PALL

Microelectronics

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Application Bulletin

Removal of Siloxane Impurities From Silane Gas in the Silicon Epitaxy Process

Epitaxy is a chemical vapor deposition (CVD) process used in the fabrication of semiconductors. Circuits are built on a thin, lightly doped epitaxial layer over a heavily doped substrate. The elimination of impurities such as oxygen and moisture in the epitaxial layer allows the subsequent doping process to be well controlled.

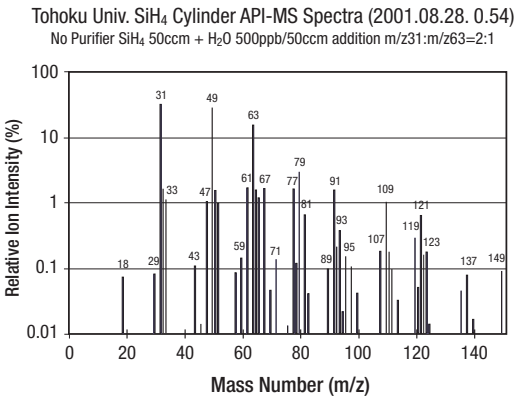
Contamination in silane gas leads to on-wafer defects

Silane (SiH_4) gas is the primary chemical vapor source used in commercial silicon epitaxial deposition. Contamination in the silane such as moisture, siloxanes, and particles can lead to yield-reducing defects on the wafer surface. When moisture is present in the silane gas, the moisture and silane can react, resulting in the formation of silicon dioxide (SiO_2) nuclei. These nuclei tend to condense to form siloxane molecules, which can combine to form particles.[1]

Particles generated in the delivery line are typically removed with standard Pall gas filters. However, the presence of moisture can also result in particles forming downstream of the filter, requiring an alternative approach to producing virtually particle-free gas. The Gaskleen® purifier assembly with SIP purification material can resolve these issues.

Gaskleen® purifier reduces siloxane levels in silane gas

Siloxane removal testing was performed at Tohoku University with an atmospheric pressure ionization mass spectrometer (APIMS) to determine the benefit of using a Pall purifier with SIP purification material in silane gas delivery systems. Analysis was conducted in silane that was purified, then spiked with 500 ppb of moisture. This was done to insure a known level of moisture in the test gas. APIMS spectra were obtained on the test gas both with and without the Pall purifier. Results indicated a reduction in levels of siloxane species when a Pall purifier was used (see Figures 1 and 2).



Silane: m/z 31 and 63 (SiH_3+ and SiH_4-SiH_3+)
Siloxane: m/z 77 and 109 (SiH_3OSiH_2+ and (SiH_3)2O-SiH_3+)
Disilane: m/z 61 and 93 (Si_2H_5+ and SiH_4-Si_2H_5+)

Figure 1. APIMS reading of siloxane impurities without purification

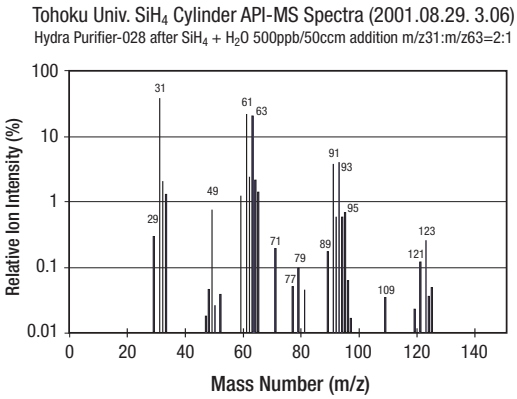


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Figure 2. APIMS reading of siloxanes with purification

1 "Elimination of siloxane impurities from silane process gas using next-generation purification". B. Gotlinsky, J. O'Sullivan, S. Babasaki. Micro, July / August 2000.

Filtration. Separation. Solution.℠

A major DRAM manufacturer used a KLA-Tencor surface scanner to detect the presence of particles in the 0.1 µm – 0.2 µm range that may have formed and deposited on the wafer. Counts were taken before and after the installation of a Pall purifier. Results show a significant reduction in the number of particles on the wafer surface when a purifier is used in silane gas (see Figure 3).

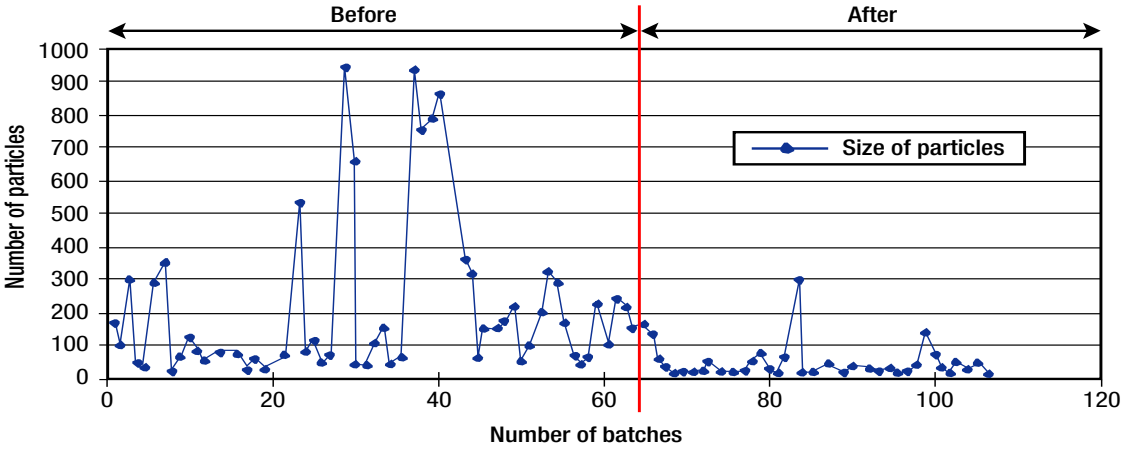


Figure 3. Wafer counts of 0.1 µm – 0.2 µm particles, with and without the purification of the silane gas.

Pall purifier surpasses stringent requirements for POU filtration of silane gas

Purification of silane gas during the silicon epitaxy process ensures the highest quality of epitaxial films. The Gaskleen purifier assembly with SIP purification material provides process benefits over the use of a stand-alone point-of-use (POU) filter in silane gas.

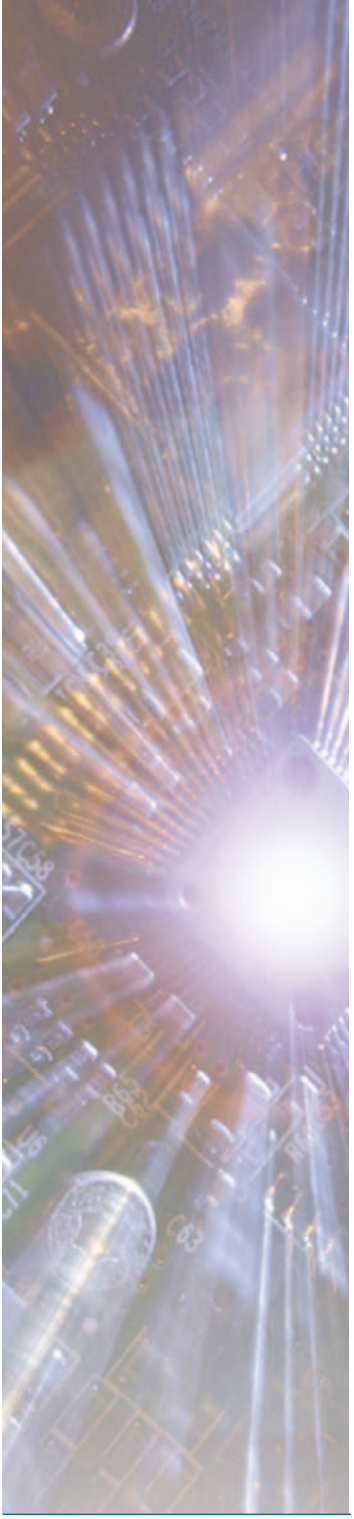
Process benefits

The Gaskleen purifier with SIP purification material has been shown to remove siloxanes to low levels in process gas. The result is minimal detrimental particles in the distribution system and on the wafer surface.

Product features and benefits

Specific features of the Gaskleen SIP purifier have associated benefits over other commercially available technologies.

Feature	Benefit
Inorganic substrate	Provides good stability during operation
Room temperature operation	Eliminates the need for heating or cooling sources
Purification process works through chemisorption	Contaminants are strongly bound to substrate
Small, uniform substrate	Allows for a tightly packed bed that a) enables the purifier to be installed in either the horizontal or vertical position (orientation insensitive) b) provides sharp breakthrough and accurate estimate of purifier's service life
Integral 3 nm metal filter	Removes particles that lead to yield-reducing defects



Recommended Gaskleen purifiers

Mini Gaskleen purifier, P/N GLPSIPVMM4: Rated for 1 slpm, ¼″ gasket seal (VCR* compatible) connections. (Refer to the product data sheet at http://www.pall.com/pdf/A79.pdf)

Gaskleen II purifier, P/N GLP2SIPVMM4: 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 GLP5SIPVMM4: 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 1⅛″ C-seal purifier, P/N GTMP3SIPCC4: Rated for 3 slpm, C-seal 1⅛″ interface connections. (Refer to the product data sheet at www.pall.com/pdf/A86.pdf)

Larger flow purifiers are also available. Please visit www.pall.com for further details.

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