THE PMI BET SORPTOMETER

BET-203A

Porous Materials, Inc.

Not just products...*solutions!*

Description

PMI's BET Sorptometer, BET-203A accurately measures total surface area (via single and multi-point methods), adsorption and desorption isotherms, mean pore size, pore size distribution, pore volume, and pore structure based on the Volumetric Gas Adsorption Principle. PMI's BET Sorptometer can assess a wide variety of samples, including powders and bulk solids, and can analyze both micropores and mesopores.

Applications

PMI's BET Sorptometer has a multitude of applications in industries worldwide. Some applicable industries include Rubber, Automotive, Chemical, Ceramic, Paper, Battery Separator, Fuel Cells, Filtration, Pharmaceuticals, and Powder Metallurgy.

Capabilities

- Analyze three samples simultaneously and independently of each other, in addition to the dedicated port for saturation pressure measurement
- P_0 measurement port with dedicated transducer
- Allows measurement, calculation, and manual entry of free-space
- Measures the following parameters:

  - BET and Langmuir Surface area (Multipoint)
  - Adsorption and Desorption Isotherms
  - Total pore volume
  - MP method
  - Freundlich and Temkin isotherms
  - Horvath Kawazoe
  - T-Plot: Harkins and Jura thickness equation, Halsey Thickness equation, Carbon STSA Broekhoff-de-Boer, Kruk-Jaroniec-Sayari
  - DA and DR method
  - BJH adsorption and desorption: Standard, Kruk-Jaroniec-Sayari
  - Dollimore-Heal adsorption and desorption
  - Mesopore and Macropore – Volume and area distribution by poresize
  - Poresize distribution based on Density Function theory
  - DFT Surface energy
  - Summary report
  - SPC reports
  - Validation reports
  - 0-10 mmHg transducer
  - Analysis using Kr gas (for very small surface area as low as 0.001 m2g)

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.

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
W_m = 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 W_m. 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
W_m = amount of gas adsorbed in moles

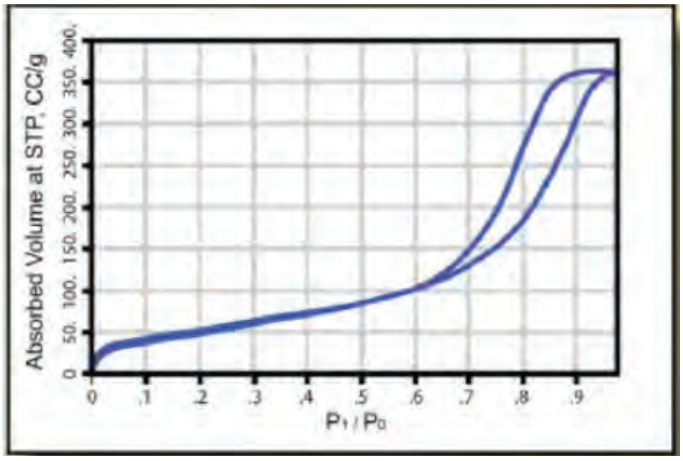

Figure 1
Adsorption and Desorption Isotherms at Liquid N_2 temperature

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:

g = surface tension of condensed liquid
V= molar volume of condensed liquid
q = 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.

Pore Volume and 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.

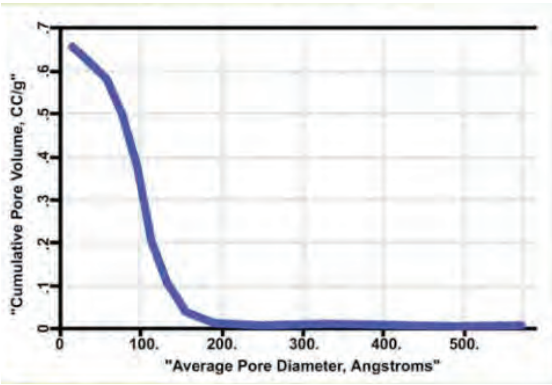

Figure 2
Cumulative Pore Volume

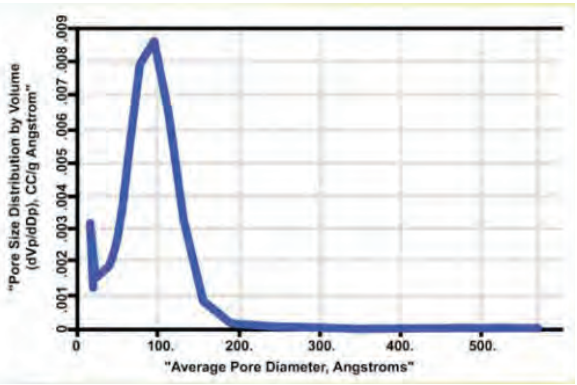

Figure 3
Pore Volume Distribution

Adsorption and Desorption Isotherms

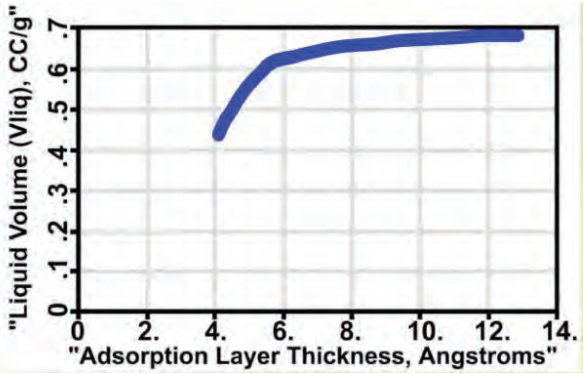

Figure 4

T - Plot Method - Micropore Volume Analysis

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.

Chemisorption

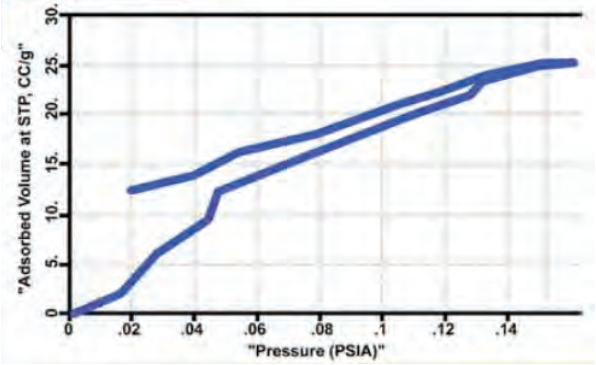

Figure 5

Adsorption and Desorption Isotherms - Water Vapor at 0˚C

PMI BET Sorptometers can use specialty gasses like NH_3 and H_2O for measuring chemisorption. Other gasses can be used by creating additional gas specification files. The user can specify any temperature and pressure of gas, limited only by the capabilities of the instrument and the equilibrium vapor pressure of the gas at the temperature selected.

Features

- 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 6 samples under heat, flow and/or vacuum
- Provision for transferring the sample from preparation station to analysis station and under vacuum
- Liquid nitrogen level control is accurate and available on the instrument without any electromechanical system
- The controlling and analysis software is be compatible with Windows Environment
- Suitable UPS with built in output isolation transformer to operate the machine and computer with battery backup for 30 mins

Features Cont.

- Comes with suitable liquid nitrogen container with suitable vacuum pump
- Suitable Desktop computer and printer for control and data acquisition and control of the machine
- Capable of video clips
- Ethernet communication between the computer and unit
- Built-in test points and diagnostic features
- Additional accessories will be quoted

Specifications

- Analysis Dewar capacity : > 24 hours
- The system allows for high resolution customized dosing routines to collect 1000 data points on adsorption and desorption isotherms
- Computer configuration: Current configuration or Intel I 7 with 8GB RAM, 1000GB HDD
- Graphic card-1GB, DVD Drive, 18”TFT monitor, Keyboad, Mouse, Windows-8 OS and BW Laser Printer

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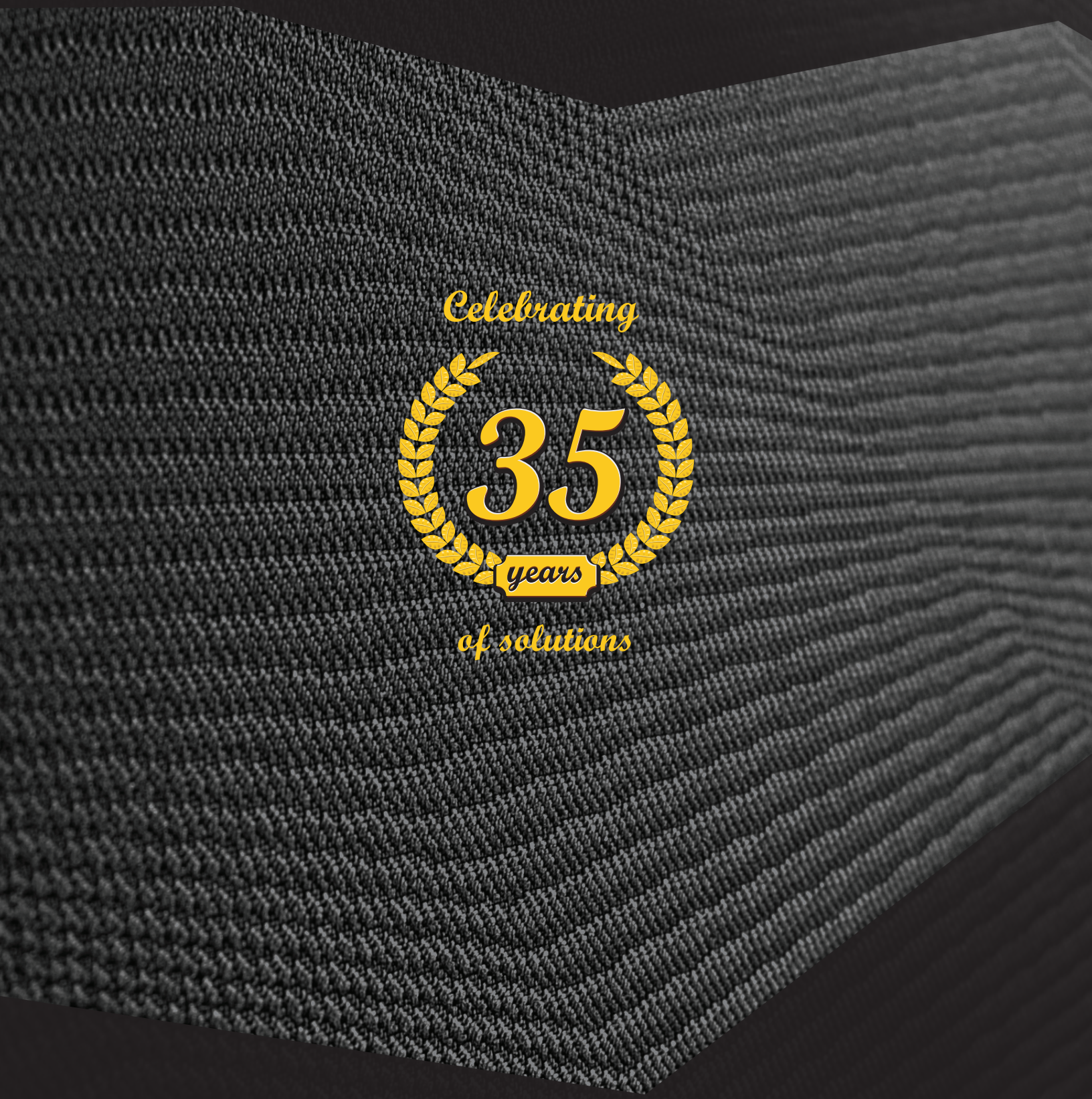
The most advanced, accurate, easy to use and reproducable porometers in the world.



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