DVS
RESOLUTION

Surface Measurement Systems
World Leader in Sorption Science

The Most Advanced Dynamic Vapor Sorption Instrument



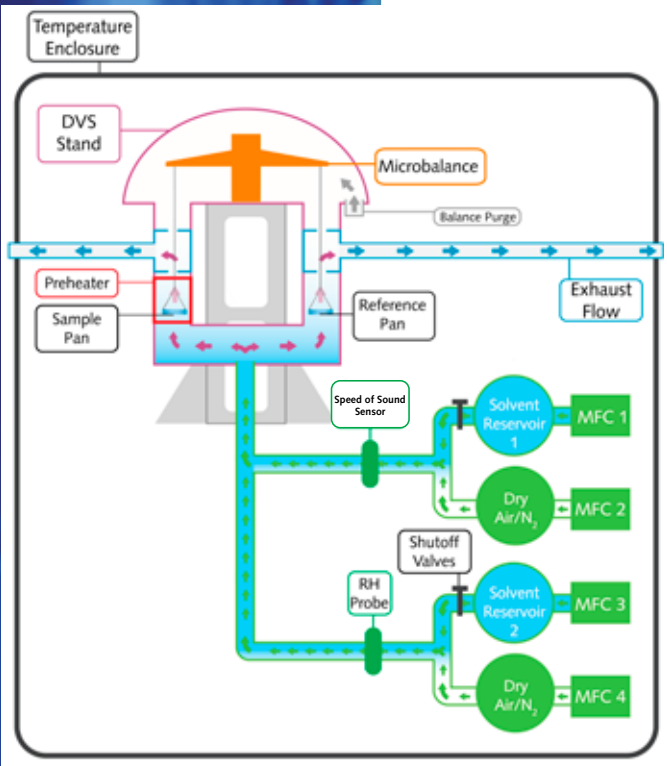
- Organic and Water vapor sorption kinetics 5 to 85 °C
- Organic and Water vapor sorption isotherms
- Co-adsorption with two vapors
- Real time partial pressure measurement and control
- *In-situ* sample drying/activation
- Color Video Microscopy/ Fiber Optic Probe Spectroscopy
- True0™ drying at 0.0% RH
- Upgradable and modular system

www.SurfaceMeasurementSystems.com

DVS Resolution

Dual Vapor Gravimetric Sorption Analysis





DVS Resolution Schematic

Key Applications

- Hygroscopicity of pharmaceuticals solids
- T_g and RH phase transitions in polymers
- Amorphous content determination of solids
- Diffusion and permeation in polymers
- Food, flavors and fragrances
- Sorbents
- Wood and cellulosic materials
- Composites
- Hydrophillic and hydrophobic materials

Key Hardware/Software Benefits

- Only system to measure organic vapor partial pressure directly using the Speed of Sound Sensor (patent pending)
- Open stainless steel stand design enabling easy access to sample pan while minimizing static electric charging
- Accurate and uniform temperature across a broad temperature range (5-85 °C)
- Next generation software for instrument control and data analysis, facilitating advanced experimental design and sample characterization
- Optional IR, Raman and video imaging with integrated control software for Raman and video

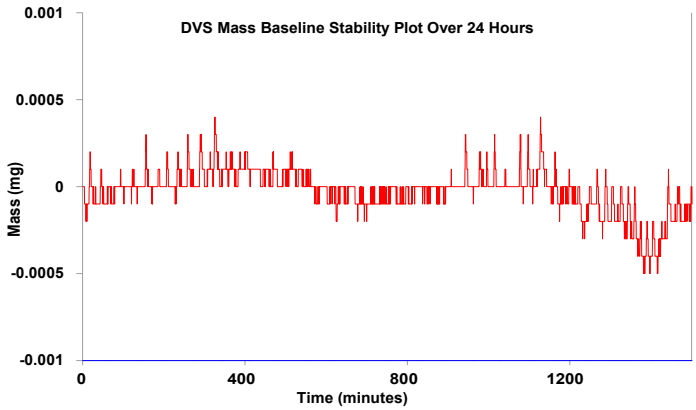
Solvent Delivery Configurations

The DVS Resolution can precisely deliver combinations of:

- Humidity
- Organic vapors
- Gases
- Two different components eg. an organic vapor with background humidity

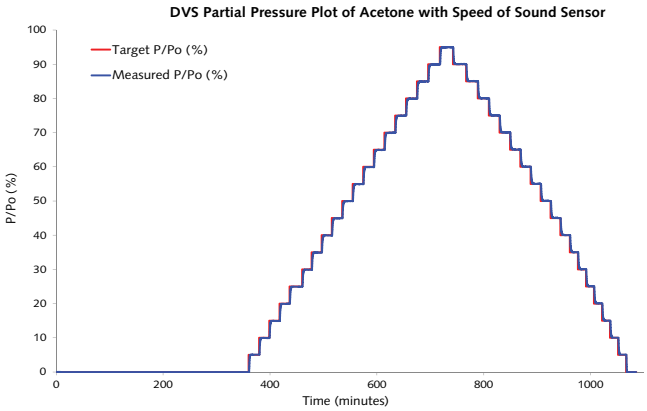
Outstanding Performance

Mass Measurement



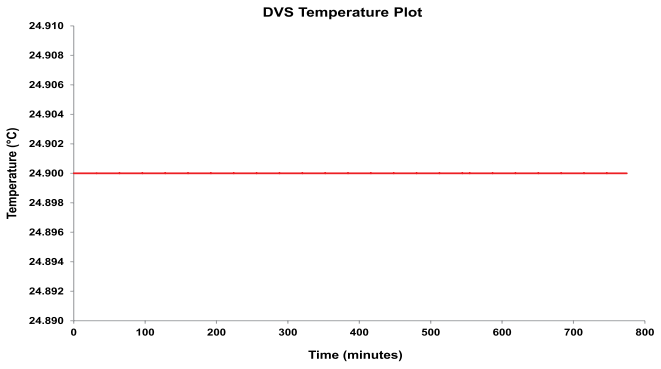
- Sample masses from 1 mg to 5000 mg with Ultrabalance
- Mass changes at a resolution of 0.01 µg for low mass balance
- Root mean square noise of ≤ 0.3 µg for low mass balance

Partial Pressure Control



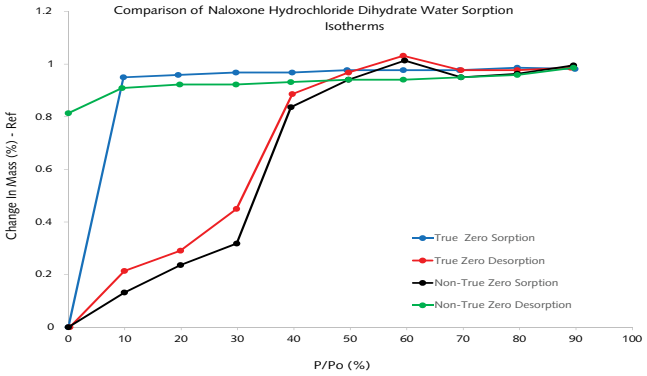
- Resolution of ±0.1% P/P_0 of target P/P_0
- Speed of Sound and Relative Humidity sensors standard

Temperature Control & Stability



- Stability at 25 °C is ± 0.05 °C per 6 hours
- Vapor generation and delivery at sample temperature prevents condensation issues found in instruments with multiple temperature zones
- Allows for accurate and stable vapor generation and delivery: a 1 °C temperature variation can alter humidity up to 4% at 25 °C

True0™ RH



- Only DVS instrument offering True0™ RH
- Achieve partial pressures of water as low as 0.0% RH
- Hydration and dehydration kinetics below 1% RH can be readily studied
- Measurement of sorption/desorption isotherms at low RH or oganic vapor concentrations

Outstanding Performance

Speed of Sound Sensor

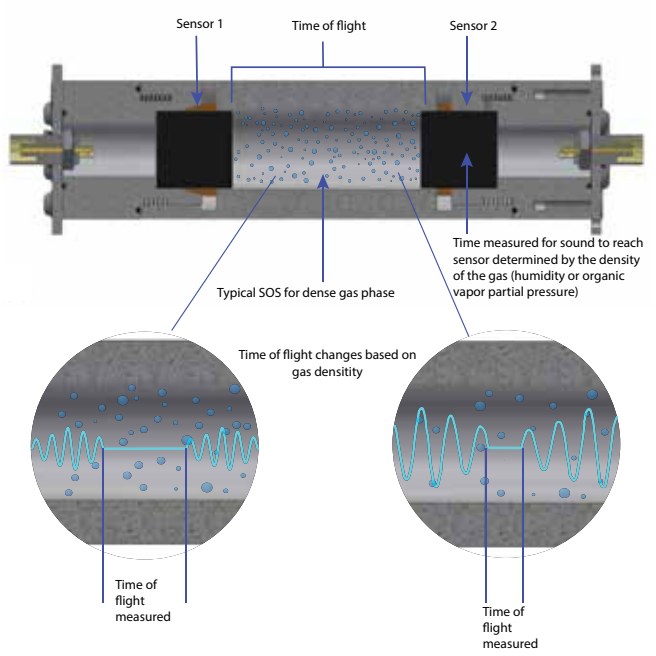
• The patent pending Speed of Sound (SoS) Sensor in the DVS Resolution is the only method to directly measure the vapor concentration ultrasonically

• The SoS is an intrinsic property of the vapor or gas measured which depends on temperature, vapor/gas concentration and the vapor/gas species. The SoS sensor determines the gas/vapor concentration in real time based on the speed of sound travelling through a fixed volume of solvent vapor or gas

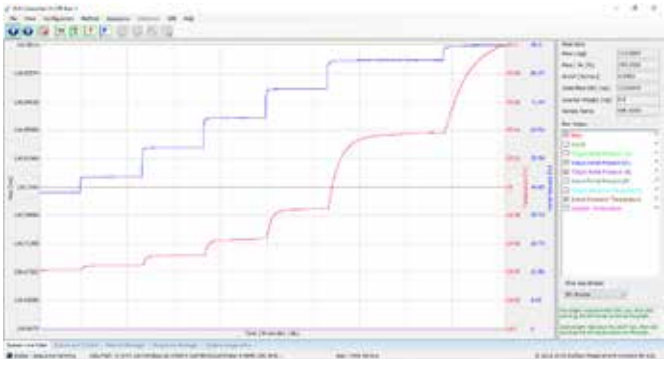
• SoS based concentration measurements enable active closed loop control significantly more accurate than open loop control using mass flow controllers/look-up table values only

• Dual SoS sensors available for complex co-adsorption control or solvent exchange

• Automated SoS sensor normalization prior to each experiment



Control Software



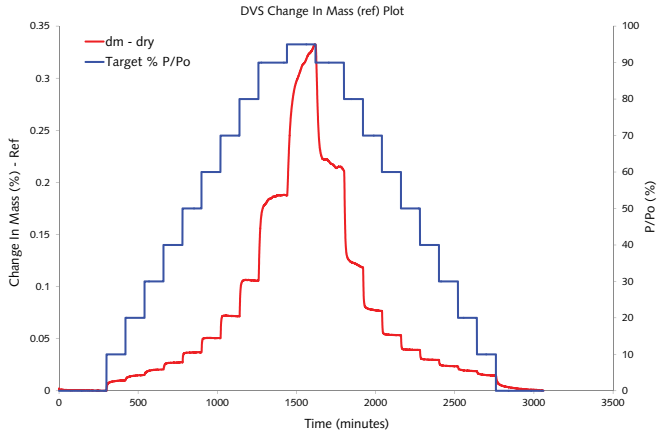
Live data panel depicts real time data from a DVS experiment. The panel digitally displays all experimental data and plots are user customizable.



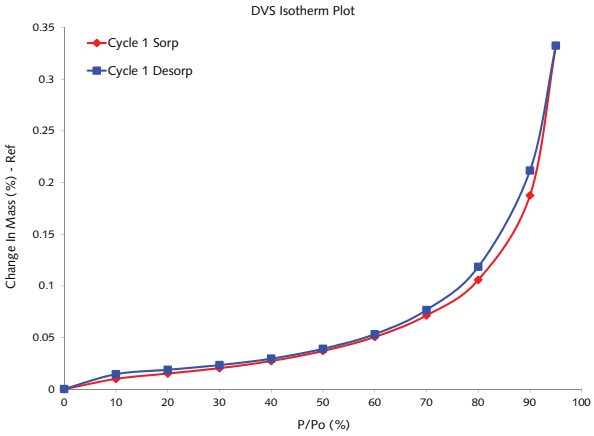
Method panel within the sequence manager displays numerically and graphically the current method for a water sorption experiment at 25 °C. The active stage of the ongoing experiment is highlighted in green.

Applications

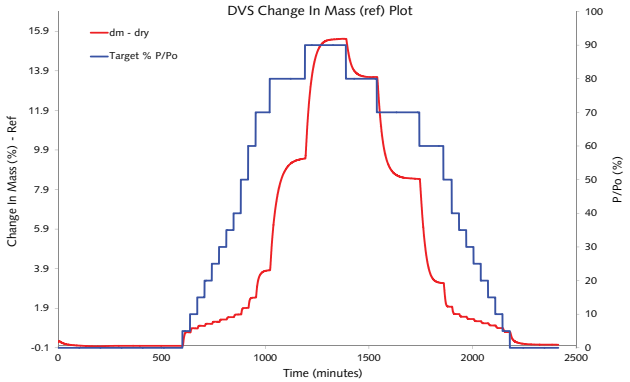
Typical Water and Organic Vapor Sorption Data



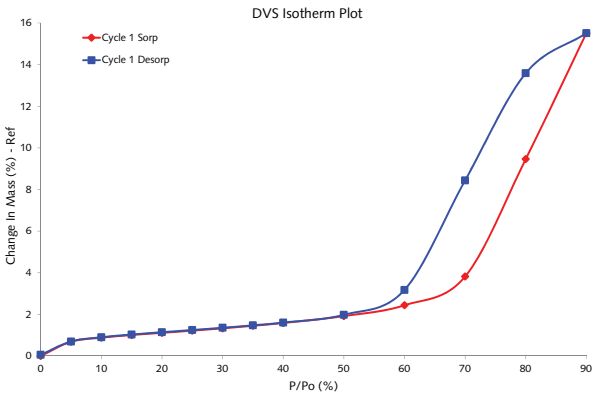
- Water sorption kinetic data for a hydrophobic powder at 25 °C



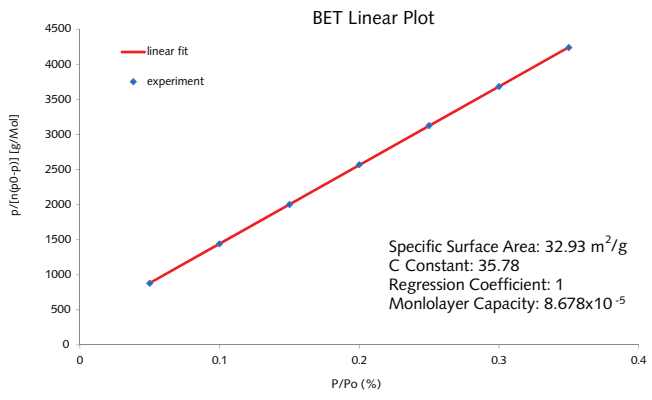
- Water sorption isotherm for a hydrophobic powder at 25 °C



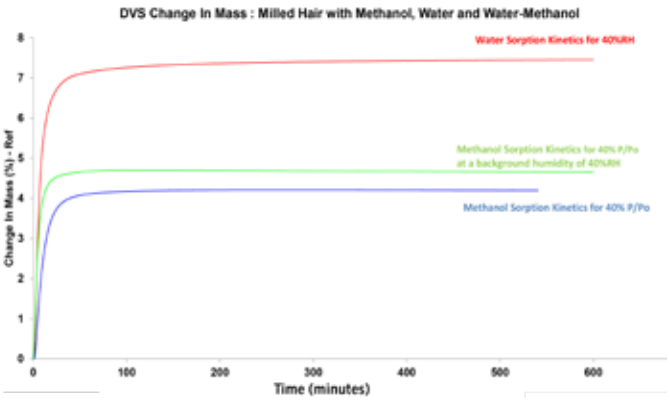
- Octane sorption kinetics for ceramic powder at 25 °C using Speed of Sound Sensor



- Octane isotherm plot for ceramic powder at 25 °C



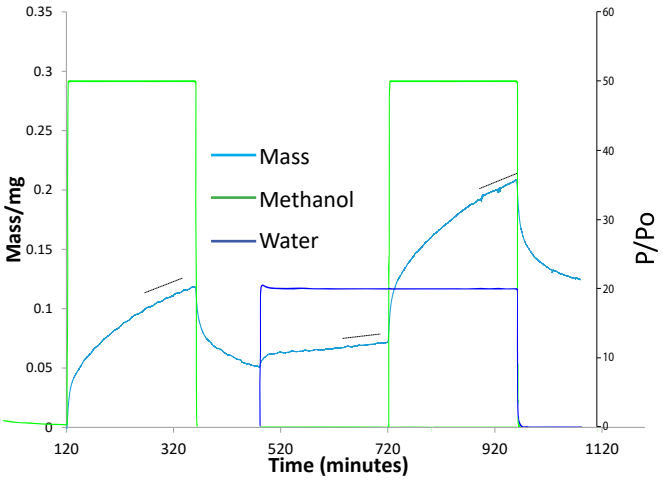
- Octane BET linearized plot for surface area determination at 25 °C



- Individual water and methanol sorption and water/methanol co-adsorption kinetics for hair.

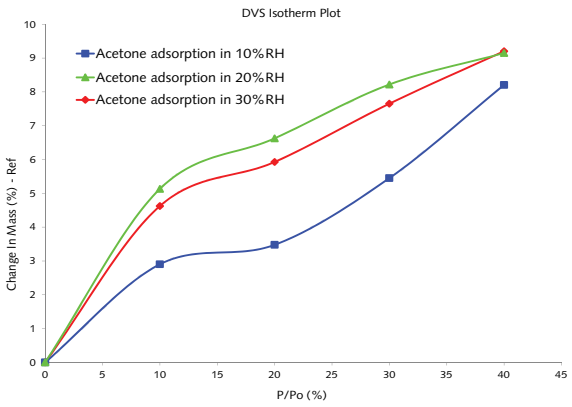
Applications

Thin Film Co-Diffusion



- Co-diffusion of two solvents into a thin film
- Independent control of individual moisture and organic vapor flows for single component and co-adsorption experiments

Spray Dried Polymer Co-Adsorption Isotherms



Acetone sorption in background humidity

- Acetone isotherm in blue/10%RH background
- Acetone isotherm in green/20%RH background
- Acetone isotherm in red/30%RH background

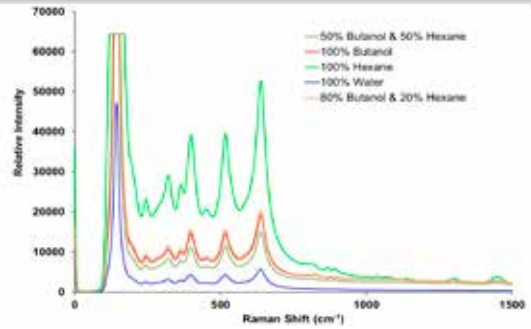
Why Surface Measurement Systems?

- Invented the DVS Technology with over 25 years of continuous innovation
- Our industry leading sorption scientists stand behind every instrument
- Our service team provides uncompromising support to our customers and partners
- Outstanding instrument performance
- Most complete and intuitive Windows software for experimental control and analysis

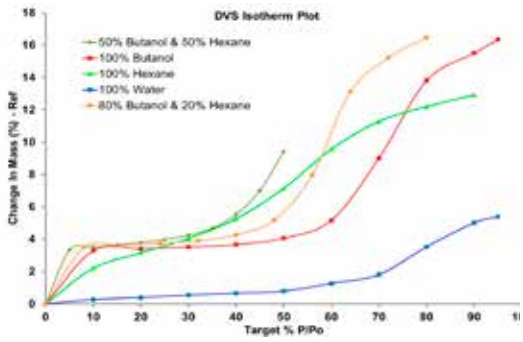
Modular Capabilities

Raman Spectroscopy

- Fully integrated hardware/software solution for triggering and capturing Raman spectra during sorption experiments
- Simultaneous operation of Raman and optical microscopy during the DVS experiment
- Allows for a more complete understanding of vapor-solid interactions for materials

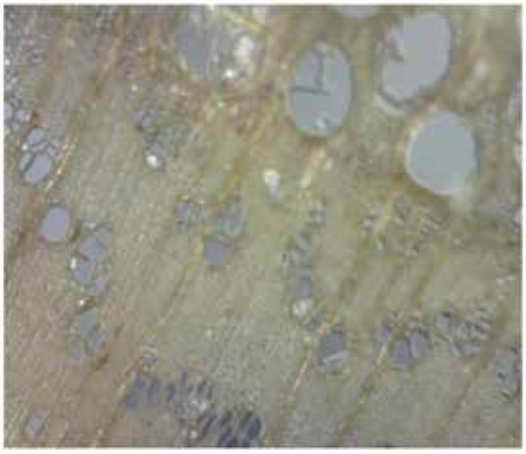






Microscopy and Video

- Optional 1.3 megapixel color camera
- 200x optical zoom
- Images have time-date-temperature-humidity stamps
- Grid overlay and calibration for measuring dimensional change
- The images can be composed into a timelapsed video



Cedar wood sample

High Temperature Preheater for Drying, Curing and Vapor Generation at Elevated Temperatures

- *In-situ* degassing/activation of samples up to 200 °C
- The temperature is measured by Pt-100 directly below sample pan
- Humidity generation up to 150 °C



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Specifications

Temperature

Temperature controlled enclosure
Control range: 5 °C to 85 °C
Temperature accuracy ± 0.1 °C
Temperature stability ± 0.05 °C per 6 hours
Temperature resolution 0.01 °C

High temperature pre-heater for drying samples

200 °C (maximum local temperature)
Heating ramp rates: up to 10 °C/min
Temperature sensor: Pt-100
Temperature accuracy ±1 °C

Resolution Stand

Manifold: 316 stainless steel
Seals: Viton® and Kalrez® or equivalent
Tubing: 1/4 inch stainless steel

Solvent Reservoirs

Material: Pyrex® glass
2 Reservoirs, 0.25 and 0.5L, as standard

Heated reservoir [1] (option for extended 85 °C 85% RH operation)

Flow Control

High accuracy digital mass flow controllers
Wide dynamic range - turndown ratio 1000:1
Carrier Gas - Dry air or Nitrogen

Relative Humidity

Relative humidity range from 0 to 98% for 5-60 °C [2]
Relative humidity range from 0 to 85% for 60-85 °C [1,2]
Relative humidity resolution ± 0.1%
Relative humidity stability ± 0.1% per 6 hours
RH range accuracy from 5 - 60 °C ± 0.5% [3]
RH range accuracy from 60 - 85 °C ± 1% [3]

Organic Vapor Generation and Measurement using Speed of Sound Sensor [4]

Partial pressure range from 0 to 90% P/P_o [5]
P/P_o resolution ± 0.1%
P/P_o accuracy from 5 - 85 °C ±1% P/P_o [3,6]

Speed of Sound Sensor for organic vapors

Optional configuration

Dual balance station configuration for 2 sample analysis in parallel

Solvents Available include: [7]

Water	Toluene	Dichloromethane
Pentane	Acetone	Isopropanol
Heptane	Chloroform	Ethyl Benzene
Hexane	*o*-Xylene	n-propanol
Octane	*m*-Xylene	Dimethylsulfoxide
Nonane	*p*-Xylene	Methanol
Decane	Benzyl Acetate	Ethanol
Cyclohexane	Ethyl Acetate	Phenol
Dioxane	*d*-Limonene	Tetrahydrofuran

Mass Measurement

Ultrabalance Low Mass

Sample mass: 1 to 1000 mg
Mass change: ±150 mg
Resolution (precision): 0.01 µg
Balance noise: ≤ 0.3 µg [8]

Ultrabalance High Mass

Sample mass: 10 to 5000 mg
Mass change: ±1000 mg
Resolution (precision): 0.1 µg
Balance noise: ≤ 3 µg [8]

[1] Optional configuration (heated reservoir) for long term term 85 °C, 85% RH operation

[2] System factory calibrated at 25°C. Calibrations at other temperatures upon request.

[3] 1-σ confidence level with % RH or P/P_o calibration performance based on SMS factory certified methods

[4] Speed of Sound sensor is calibrated for solvents listed.

[5] Depending on the solvent selected and experimental temperature

[6] Depending on the solvent selected

[7] For a current list of calibrated solvents or to request a solvent calibration contact SMS

[8] Root mean square

System Software

Next generation purpose built software for use with Windows 10

DVS Control Software

- Sample pre-heating
- Vapor sorption
- Temperature changes in a single experiment
- Ramp or step changes in relative humidity
- Automated video image and Raman spectra acquisition
- Complex isotherm experiments
- Organic vapor sorption partial pressure
- Experimental stages may be based on fixed-time or a user-defined dm/dt criteria
- Experiments may include half, full or multiple partial pressure or temperature cycles
- Dual vapor co-adsorption

DVS Analysis Software

- Isotherms
- Permeability and diffusion
- Kinetics information
- Surface area models
- Amorphous content
- Heat of sorption
- T_g determinations

Software Options

Standard

- DVS Control Software
- DVS Standard Analysis

Advanced

- DVS Advanced Analysis Suite
- DVS Isotherm Analysis Suite

21CFR Part 11 software solution optional

Instrument information

Physical dimensions: Width: 520 mm (20.5''), Height: 980 mm (38.5''), Depth: 610 mm (24''), Weight: 80 kg (180 lb)
Laboratory environment: Temperature: 10-30 °C (50-85 °F)
Relative Humidity: 20-80% RH (non-condensing)
Electrical: 200-240 V, 50/60 Hz, 1500 VA

QAS INTERNATIONAL ISO 9001:2015 REGISTERED COMPANY Certificate No. CA10727

WINNER Innovation Award FUTURE MANUFACTURING awards

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