for automated multiple sample sorption measurements.
- **AUTOSORB® 1** for high resolution physisorption and chemisorption measurements.
- **CHEMBET®-3000 TPR/TPD** for chemisorption studies and catalyst characterization.
- **MONOSORB®** for automated single point B.E.T. surface area determinations.
- **HYDROSORB™** for water vapor sorption analysis.
- **THERMOFLOW™** degassing instruments.
- **FLOW CONTROLLER** for gas mixing.
- **POREMASTER® SERIES** Mercury Porosimeters (60,000 psi and 33,000 psi) for a full range of pore size distribution.
- **ULTRAPYCNOMETER™ 1000 & PENTAPYCNOMETER** for automatic volume and true density measurements.
- **MULTI & STEREOPYCNOMETER™** for manual volume and true density measurements.
- **AUTOTAP™ & DUAL AUTOTAP™** for tap - volume and tap density measurements.
- **SIEVING & MICRO ROTARY RIFFLERS™** for accurate representative sampling.
- **REFERENCE MATERIALS** for surface area and porosimetry.



The Flow Degasser for flow degassing of up to six samples

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 or Autosorb series of surface area and pore size analyzers.