

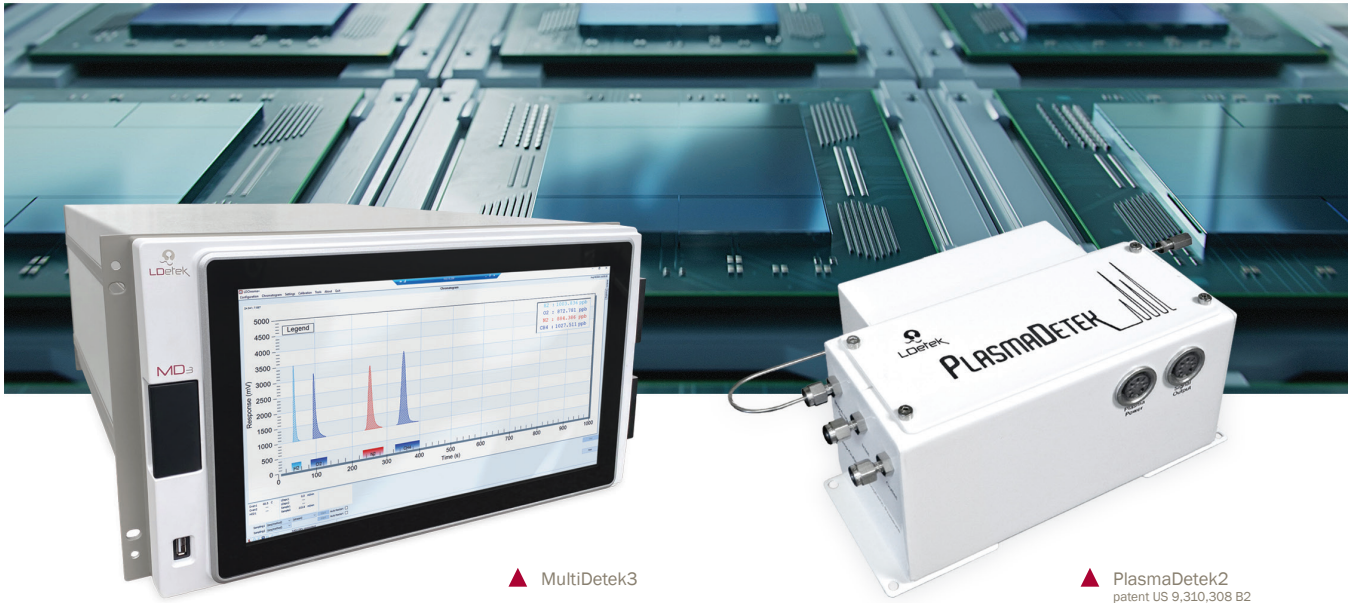
APPLICATION NOTE

LD24-01

PST
PROCESS SENSING
TECHNOLOGIES


LDetek
A PST BRAND

Analysis of trace impurities in UHP Silane



A silane semiconductor is a type of semiconductor that is composed of silicon and hydrogen atoms. It has the distinction of being one of the most stable known compound semiconductors. Its relative simplicity, stability and cost-effectiveness make it an ideal choice for a wide range of electronic applications, including transistors, memory chips, integrated circuits, photodetectors and solar cells.

The use of silane has become increasingly popular in the world of electronics due to its impressive capability. This type of silane allows component manufacturers to produce components that are smaller and faster than ever before, allowing them to create highly advanced electronic devices.

The leading manufacturers of silane semiconductors are a relatively small, but prestigious group. Intel Corporation, Renesas Technology and Texas Instruments lead the way in producing top-tier products with silane semiconductors. Other electronics firms such as KLA Corporation, AMD and 3M have successfully implemented their own processes for production utilizing this type of technology.

LDETEK SOLUTION

The purity of silane can be qualified with the use of the MultiDetek3 gas chromatograph configured with PED.

The unit is configured with a measuring range of 0-10ppm and Idl of 5-10ppb for impurities H₂-(Ar+O₂)-N₂-CH₄-CO₂-CO-C₂H₆-C₃H₈-SiCl₄-SiH₂Cl₂-H₆Si₂-SiH₃Cl in a sample gas UHP silane(SiH₄). The PED (plasma emission detector) has been mounted in the GC to measure the ppb impurities in UHP silane using Helium as carrier gas. All previously listed impurities are measured within one single analyser.

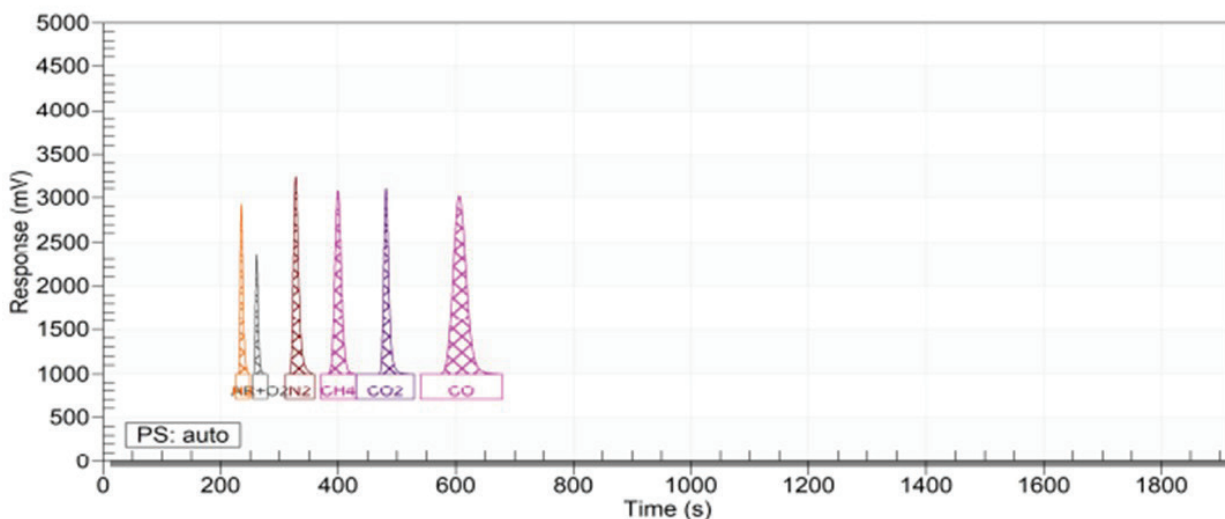
As the silane is highly flammable and pyrophoric, our GC configuration offers here a specific configuration of the sample flow path. A multiport selection valve mounted in a purged box which is purged with the helium carrier gas ensures the sample is not in contact with its surrounding air. The selection valve ensures to minimize the period which the silane is going into the injection's valves and the sample loops. A specific sequence is configured to have mostly helium in the GC sample flow path with a small period having the silane filling the sampling loops for proper analysis. The sequence is built in consequence to properly purged the loops prior to fill with silane.

This solution offers the GC to have an improved safety level and have an extended lifetime due to the limited time of the components in contact with silane.

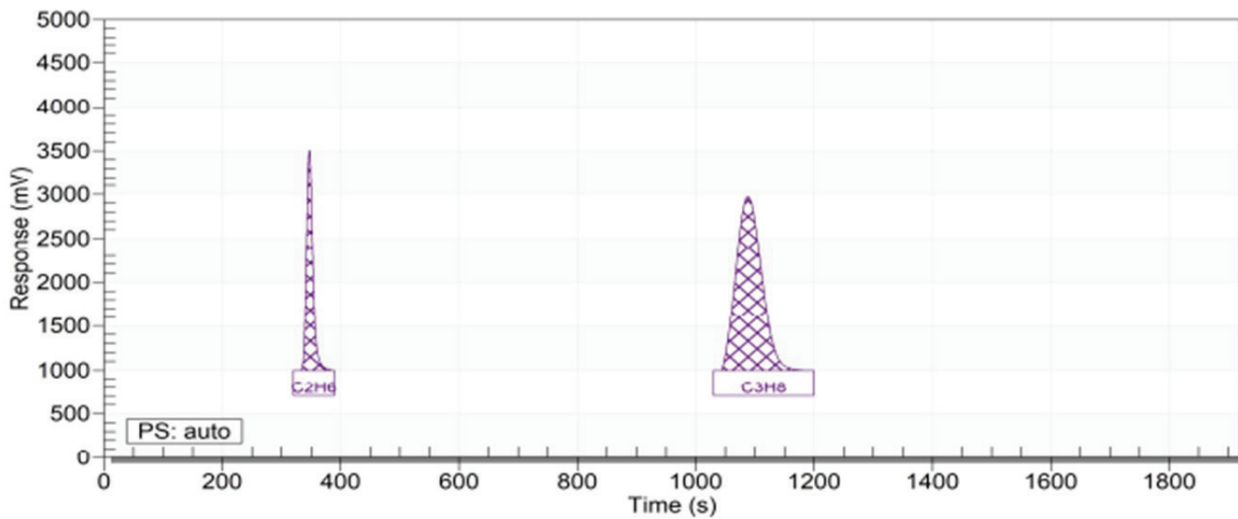
Other configurations and ranges/Idls are possible. The parameters mostly depend on the site production requirements and process.

RESULTS

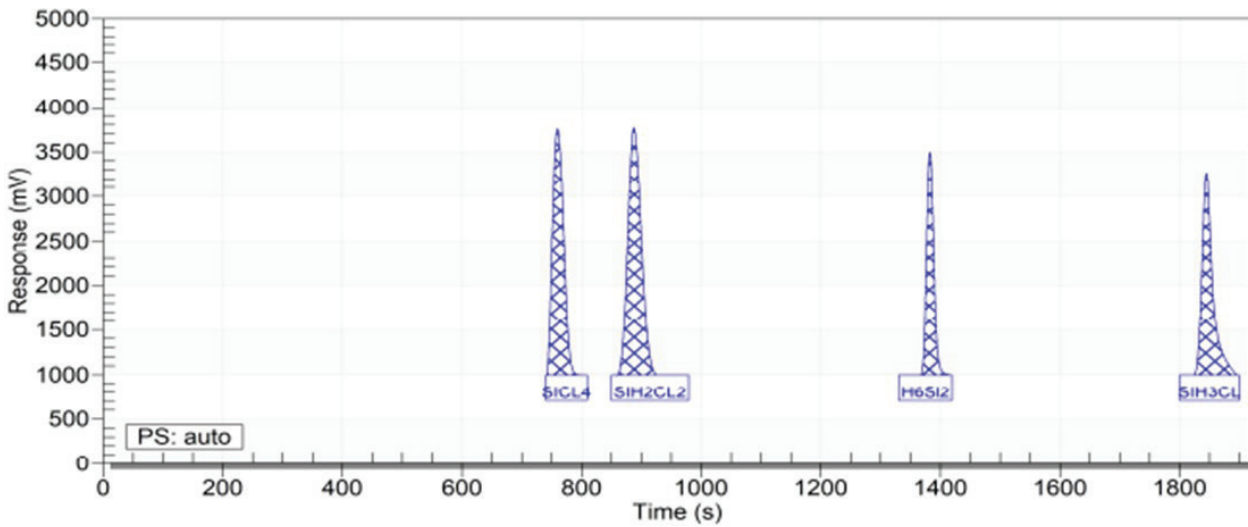
A series of chromatograms (Span calibration) of trace impurities H₂-(Ar+O₂)-N₂-CH₄-CO₂-CO-C₂H₆-C₃H₈-SiCl₄-SiH₂Cl₂-H₆Si₂-SiH₃Cl in balance gas UHP Silane (SiH₄)



| Peak | Unit | Calibration Value | _Area Counts |
|-------------------|------|-------------------|--------------|
| H ₂ | ppm | 10.00 | 6678 |
| AR+O ₂ | ppm | 5.19 | 5433 |
| N ₂ | ppm | 9.14 | 24090 |
| CH ₄ | ppm | 9.94 | 51661 |
| CO ₂ | ppm | 9.75 | 12089 |
| CO | ppm | 9.91 | 58055 |



| Peak | Unit | Calibration Value | _Area Counts |
|------|------|-------------------|--------------|
| C2H6 | ppm | 10.00 | 29092 |
| C3H8 | ppm | 10.00 | 52059 |



| Peak | Unit | Calibration Value | _Area Counts |
|---------|------|-------------------|--------------|
| SiCL4 | ppm | 10.00 | 16831 |
| SiH2CL2 | ppm | 10.00 | 1294 |
| H6Si2 | ppm | 10.00 | 15842 |
| SiH3CL | ppm | 10.00 | 3508 |

Limit of detection (based on 3 times the noise level from a blank)

| COMPONENTS | CONCENTRATION (ppm) | PEAK HEIGHT | NOISE | LDL (3X NOISE) |
|-------------------|----------------------------|--------------------|--------------|-----------------------|
| H2 | 10.0 | 1922mV | 0.43mV | 6ppb |
| Ar+O2 | 5.19 | 1410mV | 0.36mV | 4ppb |
| N2 | 9.14 | 2291mV | 0.51mV | 6ppb |
| CH4 | 9.94 | 2095mV | 0.59mV | 8ppb |
| CO2 | 9.75 | 2133mV | 0.48mV | 7ppb |
| CO | 9.91 | 2032mV | 0.46mV | 7ppb |
| C2H6 | 10.0 | 2500mV | 0.51mV | 6ppb |
| C3H8 | 10.0 | 2000mV | 0.47mV | 7ppb |
| SiCl4 | 10.0 | 2788mV | 0.49mV | 5ppb |
| SiH2Cl2 | 10.0 | 2795mV | 0.37mV | 4ppb |
| H6Si2 | 10.0 | 2500mV | 0.47mV | 6ppb |
| SiH3Cl | 10.0 | 2300mV | 0.69mV | 9ppb |

Note: other LDL could be obtained with different injection volume and chromatographic condition.

Repeatability: Based on the GC standards. Using 6 of 10 consecutive runs, being lower than 5% of 3*CV%

Linearity: Based on the GC standards. A linear curve having its R2 at a value between 0.998 and 1.00.

Accuracy: Based on the GC standards. <= 1% of error or Idl whichever is higher

The MultiDetek3 detailed in this application note complies with the previously listed repeatability/linearity and accuracy standards.

CONCLUSION

The MultiDetek3 configured with the PED module offers a good analytical solution for trace ppb/ppm impurities for the validation of the quality and the production for semiconductor Silane. The gas chromatograph is configured with standard industrial communication protocols and a remote-control interface. Due to its high sensitivity plasma emission detector, measuring trace impurities with the MultiDetek3 gas chromatograph down to sub ppb is perfectly suitable for the semiconductor silane. The MultiDetek3 is a very robust gas analyzer configured for industrial market to run 24/7. Combined with the other LDetek accessory modules, it fits the complete application requirements of the industry.

