Porous Materials, Inc.

The PMI Advanced

BET SORPTOMETER

BET-203A-3OS

Not just products...solutions!

Description

PMI's BET-Sorptometer is fully automated, volumetric gas sorption analyzer to measure accurately adsorption and desorption isotherms for the characterization of surface area, pore size distribution, pore volume and pore structure of micro and mesoporous materials as well as the kinetics of adsorption. *The system allows for high resolution customized dosing routines to collect unlimited data points on adsorption and desorption isotherms.*

Application


PMI's BET Sorptometer has a multitude of applications in industries worldwide. Some applicable industries include

- Catalyst and Carbon
- Oil & Gas Industry/Geoscience
- Battery/Fuel Cells Industry
- Chemical Industry
- Ceramic Industry
- Filtration Industry
- Paper Industry
- Pharmaceutical/Medical Industry
- Powder Metallurgy Industry
- Automotive Industry




Principle

When clean surface is exposed to a gas, an adsorbed film forms on the surface. Adsorbed films also form on the surface of pores within a material and vapor can condense in the pores. At a constant temperature, the amount of adsorbed/condensed gas on a surface depends on the pressure of the gas. Measurement of the amount of adsorption/condensation as a function of pressure can give information on the pore structure. The PMI Sorptometers use gas adsorption/condensation to analyze pore characteristics. Further, measurement of pressure as a function of time provides the kinetics information of adsorption.

Physical Adsorption

Weak van der Waal's type interaction of molecules with a pore surface leads to physical adsorption. The Brunauer, Emmett and Teller (BET) theory of physical adsorption is normally used for analysis of adsorption data to compute surface area.

$$\frac{P}{W(P_0-P)} = \frac{1}{CW_m}\frac{C-1}{CW_m}\frac{P}{P_0}$$

Where:
W = amount of adsorbed gas
Wm= amount of gas adsorbed in a monolayer
P = gas pressure
P_0= equilibrium (saturation) vapor pressure at the test temperature
C = dimensionless constant that depends on the temperature and the gas/solid system

When vapor pressure, P is low compared with P_0 ($0.05 < P/P_0 < 0.3$), the plot of $[P/W (P_0 - P)]$ verses $[P/P_0]$ is linear and the plot yields the magnitudes of C and Wm. The surface area S per unit mass, m, of the sample is computed using the cross-sectional area of the adsorbed gas molecule:

$$S = \frac{W_m N_o a}{m}$$

Where:
N_0 = Avogadro's number
a = cross sectional area of the adsorbed gas molecule
Wm= amount of gas adsorbed in moles

Vapor Condensation

As the relative vapor pressure (P/Po) increases, vapor eventually condenses in the pores utilizing the surface free energy available due to replacement of the solid/vapor interface by solid/liquid interface. The amount of vapor condensed in pores gives the pore volume, and the Kelvin equation gives the pore diameter.

$$\ln\left(\frac{P}{P_0}\right) = -\frac{4\gamma V \cos\theta}{DRT}$$

Where:

γ = surface tension of condensed liquid
V= molar volume of condensed liquid
θ = contact angle
D = pore diameter
R = gas constant
T = absolute test temperature

Adsorbed layers of molecules form on the pore walls before condensation fills the pores. Therefore the actual pore diameters are computed by adding two times the thickness of the adsorbed gas layer to D.

A complete adsorption isotherm is determined by measuring the amount of vapor adsorbed as a function of increasing pressure. A desorption isotherm is determined by measuring the amount of adsorption as a function of decreasing pressure. Based on this technique, characteristics of materials related to adsorption, desorption, surface area and pore volume can be determined.

Adsorption & Desorption Isotherm

Adsorption and desorption of gasses on samples can be accurately measured using our BET Sorptometer. The user has independent control over the quantity and spacing of pressures used in both adsorption and desorption testing. Many different kinds of analyses are available to interpret data using the supplied report generation software.

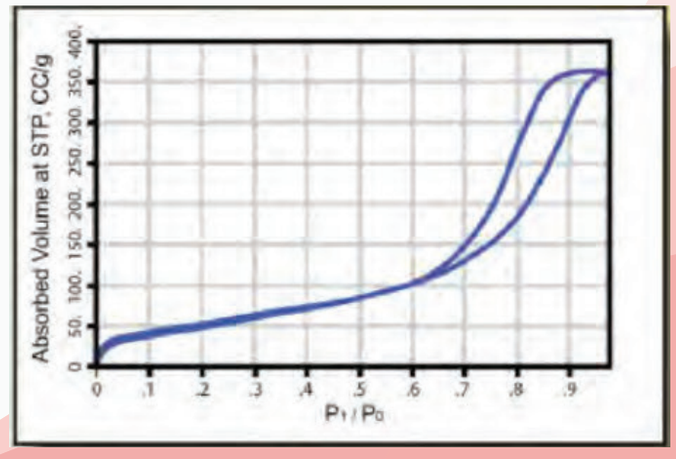

Figure 1
Adsorption and Desorption
Isotherms at Liquid N_2 temperature

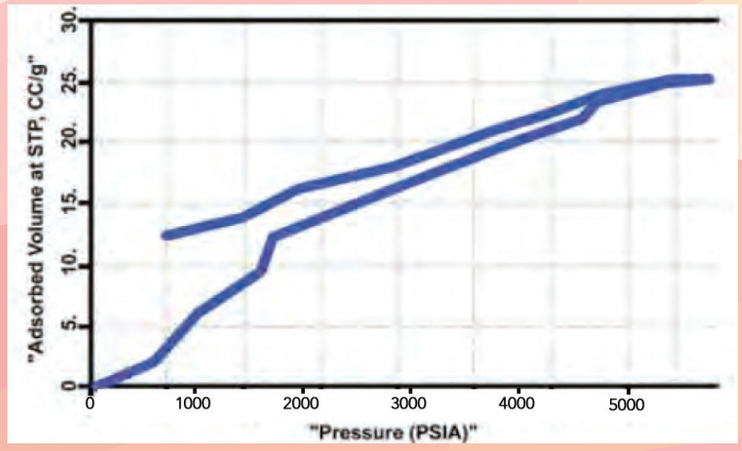

Figure 2
Adsorption and Desorption
Isotherms at Water Vapor at 0˚C

Pore Volume & Pore Diameter

Pore volume, pore diameter and pore volume distribution can be determined accurately by the PMI BET Sorptometer. The distribution function is such that area under the function in any pore diameter range is the volume of pore in that range.

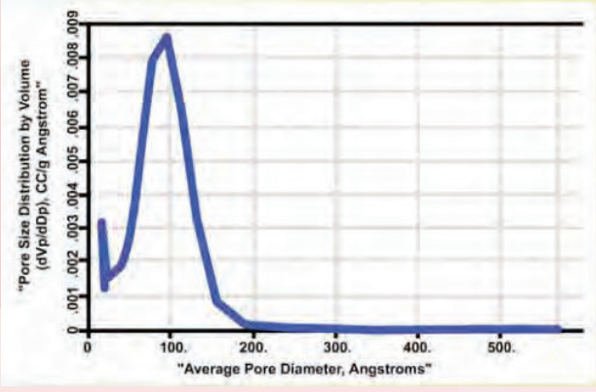

Figure 3
Pore Volume Distribution

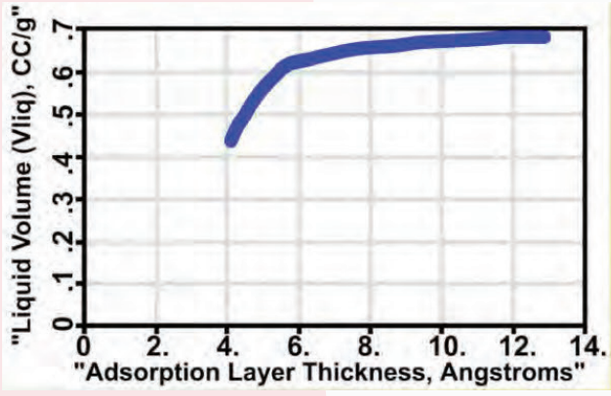

Figure 4
T - Plot Method - Micropore Volume Analysis

Features

- Automated Control
- Display of full adsorption and desorption isotherms
- Isotherm Analysis includes over unlimited data points on Adsorption and Desorption Isotherns per station
- Liquid Nitrogen level sensor
- Automated Control with Data Collection and ability to export data to MS Excel or other Programs
- Analysis Dewar capacity upto 48 hours
- Special vacuum isolation value provision for transferring the sample from preparation station to analysis station under a vacuum.

- **Surface Area Measurements (Mesopore & Micropore):**
  - Total Pore Volume
  - Average Pore Size
  - αs Plot
  - f-Ratio plot
  - Freundlich & Temkin isotherms
  - Langmuir Surface Area
  - Adsorption and Desorption Isotherms
  - QSDFT Method
  - MP Method
  - deBoer t-plot method (for measurement of micro pore volume in cc/g & micropore area in m^2/g), Harkins and Jura thickness equation, Hasley Thickness equation, Carbon STSA
  - NLDFT Method
  - BJH pore size distribution
  - Dollimore-Heal adsorption and Desorption Standard
  - DFT pore size method
  - BET Surface Area
  - STSA pore size method
  - DH pore size distribution
  - DA and DR Method
  - Microporesize distribution (by Horvath-Kawazoe method)
  - Automatic BET Point Selector for Microporous Materials
  - Summary Report in tabular excel format

Inbuilt diagnostic & Safety features:

- System will not get over pressurized and checks for leakages on its own
- Any moving parts will not move unless user specifies
- Quartz Heating Mantles on all ports have over-temperature protection in degassing stations.

Superior features of the offered instrument:

- Able to analyze 3 samples simultaneously and independently of each other, in addition to the dedicated port for saturation pressure measurement
- External provision for simultaneous preparation of 3 samples under heat, flow and/or vacuum.
- Provision for transferring the sample from preparation station to analysis station and under vacuum
- The controlling and analysis software is be compatible with Windows Environment .
- Outgassing can also be done at the test station itself, hence there is no need to transfer the sample.

Other Facility:

- System has features for automated real time free space measurement
- System design ensures isothermal conditions during analysis of samples
- System Includes liquid Nitrogen Level Sensor
- Sample tubes of various sizes with vacuum seal and quartz wool/filler provided.
- Dewar flask included for liquid Nitrogen with appropriate sensors for all 3 ports
- BET 203A can also be equipped with a close-coupled mass spectrometer (no separate vacuum required) for detailed catalyst characterization involving identification of gaseous species.
- The instrument's software controls data acquisition by the mass spectrometer, so only one PC is required.

Degasser System/ Vacuum Degassing Stations: 3

- Three (3) Sample Chamber Vacuum Degassing Station
- Degassing Station Includes: Rotary Vaccum Pump & Applicable Accessories including :
    - Includes Oil Mist Filter
    - Independent Temperature control on each port
    - Quartz heating mantles on all ports with over temperature protection
    - Temperature range from Ambient to 400°C

SOFTWARE

- The system is controlled through most up-to-date version of Microsoft Windows based software
- Calibration routines able to be controlled by PMI's software
- Includes features for creation of methods for measuring the adsorption/desorption isotherms
- PMI Software has built in features for automatic start up and shut down procedures, real time display of the sample analysis progress
- PMI Software includes all the data handling features including user defined report generation, data, figures & ability to export to spreadsheets, offline data processing, etc.

Figure 5
Software Main Screen

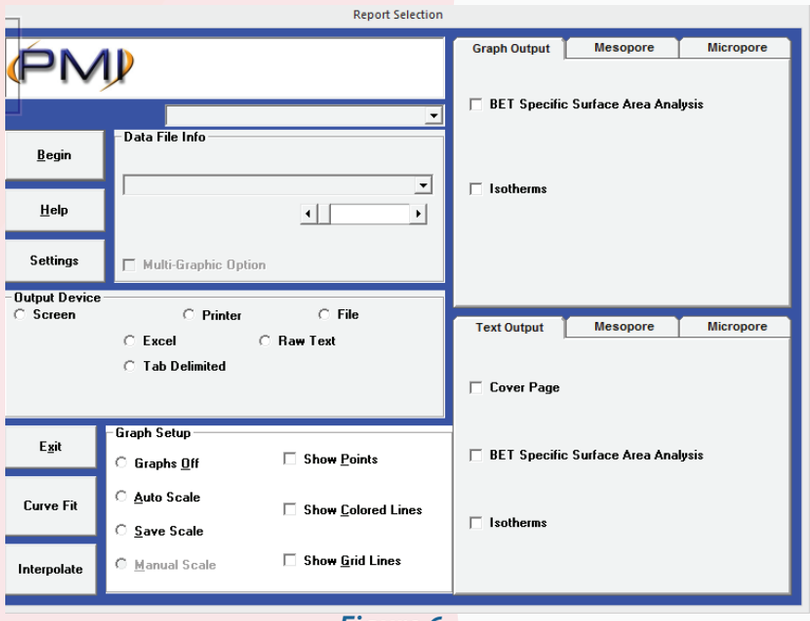

Figure 6
Report Selection Screen

Specifications

- **Sample Chambers:** 3 (able to operate simultaneously)
- **Pore Diameter Range:** 0.35nm to 200 nm
- **Micropore Volume Range:** Detectable within 0.0001 cc/g or less
- **Adsorbates:** N_2, Kr, Ar, O_2, CO_2, H_2, CO (or any non-corrosive gas)
- **Surface Area Ranges (in m^2/g):** >0.01 (Nitrogen)
- **Micropore Volume Resolution:** Detectable within 0.025 µl
- **Number of Gas Inlet Ports:** 2 (more ports available upon request)
  - Includes Valves of Appropriate Pressure ratings
  - Exchange of gas cylinder not required
- **Pressure Transducers (MKS Type):** 3
  - 1000 mmHg Pressure Transducer
    - Pressure Transducer Resolution: 1 part in 10,000
    - Pressure Transducer Accuracy: 0.15% reading
  - 10mmHg Pressure Transducer
    - Pressure Transducer Resolution: 1 part in 10,000
    - Pressure Transducer Accuracy: 0.15% reading
  - 0.1mmHg Pressure Transducer
    - Pressure Transducer Resolution: 1 part in 10,000
    - Pressure Transducer Accuracy: 0.15% reading
- **Adsorption Temperature:** -195.6°C (Liquid Nitrogen)
- **Regeneration System (Pretreatment System): 3**
  - Temperature Range: Ambient to 400°C Vacuum pump
  - Temperature Accuracy = ± 1 %
  - Power Requirements: 220 VAC, 50/60 Hz (Others Available)
- **Measurement Method:** Volumetric Gas Physisorption

Pore Structure Characteristics:

- Mean Pore Size
- Pore Size Distribution
- Total Pore Volume
- Single Point Surface Area
- Multi-Point Surface Area
- Adsorption & Desorption Isotherms

Sales & Services

We at Porous Materials Inc., have dedicated sales team helping thousand's of our customers identify the right solution for their scientific problems. We are also proud to offer customized instruments for your unique needs. Our service and applications team is committed to effective support with short response times, we offer comprehensive range of solutions from new and customized systems, calibration and maintenance to testing services.
Explore more about us at www.pmiapp.com

Customize your machine today!

Our Other Products

POROMETERS

- Advanced Capillary Flow Porometer
- Advanced Permeability Porometer
- Automated Filter Cartridge Tester
- Automated Humid Air Porometer
- Bubble Point Analyzer
- Cake Forming Porometer
- Capillary Condensation Flow Porometer
- Capillary Flow Porometer
- Cartridge Bubble Point Tester
- Clamp-On Porometer
- Complete Filter Cartridge Analyzer
- Confining Porometer
- Geo Pore Pro Porometer
- Pore Pro Porometer
- Compression Porometer
- Custom Porometers
- Cyclic Compression Porometer
- Filtration Media Analyzer
- Fuel Cell Porometer
- In-Plane Porometer
- Integrity Analyzer
- Liquid-Liquid Porometer
- Macro/Micro/Nano Porometer
- Microflow Porometer
- Multipoint Simultaneous Pore Structure

POROSIMETERS

- Liquid Extrusion Porosimeter
- Compression LEP
- Mercury/Non-Mercury Intrusion Porosimeter
- Water Intrustion Porosimeter
- Porosimeter Permeameter
- Advanced Permeability Porosimeter

PERMEAMETERS

- Constant/Falling Head Permeameter
- Liquid Permeameter
- Gas Permeameter
- Envelope Surface Area Analyzer
- Vapor Permeameter
- Gas Diffusion Analyzer
- Advanced Bendsten Permeability and Surface Roughness Tester
- Frazier Permeability Tester
- Gurley Permeability Tester
- Advanced Permeability Porosimeter
- Water Vapor Permeability Tester
- Porosimeter Permeameter
- Advanced Porosimeter Permeameter
- Oxygen Gas Permeability Tester
- Advanced Pulse Decay Permeameter
- Water Vapor Transmission Analyzer
- Average Particle Size Analyzer
- Average Fiber Diameter Analyzer

PYCNOMETERS

- Gas Pycnometer
- Mercury Pycnometer

SORPTOMETERS

- Liquid Sorptometer
- BET Sorptometer

SOME OF THE INDUSTRIES WE SERVE

- Automotive
- Battery
- Beverage
- Biotechnology
- Ceramics
- Chemicals
- Civil Engineering
- Construction
- Environmental
- Filtration
- Food
- Fuel Cells
- Healthcare
- Household &
- Manufacturing
- Medical Material
- Nonwovens
- Packaging
- Paper
- Personal Hygiene
- Pharmaceuticals
- Powder Metallurgy
- R&D
- Textiles

The most advanced, accurate, easy to use and reproducible Sorptometers in the world.

Celebrating

35

years

of solutions

20 Dutch Mill Rd, Ithaca, NY 14850, USA
Toll Free (US & Canada): 1-800-TALK-PMI (1-800-825-5764)
Phone: 607-257-5544 Fax: 607-257-5639

Email: info@pmiapp.com www.pmiapp.com

PMI Porous Materials, Inc.

PROUDLY MADE IN USA