

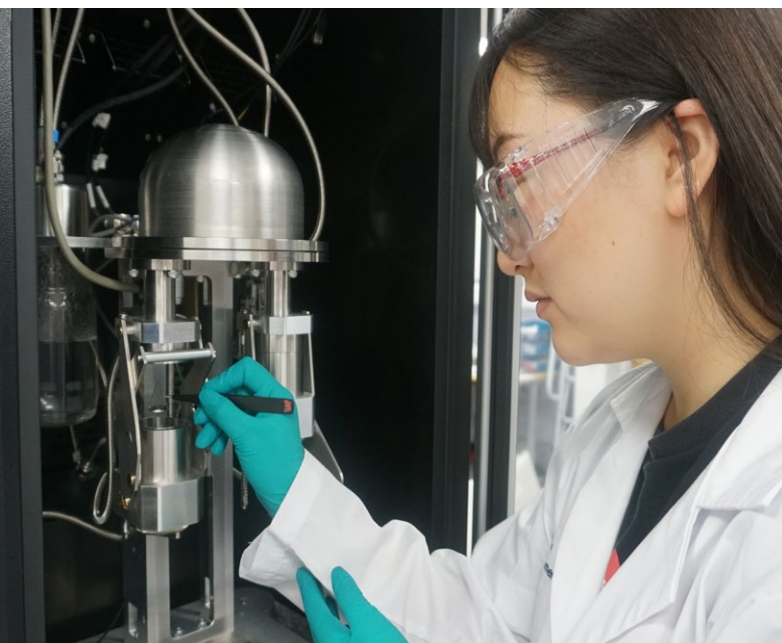


Automated Dynamic Water Vapor Sorption Analyzer

- Dynamic water vapor sorption isotherms from 5 °C to 85 °C
- Water sorption kinetics
- *In-situ* preheating/drying of samples to 200 °C
- Water diffusion and permeation measurements
- Optional Fiber Optic Raman / NIR accessory
- Optional Color Video Microscopy
- True0™ drying at 0.0% RH
- Next generation experimental control and evaluation software

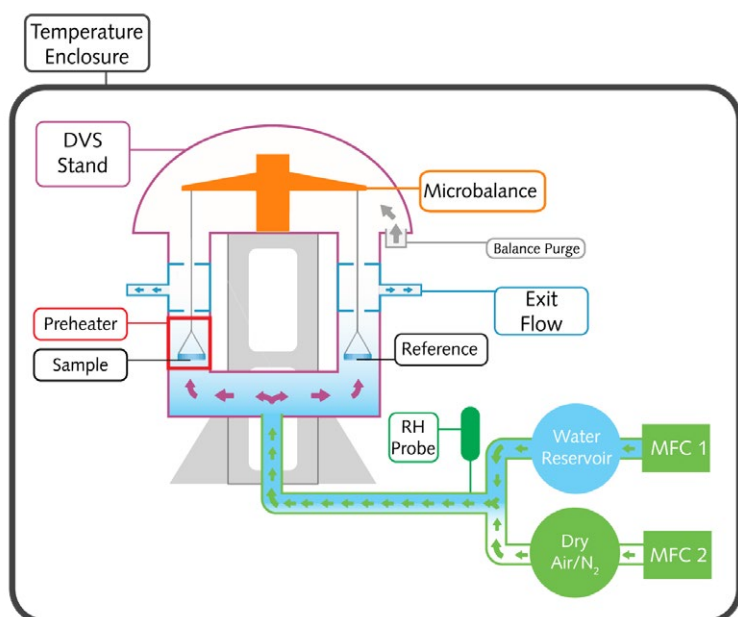
DVS Adventure Water Vapor Sorption Analyzer

Dynamic Vapor Sorption (DVS) is a gravimetric sorption technique that measures the rate and amount of solvent sorbed and released by a sample, such as a dry powder absorbing or releasing water. The DVS accomplishes this by varying the vapor concentration surrounding the sample and measuring the resultant mass changes.



Applications

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



Standard DVS Adventure Schematic

Hardware

- 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 (from 5 to 85 °C)
- Optional IR, Raman and video imaging with integrated control software
- Quick and easy to change reservoir bottle
- Variable sample area for multiple sample geometries

Software

The software package provided with the DVS Adventure allows the users to create and customize experimental methods while enabling the full analysis of the kinetic data collected. Examples of the control and analysis software used in a standard water sorption experiment are outlined below.

•Control Software

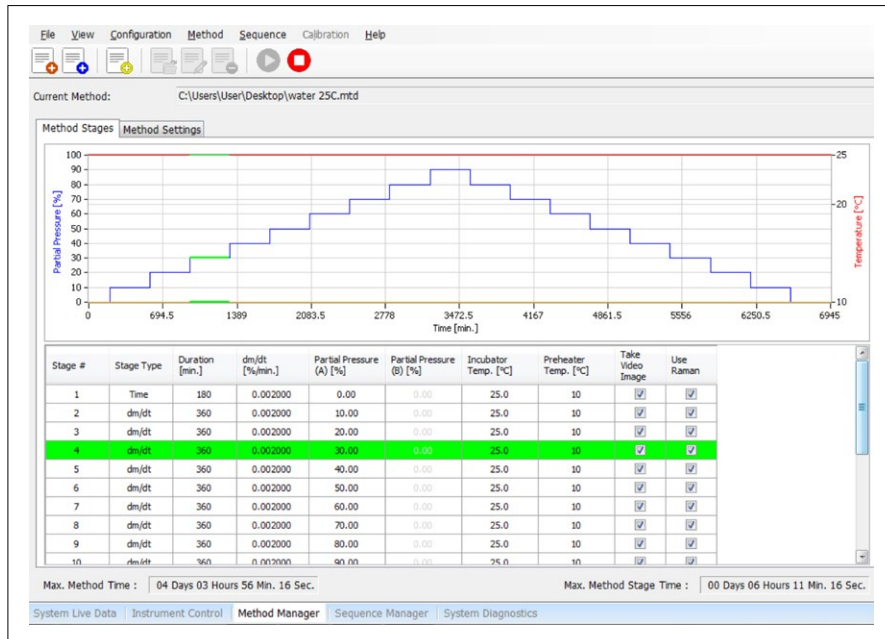


Figure 1. The above graph shows the method panel within the method manager. It displays numerically and graphically the current method for a water sorption experiment at 25 °C. The active stage of the ongoing experiment is highlighted in green. Figures 2 and 3 (below) are typical data generated by this method.

•Analysis Software

Water Sorption Data

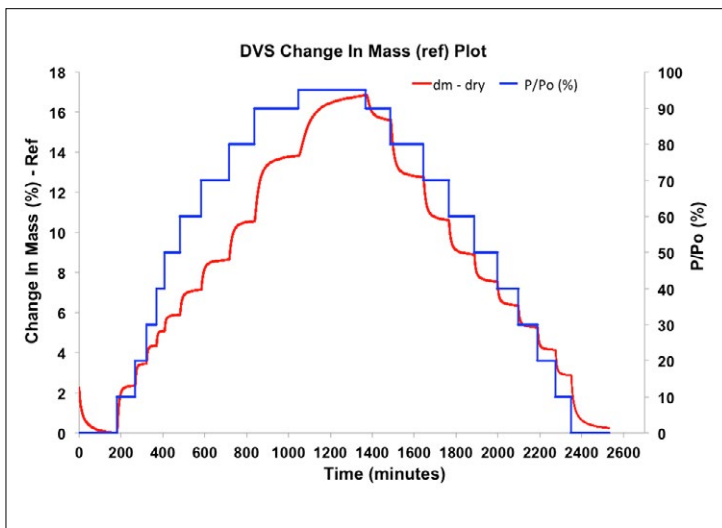


Figure 2. Water sorption kinetics of micro-crystalline cellulose membrane at 25 °C

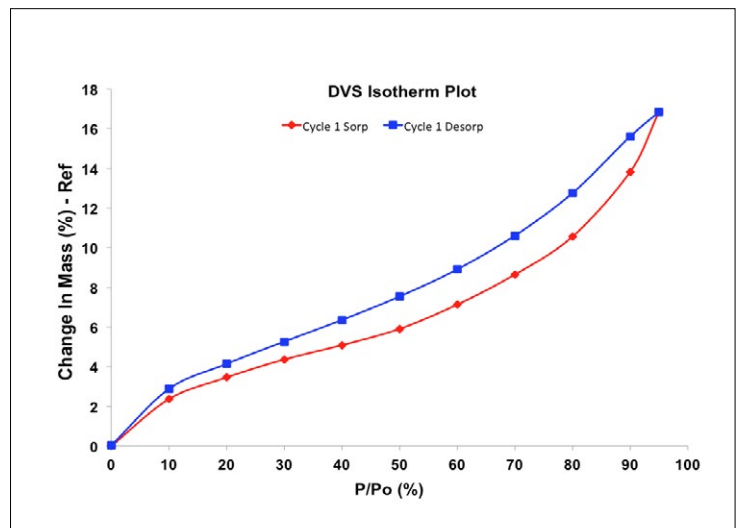


Figure 3. Water sorption isotherm of micro-crystalline cellulose membrane at 25 °C

Outstanding Performance

The DVS Adventure allows for the collection of high quality data, owing to the outstanding Ultrabalance performance (Figure 4), precise vapor generation (Figure 5) and accurate temperature control (Figures 4, 6, 7).

Mass and Temperature Measurement

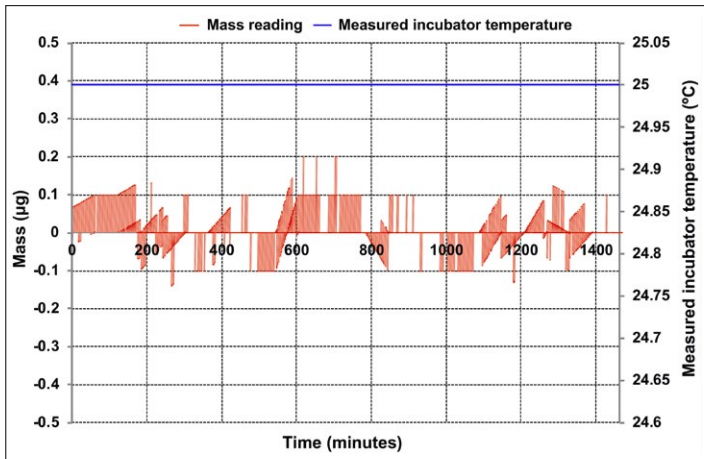


Figure 4. DVS mass baseline stability plot over 24 hours, in µg

- 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 (averaged over 24 hours)

True0™ RH

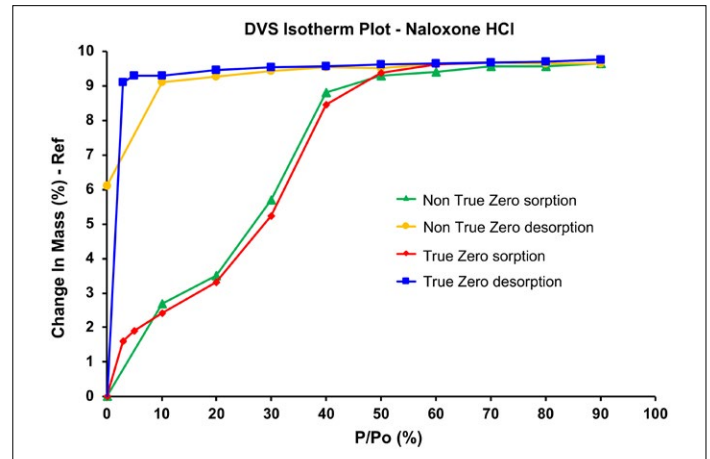


Figure 5. Comparison of Naloxone hydrochloride dihydrate water sorption isotherms

- Achieves partial pressures of water of 0.0% RH
- Hydration and dehydration kinetics below 1% RH can be readily studied

Temperature Control & Stability

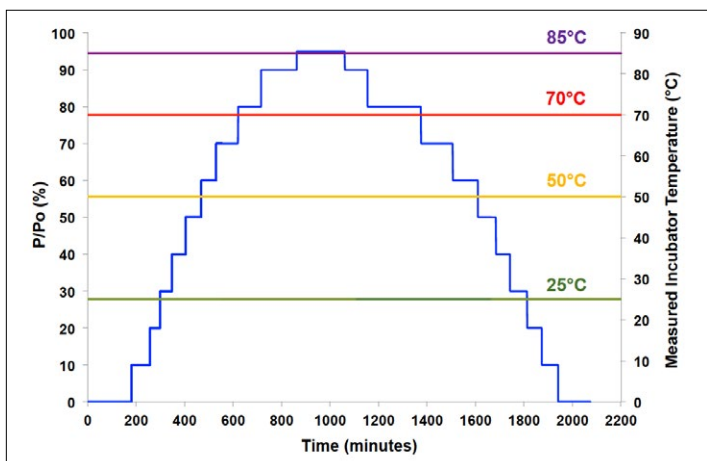


Figure 6. Multiple kinetic plots of relative humidity at different temperatures*

- Stability is ± 0.05 °C at 25 °C over 6 hours
- The single temperature enclosure environment prevents condensation issues typically found in instruments with multiple temperature zones
- Accuracy of humidity generation and high temperature stability guarantee stable isotherm experiments

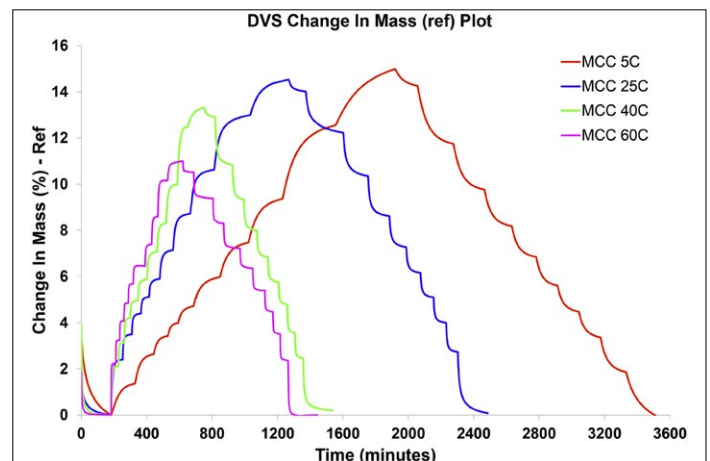


Figure 7. Microcrystalline cellulose (MCC) kinetic mass plot for different temperatures

*For extended experimental operation at 85% RH at 85 °C an optional heated reservoir accessory is available.

Applications

Stability study of hydrates

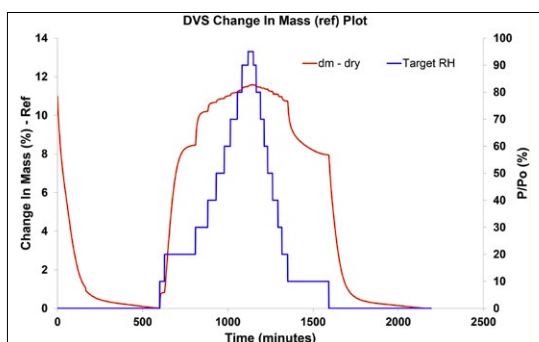


Figure 8. Water sorption kinetics of Amoxicillin Trihydrate at 40 °C

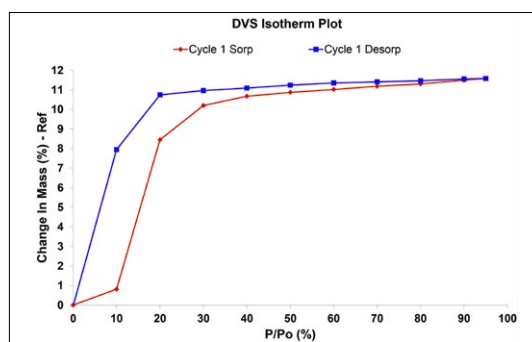


Figure 9. Water sorption isotherm of Amoxicillin Trihydrate at 40 °C

- The accurate humidity generation and excellent balance stability allows for the study of hydrate formation.
- More information about the methodology can be found in our Application Note 36 (Investigation of Hydrate Formation and Lose using the DVS).

Phase transition & recrystallization study

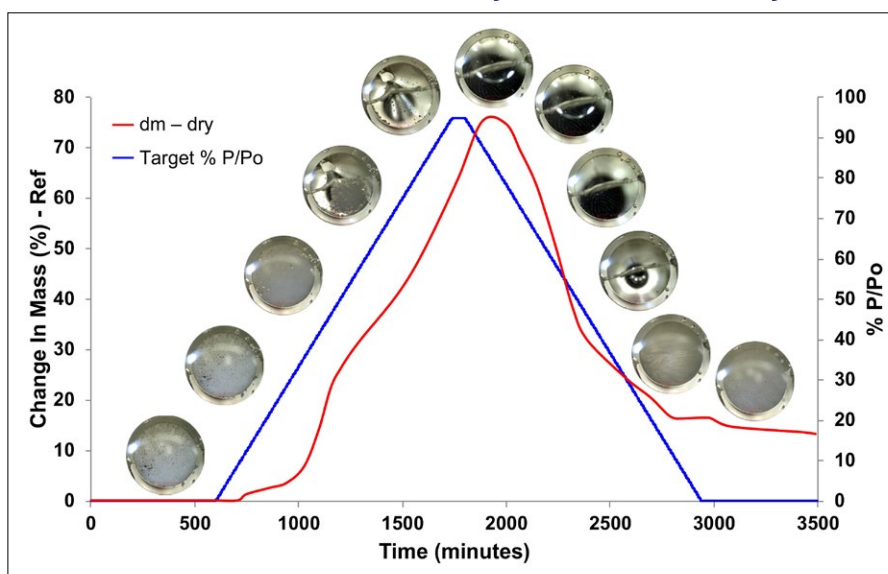


Figure 10. Moisture sorption of Amino Acid at 35 °C, collected with a ramping method & camera accessory

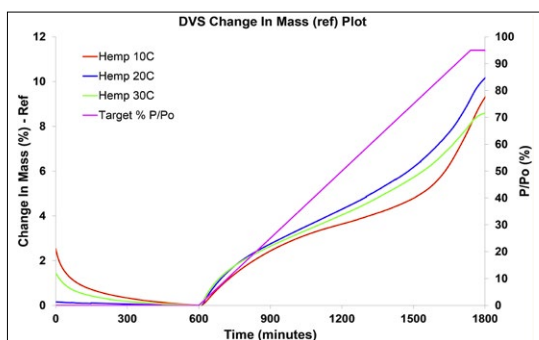


Figure 11. Water sorption of Hemp collected at 10 °C, 20 °C and 30 °C using a moisture ramping method

- Experiments performed with moisture ramping method can be used to calculate the critical % RH of the phase transition of the Hemp sample.
- More information in regard to phase transition/recrystallization studies can be found in our Application Notes 35 and 42.

Moisture-induced phase change for Hemp

Temperature	T _g RH
10 °C	80.1%
20 °C	74.1%
30 °C	70.2%

Modular Capabilities

Raman & IR Spectroscopy

- Fully integrated hardware/software solution for triggering and capturing Raman or IR spectra during sorption experiments
- Simultaneous operation of Raman or IR and optical microscopy during the DVS experiment

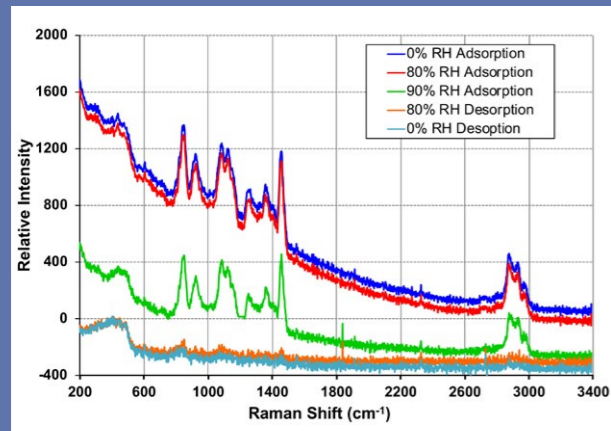


Figure 12. Raman spectra of Hydroxypropyl Methylcellulose (HPMC) at 25 °C

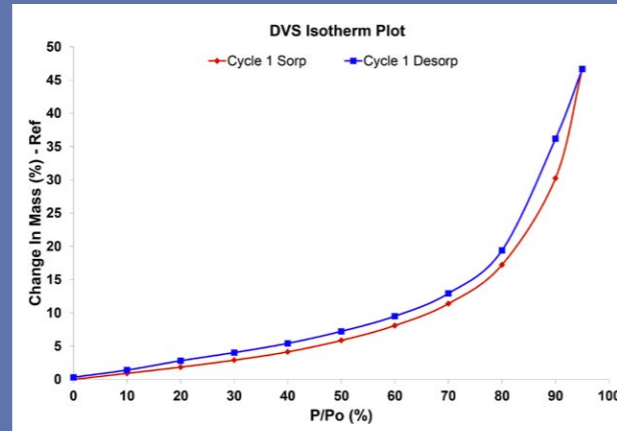
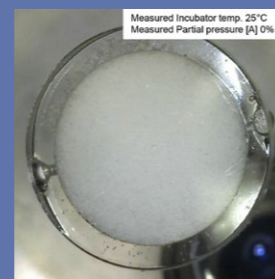


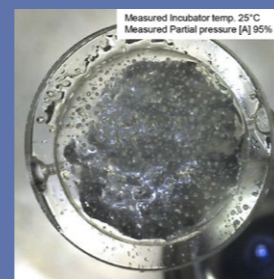
Figure 13. Moisture sorption isotherm of Hydroxypropyl Methylcellulose (HPMC) at 25 °C

Microscopy & Video

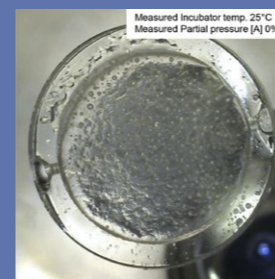
- 1.3 megapixel color camera
- Up to 200x optical zoom
- Images have time-date-temperature-partial pressure stamps
- Grid overlay and calibration for measuring dimensional change
- The images can be composed into a timelapsed video



1) Sorption 0% RH (HPMC)



2) Sorption 95% RH (HPMC)



3) Desorption 0% RH (HPMC)

High Temperature Preheater*

(for drying and curing)

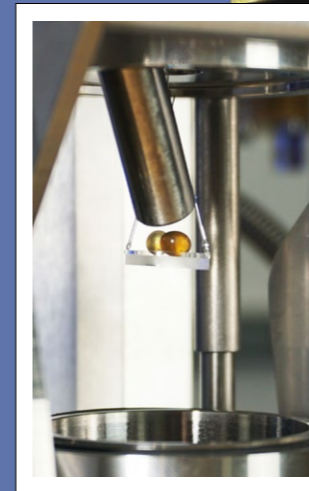
- In-situ degassing/activation of samples up to 200 °C
- The preheater temperature is controlled using a Pt-100 positioned below the sample pan
- User programmable and controlled temperature ramps or steps

NOTE: Preheater cannot be used with other modular accessories



Heated reservoir accessory*

- The heated reservoir replaces the standard glass bottle mounted on the left of the stand
- Designed for extended humidity generation 85% RH at 85°C, with fully automated temperature








Raman/IR

Reference chamber

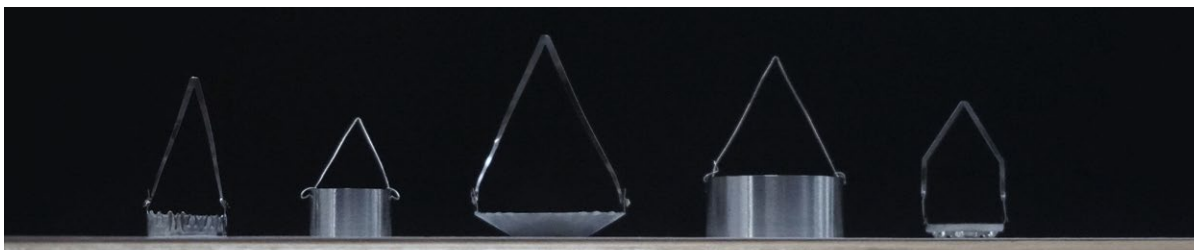
*For more information on the specification of these accessories, please contact sales@surfacemeasurementsystems.com

Accessory Compatibility

The **DVS Adventure** is compatible with a range of accessories that can greatly expand the scope and variety of your research. See the table below for a summary of the available options, and how they can work together.

	Temperature Range (°C)	Preheater	Camera	Raman	IR	Heated Reservoir
Preheater	Up to 200 °C		X	X	X	✓
Camera	Up to 50 °C	X		✓	✓	✓
Raman	Up to 50 °C	X	✓		X	✓
IR	Up to 50 °C	X	✓	X		✓
Heated Reservoir	Up to 85 °C	✓	✓	✓	✓	

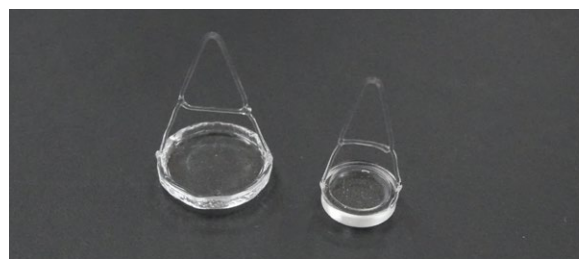
Consumables



Metal Pans: from left to right, 10mm Standard metal pans, 10mm deep pans, 17mm pans, 17mm deep pans, 10mm Aluminium Foil Holder.



Payne Diffusion Cell: Small (9mm) and Large (18mm, only for high mass balance configuration).



Quartz Video Pans: Small (10mm) and Large (19mm, only for high mass balance configuration).

For more information on consumables or accessories, or to place an order, contact our team at sales@surfacemeasurementsystems.com

Technical Specifications

Temperature

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

High Temperature Pre-heater for drying samples

200 °C (maximum local temperature)
Heating ramp rates: up to 5 °C/min
Temperature sensor: Pt-100

Adventure Stand

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

Water Reservoirs

1 glass reservoir as standard (500 ml, 1000 ml available)
Optional heated reservoir ¹

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 $\pm 0.1\%$
Relative humidity stability $\pm 0.1\%$ over 6 hours
RH range accuracy from 5 - 60 °C $\pm 0.5\%$ ³
RH range accuracy from 60 - 85 °C $\pm 1\%$ ^{1,3}

Mass Measurement

Ultrabalance Low Mass

Maximum load: 1000 mg
Mass change: ± 150 mg
Resolution: 0.01 μg
Balance noise: $\leq 0.3 \mu\text{g}$ ⁴

Ultrabalance High Mass

Maximum load: 5000 mg
Mass change: ± 1000 mg
Resolution: 0.1 μg
Balance noise: $\leq 3 \mu\text{g}$ ⁴

System Information

Dimensions: 520 mm (W) x 980 mm (H) x 610 mm (D)

Weight: 80 kg (180 lb)

Electrical: 200-240 V, 50/60 Hz, 1500 VA

System Software

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
- 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
- Windows™ 10

DVS Analysis Software

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

Software Options

Standard

- Control Software
- Standard Analysis

Advanced

- Advanced Analysis Suite
- Isotherm Analysis Suite

21CFR Part 11 software solution (optional)

Footnotes

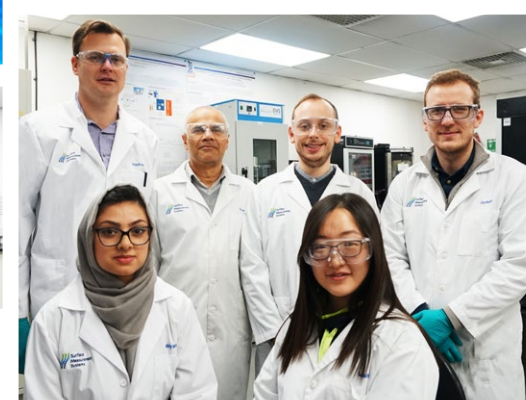
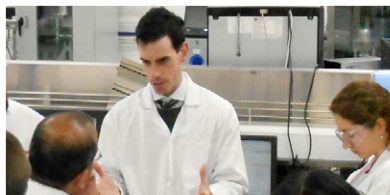
¹ Optional configuration (heated reservoir) for long term 85°C, 85% RH operation

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

³ 1- σ confidence level with % RH or P/P₀ calibration performance based on SMS factory certified methods (Salt Calibration or equivalent method)

⁴ Root mean square (averaged over 24 hours)

About Us



Surface Measurement Systems Ltd. develops and engineers innovative experimental techniques and instrumentation for physico-chemical characterization of complex solids. Our range of characterization instruments and scientific/engineering techniques has helped solve difficult problems in the pharmaceutical, biomaterial, polymer, catalyst, chemical, cosmetic and food industries, and are used by hundreds of leading laboratories and universities throughout the world.

Why us?

- Invented the DVS Technology with over 25 years of continuous innovation
- Every instrument is built upon the knowledge and experience of our industry leading sorption scientists
- 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
- Winner of EEF Innovation Award 2019 and ISO 9001:2015 accredited



Surface Measurement Systems
World Leader in Sorption Science



UK (European Office)

Unit 5 Wharfside, Rosemont Road
Alperton, London, HA0 4PE, UK
Phone: +44 (0) 208 795 9400

USA (North American Office)

2125 28th Street SW, Suite 1
Allentown, PA, 18103
Phone: +1 610 798 8299

SMS Instruments Private Ltd. (India Office)

1611-16/L/40, Teegal Guda Saleem Nagar,
Malakpet, Hyderabad, Telangana, India, 500036
Phone: +91 742 004 8972