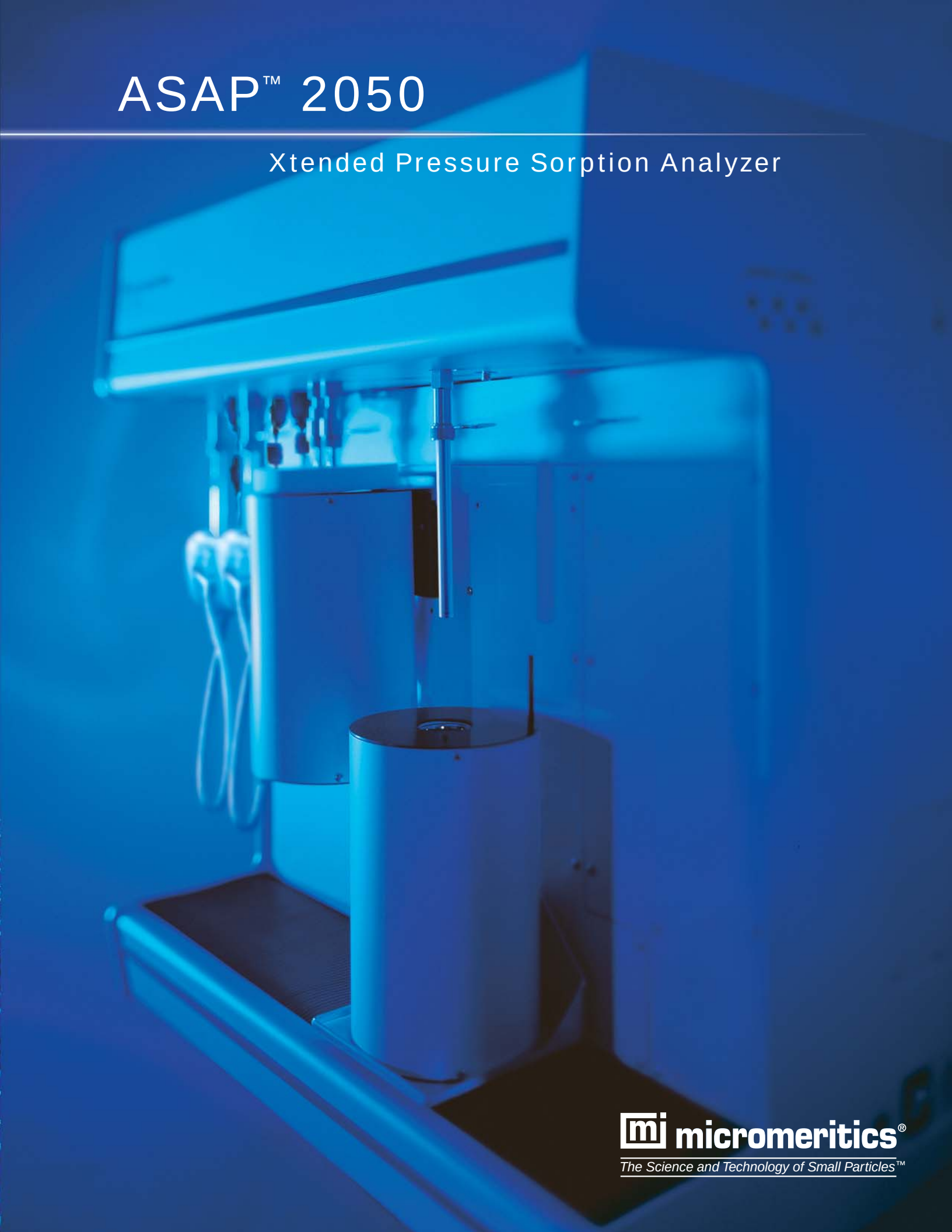
ASAP™ 2050

Xtended Pressure Sorption Analyzer



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The Science and Technology of Small Particles™

Analytical Versatility

ASAP 2050 *Xtended Pressure Sorption Analyzer*

Superior Performance Under Extended Pressure

The fuel cell and its chemical energy source, hydrogen, have received much recent attention as a promising long-term solution to the world's energy needs. Developing storage technologies involving advanced materials and the conversion of hydrogen to useful forms of energy are of critical importance. A fundamental understanding of hydrogen physisorption/chemisorption processes and adsorption/desorption kinetics is needed to optimize hydrogen uptake and release capacity rates. Knowledge of chemical reactivity and material properties, particularly with respect to exposure under different conditions (air, moisture, etc.), needs to be gathered.

Micromeritics' ASAP 2050 Xtended Pressure Sorption Analyzer is designed to address these and many other elevated-pressure sorption needs. The instrument combines many of the capabilities of Micromeritics' popular ASAP 2020 with additional features that allow the user to obtain data in an extended-pressure environment. Sophisticated system features include:

Standard ASAP Features

- Two independent vacuum systems allowing simultaneous preparation of two samples and analysis of another
- A two-station intelligent degas system for fully automated degassing with precisely controlled heating profiles
- A highly flexible and interactive reporting system that includes an extremely versatile graphic user interface allowing custom presentation of results

Additional ASAP 2050 Features

Analysis System

- Analysis manifold is capable of operating from vacuum to 10 atmospheres
- An optional chiller Dewar and recirculating bath allow the ASAP 2050 to be operated indefinitely - the instrument also supports the use of a standard Dewar with cryogen (typically liquid nitrogen or argon) that will provide at least 50 hours of unattended analysis without refilling the Dewar
- Straight-walled, stainless-steel sample tubes are capable of safe operation up to 150 psia
- Rapid collection of non-monotonic isotherms with standard isotherm cycling software
- Special degas heating mantles can be used to prepare samples in situ on the analysis port prior to analysis

Degas System

- Temperatures at each degas port, and the rate of temperature change, can be set and monitored individually from a few degrees above ambient to 450 °C
- A user-specified pressure setting protects the sample from steaming or damage during sample preparation

Typical ASAP 2050 Applications

The all new, fully automated ASAP 2050 is an essential tool for measuring adsorption isotherms up to 10 atmospheres. The ASAP 2050 also allows the user to collect traditional isotherms for determining surface area and porosity.

Catalysts – Active surface area and porous structure of catalysts have a great influence on production rates. Limiting the pore size allows only molecules of desired sizes to enter and leave, creating a selective catalyst that will produce primarily the desired product.

Adsorbents for Pressure Swing Adsorption – The adsorption capacity of alkaline-exchanged zeolites is a key parameter for the design and optimization of pressure swing adsorption processes. PSA is commonly used to produce nitrogen and oxygen from air. Both the capacity and isosteric heat of adsorption are required to evaluate the performance of new materials.

Metal Hydrides – Hydrogen storage capacity is a key parameter for fuel cell systems. PEM fuel cells for vehicles may operate in the 1 - 10 atmosphere range and at temperatures ranging from 20 - 120 °C. The performance of the metal hydride is characterized by its hydrogen storage capacity (adsorption) and subsequent release (desorption) of hydrogen.

Batteries – Rechargeable nickel metal hydride (NiMH) batteries require a large hydrogen storage capacity. Increasing the hydrogen storage capacity increases the useable time for a battery. Adsorption and desorption isotherms can be used to understand the performance of NiMH in batteries.

Fuel Cells – Fuel cell electrodes require high surface area with controlled porosity to produce optimum power density.

Nanotubes – Nanotube surface area and microporosity are used to predict the capacity of a material to store hydrogen.

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

Ceramics – Surface and porosity information helps to determine curing and bonding procedures, ensure adequate green strength, and produce a final product of desired strength, texture, appearance, and density.

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

Hardware Versatility

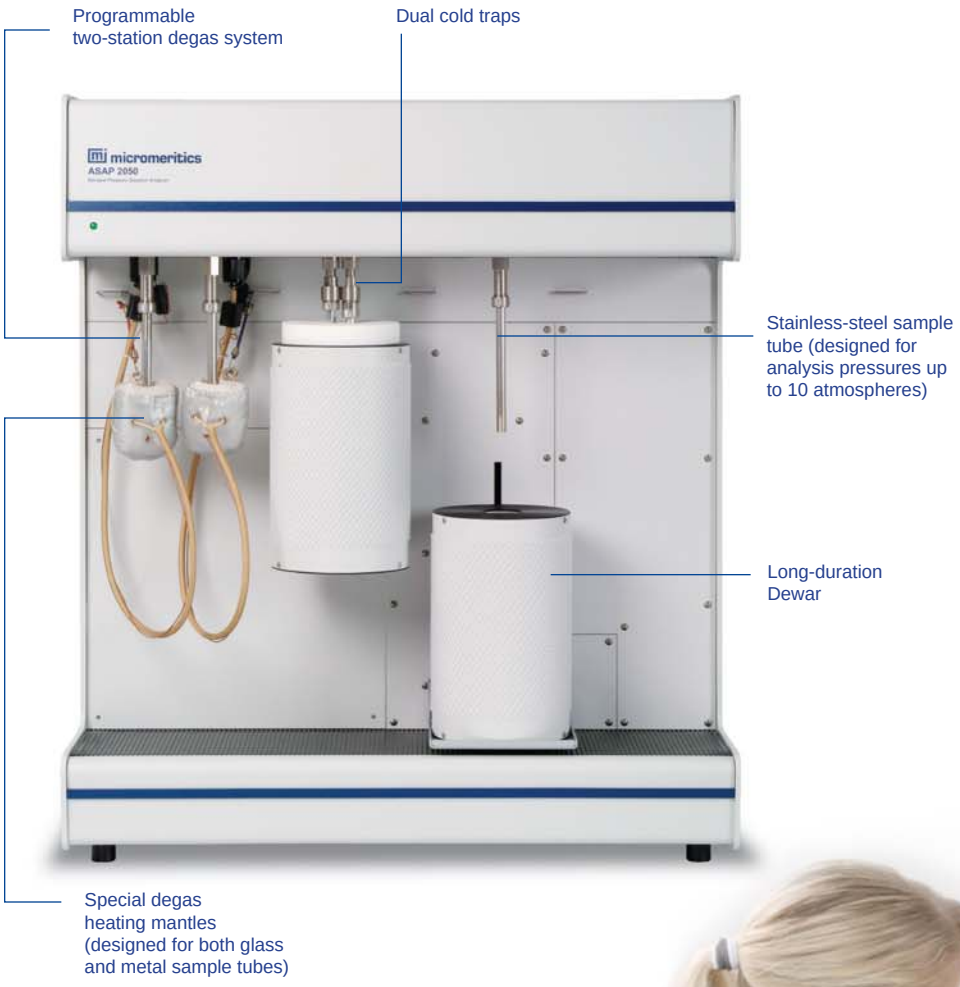
ASAP 2050 Hardware Advantages

The ASAP 2050 uses **two independent vacuum systems**, one for sample analysis and one for sample preparation. This allows preparation and analysis to proceed concurrently without the inherent delay found in single vacuum system analyzers that must share a pump. Moreover, independent systems completely eliminate the possibility of cross-contamination between the degas and analysis manifolds.

A **two-station intelligent degas system** provides fully automated degassing with controlled heating time profiles. Temperatures at each degas port, and the rate of temperature change, can be set and monitored individually. The temperature can be controlled from a few degrees above ambient to 450 ºC. A sample may be added to or removed from a degas port without disturbing the treatment of the other sample. The degas treatment information is saved as part of the sample file, included in analysis reports, and can be conveniently copied and reused for other samples to ensure repeatability and reproducibility.

S**tainless-steel, temperature-monitored analysis manifolds** are designed for optimal internal volumes and superior vacuum performance. These optimized manifolds, in combination with temperature monitoring, ensure highly accurate measurements of sorbed gas volumes. Analysis manifolds are **capable of operating from vacuum to 10 atmospheres**. This allows a rapid collection of isotherms.

An optional chiller Dewar and recirculating bath allow the ASAP 2050 to be operated indefinitely. The instrument also supports the use of a standard Dewar with cryogen that will provide at least 50 hours of unattended analysis without refilling the Dewar. Micromeritics' patented **Isothermal Jackets** can be used to assure a constant thermal profile along the full length of both the sample and saturation pressure (P_0) tubes throughout extended analyses.



Straight-walled, stainless-steel sample tubes enable extended pressure analyses and are capable of safe operation up to 150 psia (10 atmospheres).

The ASAP 2050 features a **single high-quality, stable, low-noise transducer** system for all measurements. This eliminates the possibility of progressive offset and drift between separate transducers covering the same range.

Special degas heating mantles can be used to prepare samples in situ on the analysis port prior to analysis. The new heating mantle is designed to allow the user to place the mantle on the sample tube without removing the Dewar.

ASAP Reference Materials

Lanthanum Penta-Nickel

Lanthanum nickel ($LaNi_5$) is a well-known alloy that readily forms hydrides. This reference material is recommended for use with the ASAP 2050 to demonstrate the formation and characterization of hydrides. This material is ideally suited for use with the pressure composition isotherm report.

Silica-Alumina

Silica-alumina is a typical porous, high surface area reference material. The surface area of the silica-alumina typically exceeds 200 m^2/g and the pore size is a nominal 100 Å. This material is recommended for users who analyze amorphous materials with surface area ranging from 10 to greater than 300 m^2/g for both non-porous and porous materials in the 40 - 3000 Å range. Silica-alumina is suitable for use with BET, t-plot, and BJH pore size reports.

Carbon Black

Standard Reference Blacks are available from 20 to greater than 100 m^2/g and are stable, well-characterized materials. They are recommended for all users but may be especially suited for researchers in the carbon, tire, and filler industries. Carbon black reference materials are suitable for use with BET and STSA reports.

Glass

A 5 m^2/g glass reference material is recommended for industries and users who characterize materials in the 1 through 50 m^2/g range. Glass reference material is suitable for use with BET surface area reports.

Software and Reporting Versatility

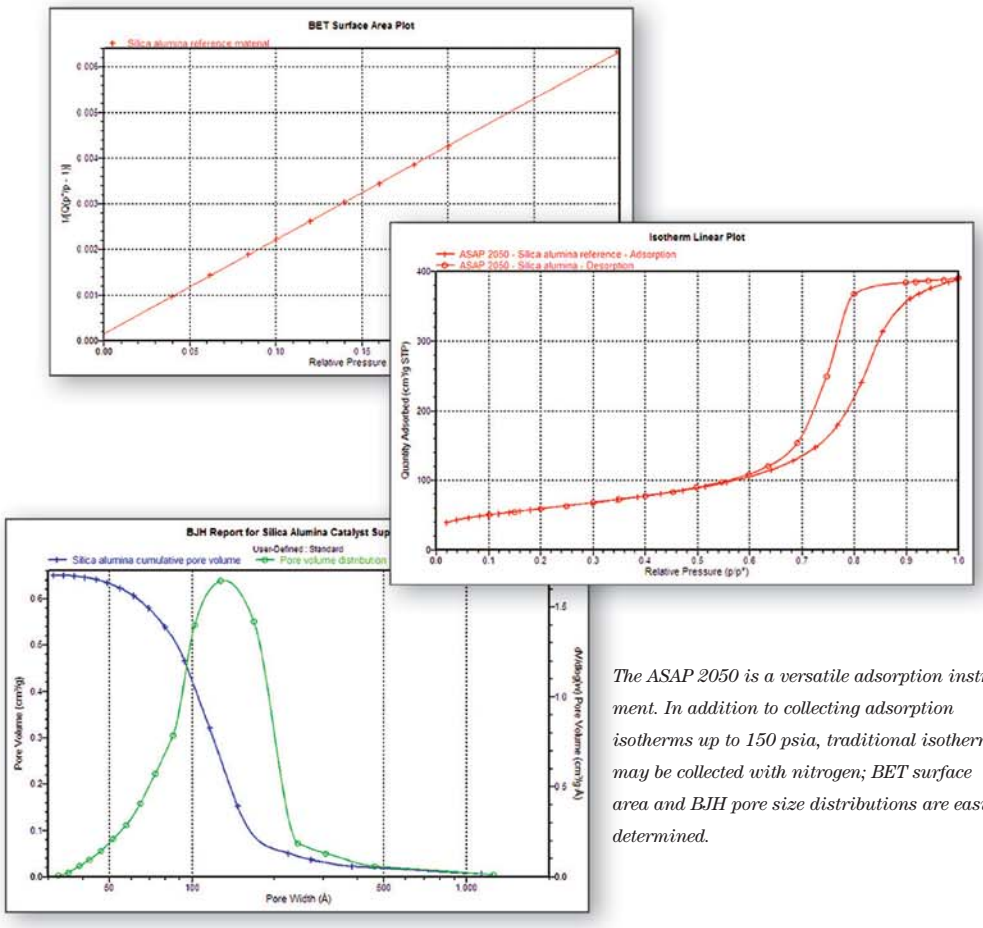
ASAP 2050 Software Features

The easy-to-use ASAP 2050 software utilizes a Windows® interface that includes Wizards and applications to help 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 data transfer channels. Features include cut-and-paste graphics, scalable-and-editable graphs, and customizable reports. Additional capabilities include:

- Degas temperature profiles and treatment time data are integrated with the sample file for future reference and verification of SOP compliance.
- The Instrument Schematic screen displays the instrument's current operating status, including the real-time isotherm, and allows the operator to assume manual control of the instrument if desired.
- One computer can control two Micromeritics ASAP analyzers of the same or different model making efficient use of valuable lab space. Other types of Micromeritics instruments can also be connected.
- Up to nine graphs can be overlaid for easy comparison of different samples or for comparison of different data reduction techniques applied to the same sample.
- Exportable data tables provide for merging and comparing data from other sources in a unified single spreadsheet file.
- Three modes of gas dosing routines provide effective choices to ensure maximum speed with full accuracy for samples with widely differing isotherm shapes.
- The patented Smart Dosing™ routine actually learns about the sample's potential to adsorb gas and adjusts the adsorptive doses accordingly. This helps prevent over-dosing the sample and obscuring porosity information.
- The user can enter any reference isotherm into the system by way of a data file or table. This isotherm can be used in place of the pre-programmed thickness curves when calculating thickness for t-Plots, α_s (Alpha-S) plots, and BJH pore size distribution. The reference isotherm can also be overlaid with other plotted data for comparisons.

Analyses and Reports

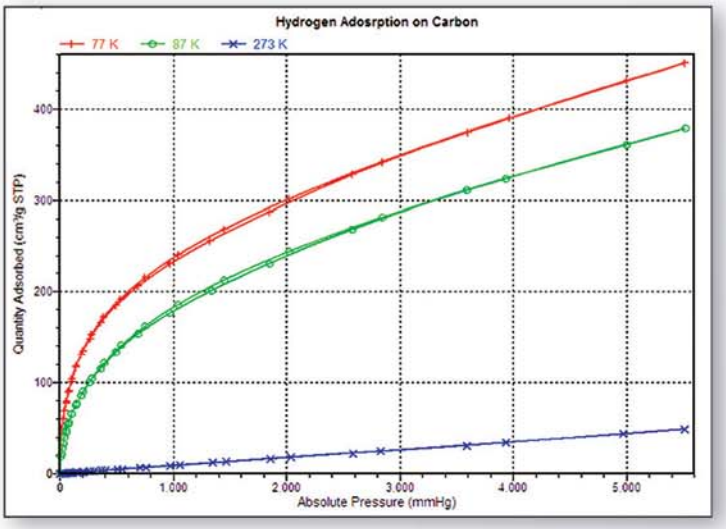
The ASAP 2050 includes powerful data reduction software to provide a variety of easy-to-interpret report options. This allows tremendous flexibility in the selection of analysis constants to best fit your specific application. All ASAP models have the capability to collect data over a prescribed segment of the pressure range, or to perform adsorption and desorption analyses over the entire pressure range, providing extensive surface area and porosity information.



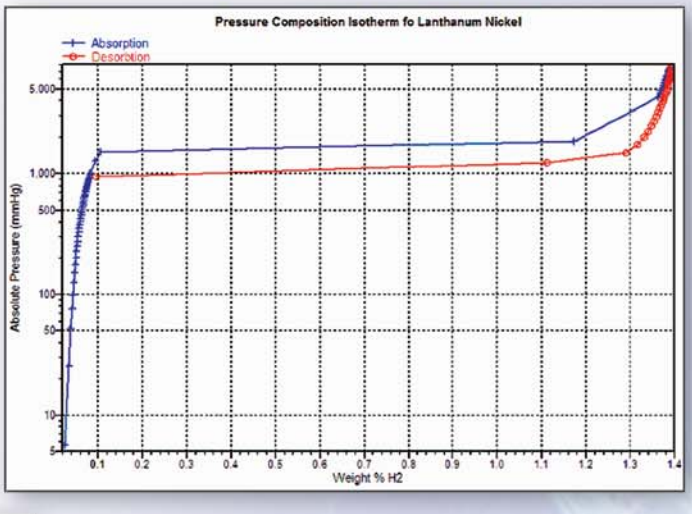
The ASAP 2050 is a versatile adsorption instrument. In addition to collecting adsorption isotherms up to 150 psia, traditional isotherms may be collected with nitrogen; BET surface area and BJH pore size distributions are easily determined.

The ASAP 2050 model includes:

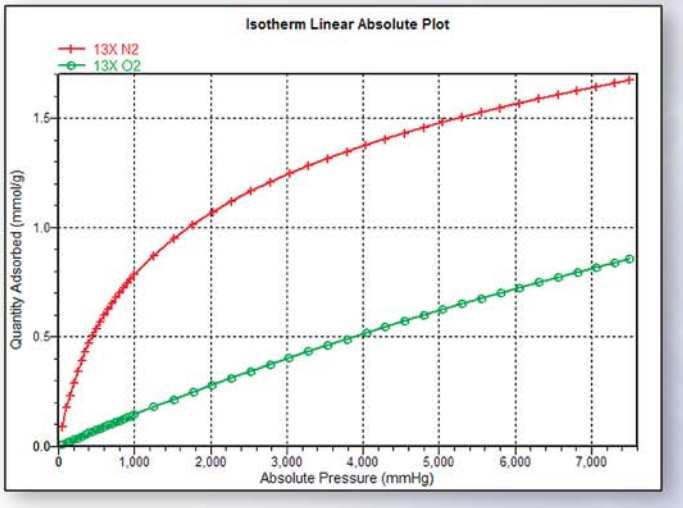
- Repetitive Isotherm Cycling
- DFT (Density Functional Theory)
- Single- and Multipoint BET (Brunauer, Emmett, and Teller) surface area
- Langmuir surface area
- Temkin and Freundlich isotherm analyses
- Pore volume and pore area distributions in the mesopore and macropore ranges by the BJH (Barrett, Joyner, and Halenda) method using a variety of thickness equations including user-defined, standard isotherm
- Pore volume and total pore volume in a user-defined pore size range
- F-Ratio plots that illustrate the difference between theoretical and experimental isotherm data
- Heat of Adsorption



Hydrogen isotherms at several temperatures are rapidly measured using the ASAP 2050.



The Pressure Composition Isotherm of lanthanum nickel demonstrates the ability to characterize hydride formation using the ASAP 2050.



High-resolution nitrogen and oxygen isotherms for pressure swing adsorption applications are easily obtained using the ASAP 2050.

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