

Pre-epitaxy Deposition Etch

Silicon epitaxial layers are typically grown on mirror-like polished wafer surfaces. To ensure good quality epitaxial growth, scratches and any residual contaminants on the wafer surface must be removed first. A high-temperature hydrogen chloride (HCl) vapor phase etching process is used for this purpose. Moisture (H₂O) in the HCl gas is detrimental to the silicon wafer etching process; even trace levels can reduce etching selectivity. When the appropriate point-of-use (POU) purifier is used, the gas will be very pure, providing a defect-free silicon surface.

Moisture in HCl gas causes wafer surface defects and delivery system corrosion

Oxygen atom contamination, of which moisture is a primary source, can cause defects that promote polycrystalline growth of subsequent layers, rather than single crystal growth. Oxygen atoms can slow down devices by occupying sites in the structure and by limiting the free flow of electrons.(1)

Small amounts of water in the HCl gas can corrode the HCl delivery system. Corrosion can be severe at the pressure regulator, especially under high flow and high pressure drop conditions. Data indicates that a moisture contamination level as low as 1 ppm can cause problems in the gas distribution system and in the semiconductor manufacturing process.(2)

Pall purifier surpasses requirements for POU purification of HCl gas

The Gaskleen® purifier assembly has been designed to surpass the stringent requirements for point-of-use HCl purification. Key features include moisture removal to ≤ 15 ppb, room temperature operation, an integral metal particle filter, and no detectable metal contribution.

Moisture removal and room temperature operation

To prevent the deleterious effects of moisture contamination, the Gaskleen purifier is designed with Pall's AresKleen™ HCLP

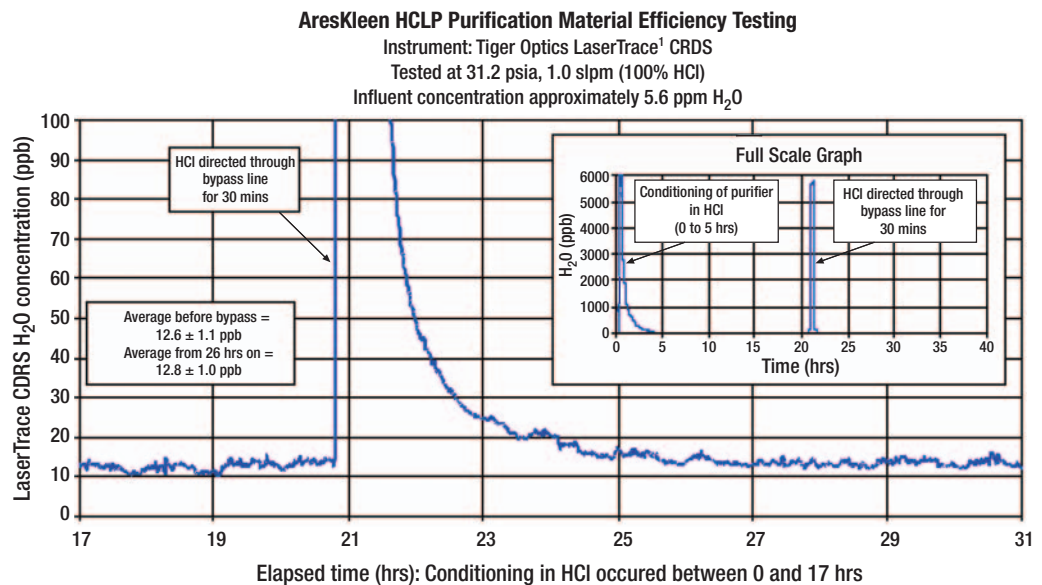


Figure 1. Typical moisture removal levels achieved using Gaskleen purifiers in HCl gas service (as monitored by CRDS)

¹ LaserTrace is a trademark of of Tiger Optics, LLC.

purification material. Analysis using a cavity ring-down spectrometer (CRDS) has demonstrated that this medium removes moisture to < 15 ppb in HCl gas. (See Figure 1.) This removal rating can be achieved during operation at room temperature.

Integral metal particle filter

The Gaskleen purifier is equipped with an integral stainless steel filter that removes particles > 3nm.

Metal contribution

To determine metal contribution of a Gaskleen purifier, a gas stream was passed through the purifier (after conditioning) and bubbled into deionized (DI) water. The sample gas was hydrolyzed and the resultant HCl acid solution was analyzed using an inductively coupled plasma mass spectrometer (ICP-MS). Test data indicates that Gaskleen purifiers do not contribute metal contaminants to the process stream. (Refer to Table 1.)

Gaskleen purifier provides key benefits in pre-epitaxial etching process

Certain attributes of Gaskleen purifiers provide distinct benefits in pre-epitaxial hydrogen chloride etching applications. (Refer to Table 2.)

Table 1. ICP-MS data indicating no detectable metal contribution at trace levels to purified HCl gas

Metal	W/O Purifier (ppb)	With Purifier (ppb)	LDL (ppb)
Be	<LDL	<LDL	2
B	<LDL	<LDL	3
Na	<LDL	<LDL	2
Mg	<LDL	<LDL	2
Al	<LDL	<LDL	4
K*	5	5	2
Ca	<LDL	<LDL	4
Ti	<LDL	<LDL	2
V*	4	<LDL	4
Cr	<LDL	<LDL	1
Mn	<LDL	<LDL	2
Fe*	7	<LDL	2
Co	<LDL	<LDL	1
Ni	<LDL	<LDL	1
Cu	<LDL	<LDL	2
Zn	<LDL	<LDL	8
Mo	<LDL	<LDL	2
Ag	<LDL	<LDL	9
Cd	<LDL	<LDL	2
Ba	<LDL	<LDL	3
TI	<LDL	<LDL	2
Pb	<LDL	<LDL	9

LDL = lower detection limit

* = metal levels within experimental error (with and without purifier)

Table 2. Attributes and benefits of the Gaskleen purifier assembly

Attributes	Benefits
Removal of moisture to low levels	Prevents defects that promote polysilicon growth and distribution system corrosion
No detectable contribution of metal contaminants	No metal oxide defects on the water surface or shorts in the circuitry
Room temperature operation	Eliminates the need for external heating or cooling sources, resulting in a lower cost of ownership
Integral metal particle filter	Provide particle removal and eliminates the need for an additional component in the system



Gaskleen purifier recommendations

- Mini Gaskleen® purifier, P/N GLPHCLPVMM4: Rated for 1 slpm, ¼" gasket seal (VCR² compatible) connections. (Refer to the product data sheet at <http://www.pall.com/pdf/A79.pdf>)
- Gaskleen® II purifier, P/N GLP2HCLPVMM4: Rated for 3 slpm, ¼" gasket seal (VCR compatible) connections. (Refer to the product data sheet at http://www.pall.com/pdf/A88_Gaskleen_II_Purifier.pdf)
- Gaskleen® ST purifier, P/N GLP5HCLPVMM4: Rated for 5 slpm, ¼" gasket seal (VCR compatible) connections. (Refer to the product data sheet at <http://www.pall.com/pdf/A87.pdf>)
- Gaskleen® 1½" C-seal purifier, P/N GTMP3HCLPCC4: Rated for 3 slpm, C-seal 1½" interface connections. (Refer to the product data sheet at <http://www.pall.com/pdf/A86.pdf>)

² VCR is a trademark of Swagelok Co.

References

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2. E. Flaherty, C. Herold, J.Wojcicki, D. Murray, A. Amato, S. Thomson. (1987). Reducing the Effect of Moisture in Semiconductor Gas Systems. Solid State Technology, (July, 1987) pp. 69-75.



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