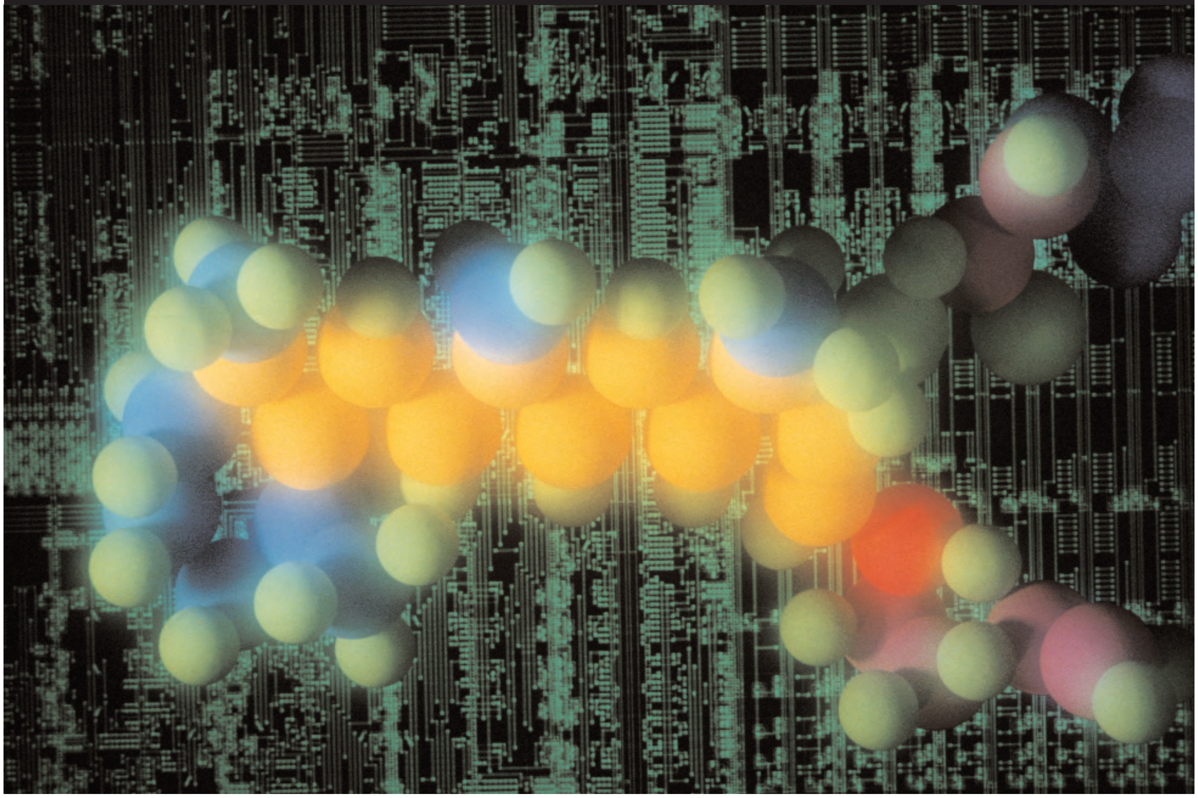
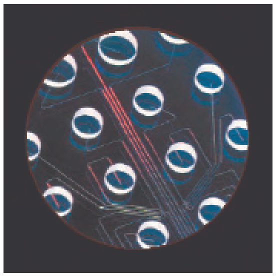
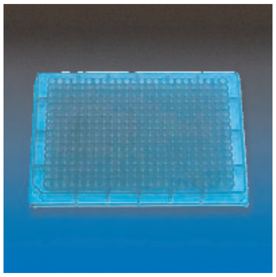
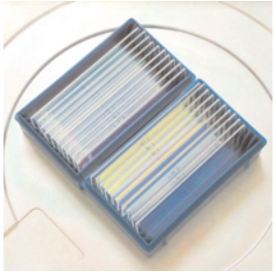
◂ Coatings for Nanotechnologies ▸

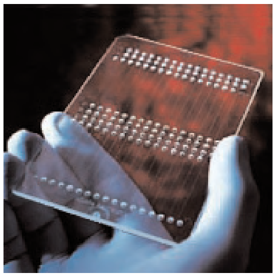
MOLECULAR VAPOR DEPOSITION™











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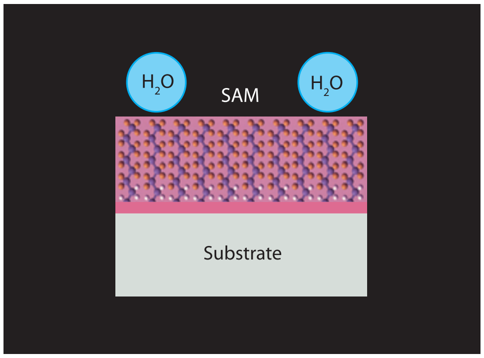
Applied MicroStructures

Superior MVD™ coating makes Sensors, MEMS and Bio-Devices work better, enable advancements in Nanotechnology.

Molecular Vapor Deposition (MVD) is a significant new technolgy that is certain to accelerate the development of next-generation coatings for a wide range of nano-scale devices. Its superior coating capabilities support full implementation of nano-technologies.

Coatings that are only Angstroms thick can be formulated as lubricants, anti-stiction layers, molecular glues, coupling agents or reactive adhesion layers. Our silane based organic coating, for example, can provide a high quality, densely packed self-assembled monolayer (SAM) that prevents "in-use" stiction of a MEMS device, significantly improving its reliability.

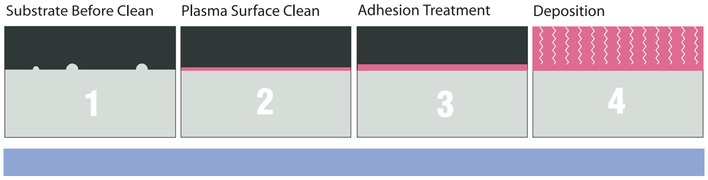


Hydrophobic Self Assembled Monolayer (SAM)

Molecular Vapor Deposition (MVD) overcomes many limitations and disadvantages of the wet immersion process. In liquid coating, which is the most common method, parts are immersed in a series of sequential baths. The process is complex, costly and limits implementation of desirable molecular coatings in many applications. For example, most SAM precursors are highly sensitive to humidity and thus are susceptible to particles and cross-contamination. Consequently, precursor liquids have an extremely short bath life, which increases manufacturing cost and limits process repeatability.

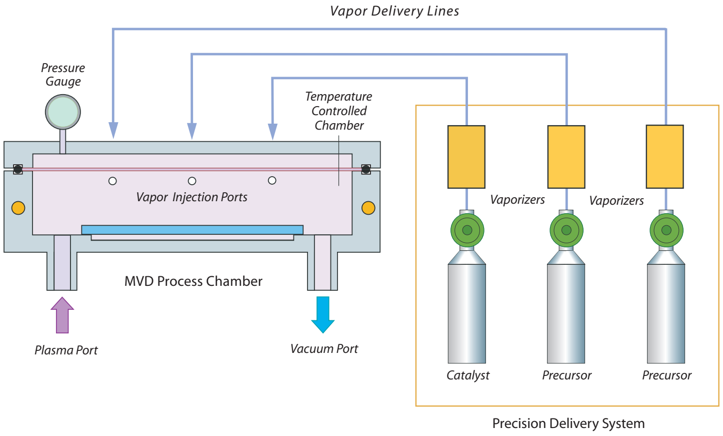
It's time to replace your complex wet processing with today's MVD process.

Multi-Step *In-Situ* MVD vapor phase coating process takes only minutes.



Integrated Processing: Plasma treatment followed by a multi-step depositon

Molecular Vapor Deposition is a simple multi-step process that can be completed in minutes. (1) Your devices are loaded into the vacuum chamber; (2) residual contamination is removed and the surface is prepared by plasma cleaning; (3) an initial layer is formed on the surface to promote adhesion; and (4) functional coatings are deposited in sequential steps .

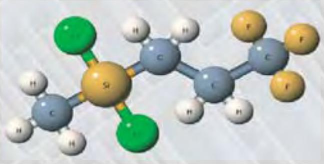


MVD-100 System – *In this low cost production tool, vapor-phase precursors are introduced into the vacuum chamber where they react with the surface of your devices to produce a functional molecular coating.*

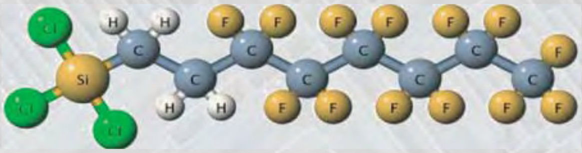
APPLIED MST

MVD™ for MEMS Devices

Common Precursors Used in MEMS

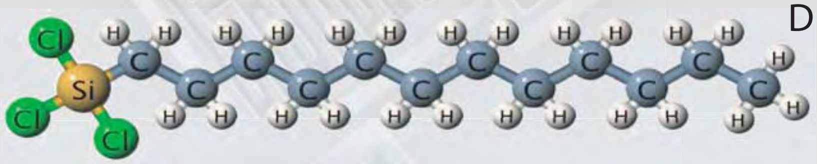


PMDCS



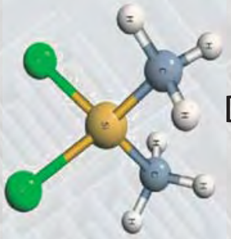
FOTS

FDTS



DDTCS

- Eliminate Stiction
- Improve Yield
- Reduce Cost
- Enhance Reliability



DDMS

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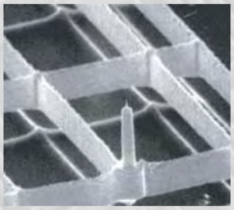
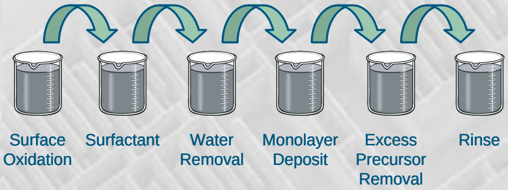
Complete, safe, low cost
MVD
with a push of a button.

COC
AMST's MVD
18¢/wafer





Surface Oxidation
Surfactant
Water Removal
Monolayer Deposit
Excess Precursor Removal
Rinse

Traditional
Liquid-Phase
Deposition
$9/wafer

Typical MEMS Precursors	Maximum Contact Angle		RMS Roughness (nm)	Cantilever Beam Length (µm)	Work of Adhesion ($\mu J/m^2$)	Coefficient of Friction
	Water	Hexadecane				
DDMS	103°	38°	0.2	650	36	0.3
FOTS	110°	75°	0.2	1300	5	0.2
FDTS	110°	68°	0.2	1500	3	0.2
Uncoated SiO_2	<5°	<5°	0.2	100	20000	1.1

Contact Us: Applied MicroStructures, Inc., 1020 Rincon Circle, San Jose, CA 95131
(408) 907-2885 .or. Toll Free (877) MVD-AMST info@appliedmst.com www.appliedmst.com

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Molecular Vapor Deposition™

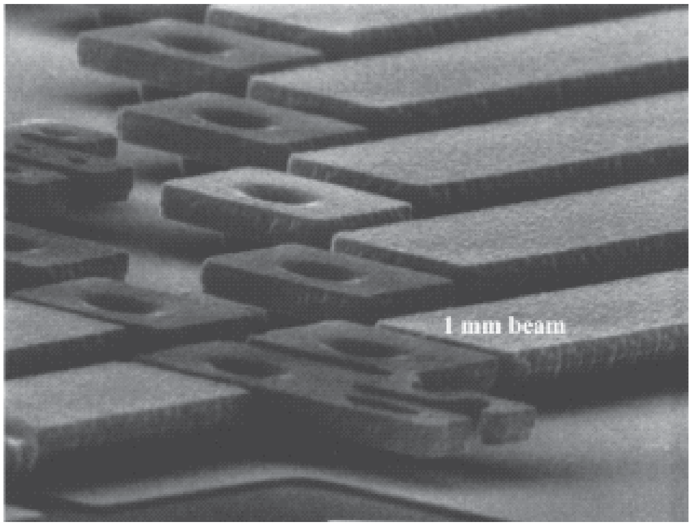
Safe Operation ▪ Improved Yield ▪ Low Cost

Hydrophobic Monolayer Coatings

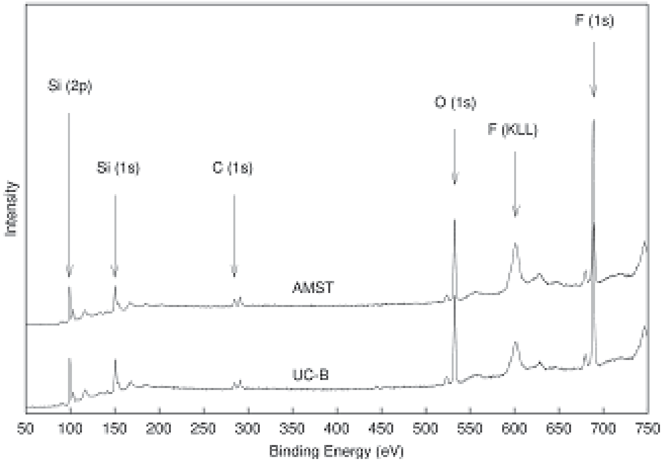
FOTS*), FDTS**), DDMS***) and other molecular films lower the work of adhesion by 1000 to 3000 fold and greatly reduce device failure caused by capillary stiction. Sensors, actuators, switches, RF-MEMS, micro-optic devices, nano-imprints and other microstructures that require low surface energies for stiction-free operation greatly benefit from monolayer coatings.

MVD Process

Molecular Vapor Deposition (MVD™) eliminates particulation and sensitivity of the monolayer coating process from the environment. In our MVD process, surfaces are treated with a plasma to assure uniform film properties and coverage. Precise, independent delivery of the precursor(s) and catalyst vapors enables control and tunability of the molecular layer properties. Automated control of the reaction parameters makes our MVD process highly suitable for both research and manufacturing.



MVD-coated freestanding polysilicon beams
(Courtesy UC Berkeley)



XPS spectra of an FDTS monolayer film showing MVD characteristics compared to a liquid-phase deposition

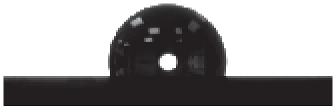
Tunable Surface Properties

Micro-fluidic and bio-devices frequently require surface modifications and the control of wetting properties. Properties of various substrates, such as semiconductors, glass, and metals, can be modified by MVD from hydrophilic-to- hydrophobic or hydrophobic-to-hydrophilic.

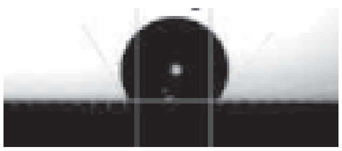
Contact Angle 20°

Contact Angle 73°

Contact Angle 102°



Contact Angle 106°



Adjustable Process

Precursors: User-selectable

Pressure: 0.1 Torr - 10 Torr

Temperature: ambient - 50°C

Plasma Chemistry: typically O_2

(Others available.)

Superior Monolayer Properties

Contact angle: 5° - 110° (water)

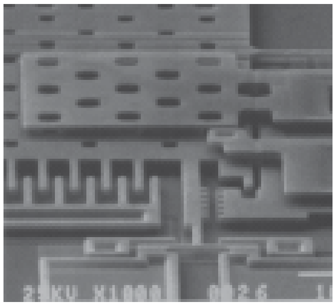
Work of adhesion: 3-100 $\mu J/m^2$

RMS Roughness: < 0.2 nm

Uniformity: ± 3%

Repeatability: ± 3% (wfr-wfr)

± 5% (run-run)



Integrated Processing

Our integrated plasma treatment of the surface followed by in-situ vapor deposition ensures high quality films with reproducible properties.

Examples of MVD Coatings

Precursor	Maximum Contact Angle	
	Water	Hexadecane
DDMS	103°	38°
FOTS	110°	75°
FDTS	110°	68°

*) FOTS - tridecafluoro-1,1,2,2-tetrahydrooctyltrichlorosilane

**) FDTS - perfluorodecyltrichlorosilane

***) DDMS - dimethyldichlorosilane

semiconductor INTERNATIONAL

EDITORS' CHOICE

BEST PRODUCT 2006

MVD100
Molecular Vapor Deposition

Applied MicroStructures process and hardware provide a complete solution for improved yield, low cost, and flexible operation to meet all device requirements. Multiple chemistries are also available for MEMS, BioMEMS and nano-tech applications.

System Configuration

Wafer/sample size: ≤200 mm

Loading: Manual

Processing modes: Auto

Semi-automatic & Manual

User interface:

Trouch-screen control

Base pressure: < 30 mTorr

Pumping capacity: 15-25 CFM

Precursor delivery: up to 3

vapor lines w/precision metering

Precursor usage: <1μl/wfr

Surface treatment: RF Plasma

Gas lines: O_2 and N_2

Footprint: 48" L x 24" W x 52"H

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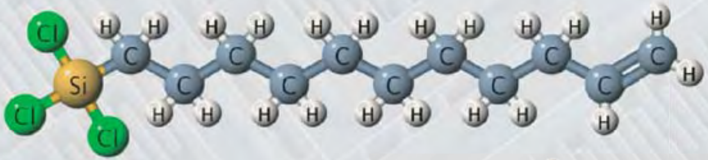
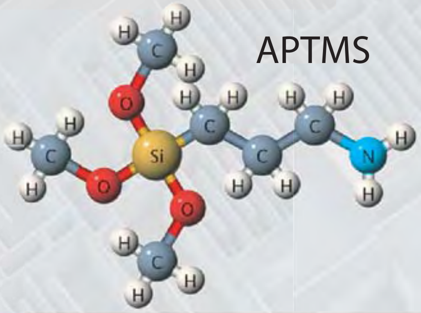
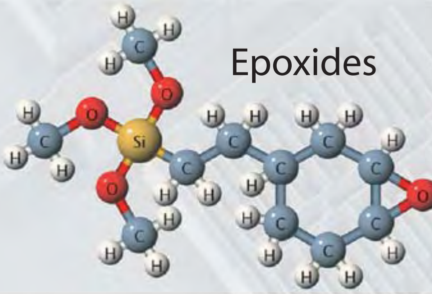
MVD™ for BioMEMS

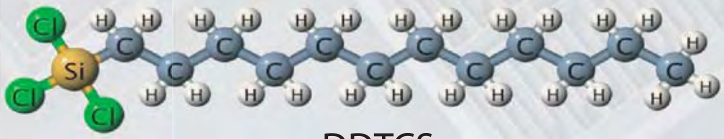
Common Precursors Used in BioMEMS

- No Chemical Waste
- Excellent Uniformity
- Low Cost
- Repeatable
- No Particles
- Safe

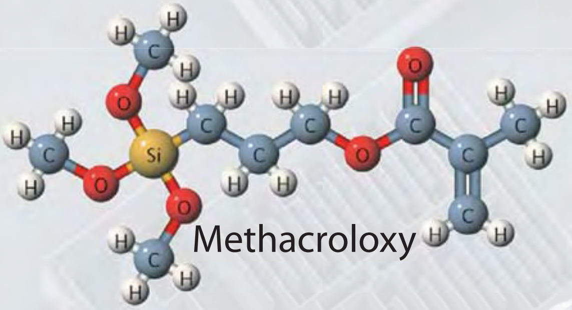

V11TCS

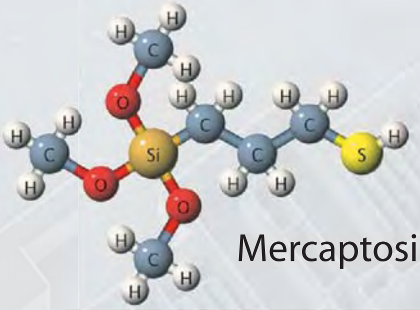

APTMS


Epoxides


DDTCS


mPEG


Methacroloxy


Mercaptosilane

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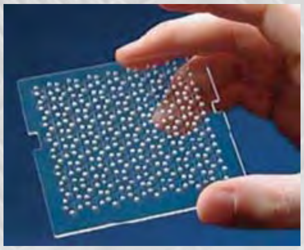
2006


Control wetting properties with MVD™


Complete, safe, low cost
MVD
with a push of a button.

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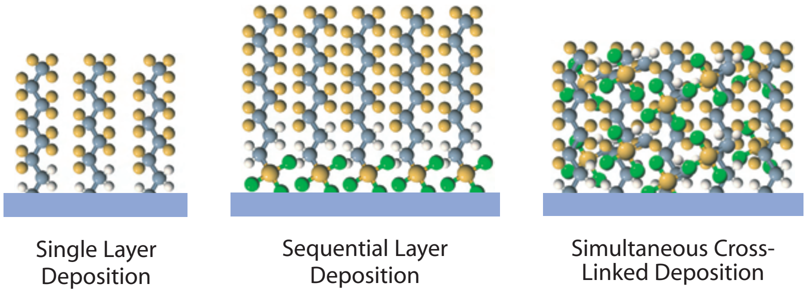
Benefits of the MVD Process

- Automated, controllable vapor deposition
- Flexible precursor chemistries
- Superior film quality (smooth, particle free)
- Tunable film properties
- Multi-layer capability with multiple precursors
- Safe, environmentally friendly
- Eliminates chemical waste stream
- Replaces wet processing (no solvents)

Examples of MVD Coatings



The MVD process offers precise control of multi-layer deposition parameters

MVD is an enhanced vapor deposition process that incorporates plasma surface cleaning and an advanced multi-precursor vapor delivery. Metered delivery of all precursors and catalytic agent vapors enables superior surface coating when compared with liquid-phase deposition. One of the most important technical benefits of using MVD is the reduction of particulates and surface roughness while retaining the desired physical and chemical properties of the coating.

The MVD-100 is able to create single and multi-layer coatings using a low temperature sequential deposition process. This results in improved film durability and surface coverage over a wide variety of substrates including glass, plastics, polymers, metals and semiconductor devices.

High Productivity and Low Cost of Ownership

The MVD-100 has been designed for automated processing in manufacturing with high throughput and process scalability. Precursor usage is greatly reduced and there are no chemicals or solvents to dispose of. This results in superior film quality at a greatly reduced cost for nano-scale device manufacturing.

Superior results for a wide range of coating applications

MEMS — Protective surface coatings reduce adhesion and stiction of displays (moving mirrors), actuators, resonators, and other MEMS sensors.

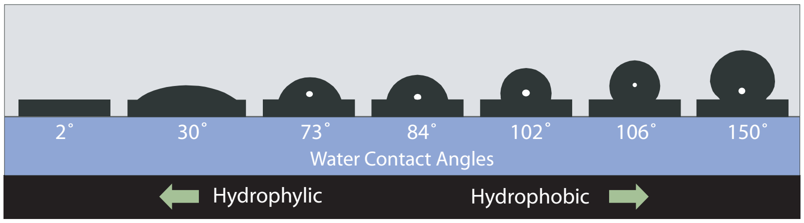
Bio-technology — MVD coatings are easily tuned from hydrophobic to hydrophilic in order to alter the wetting properties of micro channels, micro nozzles, glass slides and other substrates. Functionalized coatings enable research scientists to investigate and analyze new molecules.

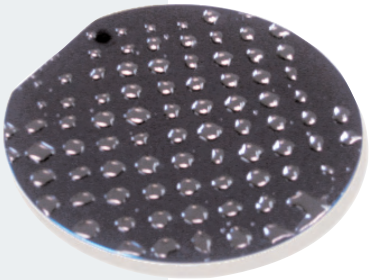
Medical Devices — Bio-compatible, wetting, and anti-fouling coatings can be used for medical tools and implants.

Lithography — Monolayer coatings act as release layers for masks and lithographic imprints.

Packaging — Hermetic moisture barrier.

Tunable Surface Properties





Water droplets on MVD Coated silicon wafer showing patterned surface with both hydrophylic and hydrophbic characteristics.

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Advanced Materials Processing
Technology Innovation of the Year Award

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MVD-100 Product Specifications

Chamber Size:	200mm Diameter x 40mm Height
Loading:	Manual
Process Modes:	Automatic and Manual
Temperature:	Controllable
Pressure Range:	≤10 Torr
Precursor Delivery:	3 Lines with Independent Vapor Metering
Precursor Usage:	Approx. 1µl per run
RF Plasma:	Remote
Deposition Modes:	Single or Multilayer
Operator Interface:	Touch-screen
Pump Size:	17 – 60 cfm (28 –100 m^3/hr.)
Footprint:	48"W x 31"D x 53"H
	(122 cm x 79 cm x 135 cm)

MVD-100 Molecular Vapor Deposition System

MVD™
MOLECULAR VAPOR DEPOSITION