

DryScrub[®], ETC.



www.DryScrub.com

DryScrub[®] System Plasma Trap

**The technology leader in particle reduction and exhaust abatement
Innovations to enhance process performance, protect equipment
and save the environment**



DryScrub[®] System 2DH

with 2nd generation Technology

The 2DH uses newly patented plasma technology which turbo charges the performance. Its compact size with ingenious design is readily adaptable for small space installations. This genuine point-of-use high performance Plasma Trap has been proven to reduce pump and valve failures, exhaust line clogging, fire and explosion hazards and airborne powder contamination. As a result system downtime and the cost of ownership are greatly improved.

Add to this the benefits of a reduction in on wafer particle counts and the abatement of >99.5% of CVD gases and >95% of PFC gasses with an annual operation cost <\$2,000, it can be seen that this system offers benefits at many levels.

Specifications*

CHAMBER:

Operating Pressure - 5 to 10,000Pa (37 to 75,000 mTorr)
Dimensions: 420 mm H x 290 mm W x 290 mm D
Mating Flange, Top and Bottom: ISO80 Bolt/Clamp Flanges
Flange to Flange separation: 350 mm
Clearance: Top and Bottom 10 mm; Side 5 mm
Front Clearance for Service 300 mm H x 310 mm W x 300 mm D
Weight: Removable Center Cylinder: 5.2 kg, Top / Bottom plates: 8.8 kg
Chamber Mounting Bolts: M8 (Metric Bolts)
Installation Orientation: Any Orientation

ELECTRODE: (New Patent Application)

Material 36L Stainless steel (reusable)
Weight: Empty Approximate 8 kg
Loaded - to 2 to 20 kg additional waste - process dependent.
Dimensions 254 mm OD x 300mm H.
Electrode Surface Area > 2.7 M²
Solid Waste Volume > 2,000 cm³
Operating time between cleanings - process dependent, 1 to 12 Months
Reusable - In-situ Etch Cleaning or External Cleaning

RF POWER SUPPLY: PS 1500

Dimensions, 177 mm H x 292 mm W x 464 mm D.
Weight = 13 kg.
Line = 208 V, Single Phase, 60/50 Hz, 25 Amps (P.F. 0.72x).
Load Power: 1500 watts

* Subject to change without notification



DryScrub[®], ETC.

1751-D Fortune Drive, San Jose, CA 95131, USA

Fax: 408-744-0446. Tel: 408-379-7278; 408-DryScrub

Toll Free: 1-888-379-7278; 1-888-DryScrub

www.DryScrub.com Email: Sales@DryScrub.com

DryScrub is a Registered Trademark of DryScrub[®], ETC

DryScrub[®] patents are held in the United States, and other countries around the world.
US Patent number 4,735,633 was issued on April 5, 1988, and Patent Application number 09,553,696 on April 21, 2000.



PECVD problems dealt with today.

As geometries become smaller, yield requirements are harder to achieve and equipment up time becomes more critical.

Electrochemical Technology Corporation has developed the DryScrub[®] system to reduce these problems.

Particles

With the decrease in linewidth size, particles become a more critical problem. In order to gain the correct process results in any CVD deposition, only about 5-20% of the gas is used to grow the film, the rest of this activated but undeposited gas flows through the system. Consequently any areas of the pumping system where similar conditions to the process tube exist are areas in which further deposition will take place.

When the 'waste' gases react in the vacuum plumbing away from the process area there is less control of conditions and nano-metre sized molecular particles can form. Although the general flow of the gases is towards and through the pump these very small particles, because of their nano-metric size and high energy/weight ratio, are able to migrate back into the process area where they can deposit on wafers and the process chamber walls. Work has been carried out which suggests that these small particles also act as seeds upon which bigger "particles" grow (coagulation).

Larger particles not only cause defects on the wafer but also in the films that deposit on the process chamber wall. These particles may cause the premature build up of stresses in these films that can lead to flaking and as a consequence, a more regular regime of process chamber cleaning is required.

Vacuum System

As the gases reach the pump they effectively enter another "process area", here adiabatic compression causes the gases to react and further deposition takes place on the walls and rotors of the pumping chambers. Because the pump is a CVD reactor, this build up continues at all times that the deposition process gas is flowing. Vacuum Pumps requires clearances to operate correctly and as the deposition takes place so these clearances are reduced leading ultimately to higher current consumption and eventual failure of the pump.

Clogging

The gases that have not reacted out after this stage flow through the exhaust system to any down line gas cleaning equipment. This down line equipment requires maintenance as the elements within the equipment start to clog. Some residual gases may pass through these systems and make their way into the environment.

The Solution

ETC has developed a proven solution to address these problems. The ETC Dryscrub[®] is a PECVD reactor placed in the vacuum line downstream of the process chamber and before the vacuum pump.

The Dryscrub[®] is effective in reacting the gases through to completion with an efficiency of at least 99.5% for most processes. The Dryscrub[®] consists of a vacuum chamber and electrode that has been constructed to give both spiral and cross-flow patterns of gas flow. As the gases pass through the plasma the deposition of a compressive stable film is made on the Dryscrub[®] electrode.

Due it's design, the Dryscrub[®] is transparent in operation. It has no effect on the process or upon the gas flows and pumping rates within the vacuum system thus leaving the current processing parameters unaffected.

By reacting the gases with an efficiency of >99.5% the Dryscrub[®] has a significant impact on increasing yield and decreasing equipment downtime by:-

1. Capturing nano-metric sized particles on the electrode - preventing them from migrating back into the process area.
2. Removal of reactive gasses - so increasing wet and dry pump reliability and period between maintenance events.
3. Easing of requirements for maintenance on downstream treatment and scrubbing equipment.
4. The reduction of gases vented to atmosphere where no other downstream equipment is used.

Benefits

ETC Dryscrub[®] provides a solution which:-

1. increases yields by reducing particles on the wafer
2. longer quartzware lifetime due to reduced cleaning requirements
3. decrease in pump and downstream gas treatment maintenance requirements
4. allows easier conformance with today's stringent environmental standards.

There are many benefits in using the DryScrub System to abate exhaust gases:

Benefits to the Equipment Engineer:

- Vacuum System. The DryScrub protects the ALL of the vacuum system.
- Process Chamber. Reduces the cleaning requirement for chamber, boats and liners.
- Vacuum Control Valves. With much less deposition on these items, they function at optimum performance for a longer period.
- Vacuum Lines. Reduces deposition in the lines minimising the requirement for cleaning/replacement and associated vacuum integrity problems.
- Vacuum Line Heating. The DryScrub usually eliminates the requirement for heaters, this has the effect of reducing maintenance time (no heaters) and eliminating the costs of running the heaters.
- Vacuum Pump. Longer service times without failure, virtually no need for frequent overhauls.
- N2 Purge. Pump purge can be reduced saving N2 and the pumping speed is increased.
- Safety. Toxic and fire hazards from the waste powders are reduced or eliminated resulting in safer conditions and less mess to clean up during maintenance.
- Stable performance. Because clogging, powders and secondary deposition are reduced the system operates at optimum performance for longer periods of time. Maintenance requirements are reduced with the associated qualification times.

Benefits to the Process Engineer:

- System Up-time increased. More time available for production as maintenance time is reduced.
- Stable Process. System more stable due to less maintenance events and less chance of in-process aborts.
- Particle Counts. The particle count is substantially reduced giving improved wafer yields and an associated reduction in tracing particle 'sources'.
- Process Drift. Deposition on the chamber walls, chuck, boats, etc. is reduced. The deposited film is also more stable allowing thicker films before cleaning is required to prevent particle problems occurring.
- Reduced Qualification time. Fewer maintenance events mean fewer qualification runs.
- Fewer Qualification runs. Reduced monitor wafer costs e.g. an LPCVD Vertical furnace requires only the top and bottom wafers instead of the usual three to five wafers. Measurement time for the monitor wafers is reduced.
- Reduced bad runs. Reduced maintenance events ensure the probability of in-process aborts or out of bound contamination levels is reduced. Less maintenance events – less failures in the system.

Benefits to the Safety and Environmental Engineer:

- Pyrophoric and Toxic Hazards. These are substantially reduce (>100X in terms of concentration and volume) as DryScrub abates and scrubs the exhaust gasses at the point of use, immediately adjacent to the process chamber and before the pump. No other currently available system can make this claim
- Volume of Dust. Because the DryScrub produces stable films on abating the gasses the volumes of pyrophoric, acidic and toxic dust is substantially reduced, often to the point of using a dust mask instead of breathing apparatus during maintenance events.
- Gas Alarms. Due to the 'point of use' abatement the amount of toxic gasses in the exhaust is greatly reduced so reducing the chance of a Toxic Gas Alarm.
- Operating principles. Other scrubber systems essentially use 'dilution' methods to treat the gasses, DryScrub is an extraction and reduction method.
- Facility Evacuation costs. Due to the greatly reduced chances of an evacuation due to fire or toxic gases on systems where the DryScrub is used, fab running costs are also reduced.
- Insurance. Many companies due to poor fire safety record has difficulty to get insurance and are paying an extra premium. DryScrub substantial reduces the fire hazard may help to reduce the insurance cost. The saving in the insurance cost could buy many DryScrub Systems.

Benefits to the Production Manager:

- Reduced Running Costs. System downtime can cost between \$2,000/day to \$4,000/day. DryScrub can cut such system down days by a factor of 2X to 10X.
- Particles. Every particle on a wafer can cost an equivalent of \$1.00 loss in the wafer yield. DryScrub can reduce particles by between 10X and 100X
- Process Stability. In-process aborts and out of specification runs are substantially reduced.
- More Reliability. Production throughput can be predicted more reliably.
- Increased Productivity. Fewer tools, less maintenance, less qualification time, fewer personnel required.

Benefits to the Facilities Manager:

- Pyrophoric and Toxic Gasses. These gasses are abated at the point of use. Exhaust and Duct lines contain less hazards.
- Scrubber loading. The load on any exhaust scrubber is substantially reduced (by a factor of >100X).
- N2. The N2 purge to the pump can be reduced. Using a saving of 25 SLM:
 $25\text{SLM} \times 60\text{min} \times 24\text{hour} = 36,000\text{ L} = 36\text{ M}^3/\text{day} - \text{about } \$10/\text{day OR } \$3650/\text{year}.$
- Exhaust Lines. The exhaust line clean up and replacement is virtually eliminated.
- Power Savings. In most processes there is no requirement for heating vacuum lines with the resulting savings (on average about \$10.00 per day per line or \$3,650 per year per line).
- Exhaust Line runs. The DryScrub can eliminate the need for any exhaust scrubber, this can result in much shorter runs.
- The DryScrub does not require any floor space

Benefits for Corporate Management:

- Green Issues. As the DryScrub abates and scrubs the exhaust gasses at the point of use the toxic loading of these gasses is reduced by a factor of >100X
- Productivity. The DryScrub reduces system downtime and maintenance frequency, it has been demonstrated that three tools with DryScrub fitted can have more productivity than four tools. This has saving implications for capital expenditure, facility layout, and manpower costs. The Cost of Ownership is greatly reduced and the Return on Investment is rapid
- Reliability. Evaluation by Customers show that the DryScrub improves reliability in the production process.
- Other Benefits. The more stable process and reduction of particles gives the user an effective upgrade to their existing tools. Time spent in implementing new and different tools along with their spares requirements reflects in both Process and Maintenance budgets

Exhaust Management System Comparison

Generic Reactor type	Exmpls of Type	Operation principle	Install location	Operation pressure	No.of Process Systems serviced	Hydride gas abatement efficiency	Hydride gas by-products	Pure PFC gas abatement efficiency	PFC gas by-products	Both Hydride and PFC in PECVD process	By-products in PECVD Process	Maintenance	Maintenanc e frequency
Plasma reactor	DryScrub 2DH	Plasma enhanced surface reaction	Before the valves and pump. Removes waste closest to source.	Under vacuum	1	>99.5%	Solid oxide film deposited on electrode	>85%	CF, and F radicals	>99.5% hydride >90% PFC, SiF4 formed	SiF4 gas 50% (water soluble), dense white solid film, water treatable CF, F radicals	Replace electrode or clean reusable electrode	Every 3 to 12 months
Flame burner	Guardian	Open flame burning with H2, natural gas, LPG	After the pump	Atmospheric pressure	1 to 4 (process dependent)	>90%	Foamy Pyrophoric Brown Powder	>90%	HF, NOx, CO2	>90% hydride >90% PFC	Foamy brown powder, white powder, HF, NOx, CO2, CF radicals	Sweep clean brown powder and clean downstream exhaust lines to prevent blockage	Every 2 to 3 weeks
Dry acid neutralizer	GRC	Hot granular rock surface chemical reaction	After the pump	Atmospheric pressure	1 to 4 (process dependent)	Rapid decay from >90% (reaction surface becomes saturated). No Abatement	Foamy Pyrophoric Brown Powder	Marginally reacted, <5%	PFC - no reaction	PFC passes through without reaction	Foamy brown powder, white powder, PFC	Replace and dispose reactor tank, clean downstream exhaust lines to prevent blockage	Every 1 to 3 weeks
Adsorber	CS Clean, Novapure	Physi- or chemi-sorption of the gases but without abatement	After the pump	Atmospheric pressure	1 to 4 (process dependent)	Rapid decay from >90% (reaction material becomes saturated). No Abatement	Foamy Pyrophoric Brown Powder	Rapid decay from >90%. No abatement.	PFC - no reaction	PFC passes through without reaction - Hydride spoils adsorber for PFC's	Foamy brown powder, white powder, PFC	Replace and dispose adsorber tank, clean downstream exhaust lines to prevent blockage	Every 2 to 3 weeks
Air mixing oxidizer	PCS	Mixing hydride gas with air for pyrophoric reaction	After the pump	Atmospheric pressure	1 to 4 (process dependent)	>90%	Micron size silicone dust - easily disperse in air	0%. No abatement.	PFC - no reaction	PFC passes through without reaction	Silicone dust, white powder, PFC	Vacuum dust, clean downstream exhaust lines to prevent blockage	Every 1 to 2 months
Heat transfer reactor	CDO	By contact or radiant heat transfer, thermal reaction	After the pump	Atmospheric pressure	1 to 4 (process dependent)	Rapid decay from >90% (reaction surface becomes saturated)	Foamy Pyrophoric Brown Powder	Marginally reacted, <5%	PFC - no reaction	PFC passes through without reaction	Foamy brown powder, white powder, PFC	Sweep clean brown powder and clean downstream exhaust lines to prevent blockage	Every 1 to 2 weeks

Exhaust Management System Comparison

Generic Reactor type	Exempls of Type	Foot print + service area; Facility space cost (\$200/ft2/yr)	*** Estimated Annual operation cost per line	Initial installation cost per exhaust line	Estimated First year total costs	Cost breakdown: U=utility; A=acid neutralizer; L=labor cost; C=consumable parts; F=fuel;	Process system impact	Facility impact	Environmental impact	Comments
Plasma reactor	DryScrub 2DH	0 foot print, installed on top of the pump	<\$2,000/line	\$35,000/line	\$37,000/line	30%U 50%L 20%C	Improvement. Patented high vacuum conductance electrode, transparent to the system. Improves wafer yield by reducing particle count. Reduces system down time by reducing vacuum component failures.	None/Improved. Load to existing Water Scrubber reduced.	Improved significantly. Highly efficient concentration process. Small quantity of by-products produced	Reasonable first year cost. Extremely low long term COO. Highest efficiencies. Lowest facility and environmental impacts. System operates individually, will not cause multiple system down
Flame burner	Guardian	12ft2 + 10 ft2; \$4,400/yr	>\$30,000/line	~\$15,000/line	\$45,000/line	12%U 10%L 5%A 8%C 65%F	None. But when the scrubber down, all linked process systems down.	Large water scrubber and large wet acid neutralizer are needed	Dilution process, large quantity of waste acidic gases	High first year cost. High long term COO. Fuel cost is extremely high. Generates large quantity of NOx and CO2. Overloads facility exhaust system.
Dry acid neutralizer	GRC	6 ft2 + 8 ft2; \$2,800/yr	>\$25,000/line	~\$20,000/line	\$45,000/line	5%U 10%L 85%C	None. But when the scrubber down, all linked process systems down.	Clogging of downstream exhaust lines.	Large quantity solid waste, disposal problem. PFC not abated	PFC not abated. High first year cost. High long term COO. Generates large quantity of waste solid.
Adsorber	CS Clean, Novapure	6 ft2 + 6 ft2; \$2,400/yr	>\$30,000/line	~\$20,000/line	\$50,000/line	5%U 10%L 85%C	None. But when the scrubber down, all linked process systems down.	Clogging of downstream exhaust lines.	Disposal of spent solid. Gases are easily re-released by secondary service provider	Very high first year cost. High long term COO. Generates large quantity of waste solid. Can not be used with both hydride and PFC gases. Not suitable for PECVD process
Air mixing oxidizer	PCS	6 ft2 + 6 ft2; \$2,400/yr	>\$12,000/line	~\$12,000/line	\$24,000/line	20%U 15%L 50%N 10%C	None. But when the scrubber down, all linked process systems down.	Large water scrubber and large exhaust ducting are required	High volume air flow carries micron sized silicone dust particles to the outside environment. PFC not abated	PFC not abated. Low first year cost. Medium long term COO. High N2 consumption. Potential health hazard for the dispersed silicon dust.
Heat transfer reactor	CDO	8 ft2 + 8 ft2; \$3,200/yr	>\$16,000/line	~\$8,000/line	\$24,000/line	40%U 50%L 10%C	None. But when the scrubber down, all linked process systems down.	Clogging of downstream exhaust lines.	PFC not abated	PFC not abated. Low first year cost. Medium long term COO. High fire and explosion hazard. Serious exhaust duct clogging problem. High maintenance cost and hazard.

***Costs for loss of production due to Equipment Downtime have not been accounted for.

Exhaust Management

THE ENVIRONMENT

