

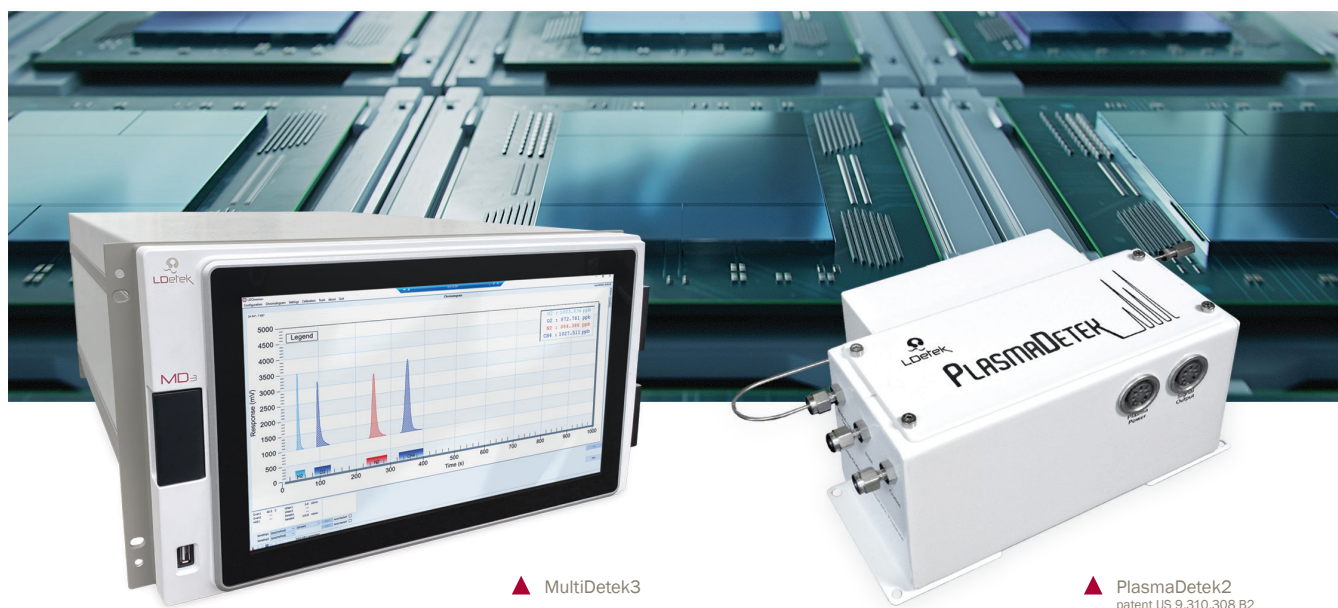
APPLICATION NOTE

LD23-07

PST
PROCESS SENSING
TECHNOLOGIES

LDetek
A PST BRAND

Analysis of trace impurities in UHP Xenon



▲ MultiDetek3

▲ PlasmaDetek2
patent US 9,310,308 B2

The Xenon is the most valuable rare gas on earth which is generally produced from large oxygen plants by ASU. In today's world, the semiconductor industry is now the largest consumer of rare gases, and the industry spent approximately \$1bn on its purchases of neon, krypton and xenon for key applications in the fab. Xenon and krypton are mainly used in the most challenging high-aspect-ratio etch applications in advanced 3D NAND memory devices. There appear to be no alternatives to these gases in this application. Neon is critical in excimer lasers for KrF and ArF lithography systems. (Flat panel displays are the second largest consumer of electronic specialty gases behind semiconductor)

Leading suppliers of electronic specialty gases, 2023: Linde, Air Liquide, Merck/EMD, Nippon Sanso Group, SKMaterials, KDK, Wonik Materials, Resonac, peric, Entegris and few others

LDETEK SOLUTION

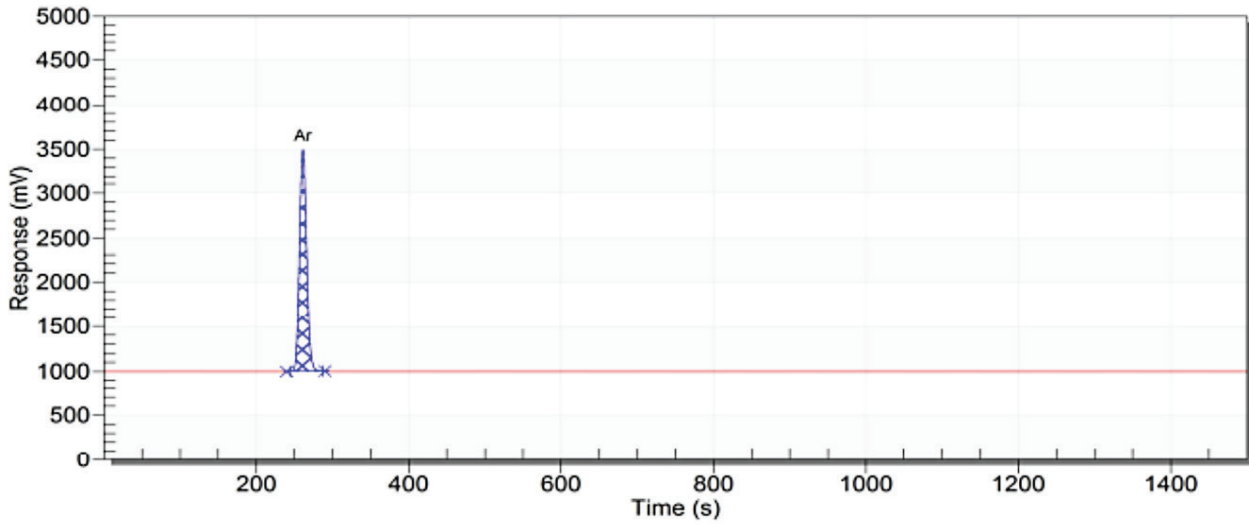
The purity Xenon can be qualified with the use of the MultiDetek3 gas chromatograph configured with PED.

The unit has been configured with a measuring range of 0-10ppm and Idl of 5-10ppb for impurities Ar-C2F6-CF4-CH4-H2-O2-CO-CO2-Kr-N2-N2O-SF6 in a sample gas UHP Xenon. The PED (plasma emission detector) has been mounted in the GC to measure ppb impurities in UHP Xenon using Helium as carrier gas. All listed impurities are measured within one single analyser.

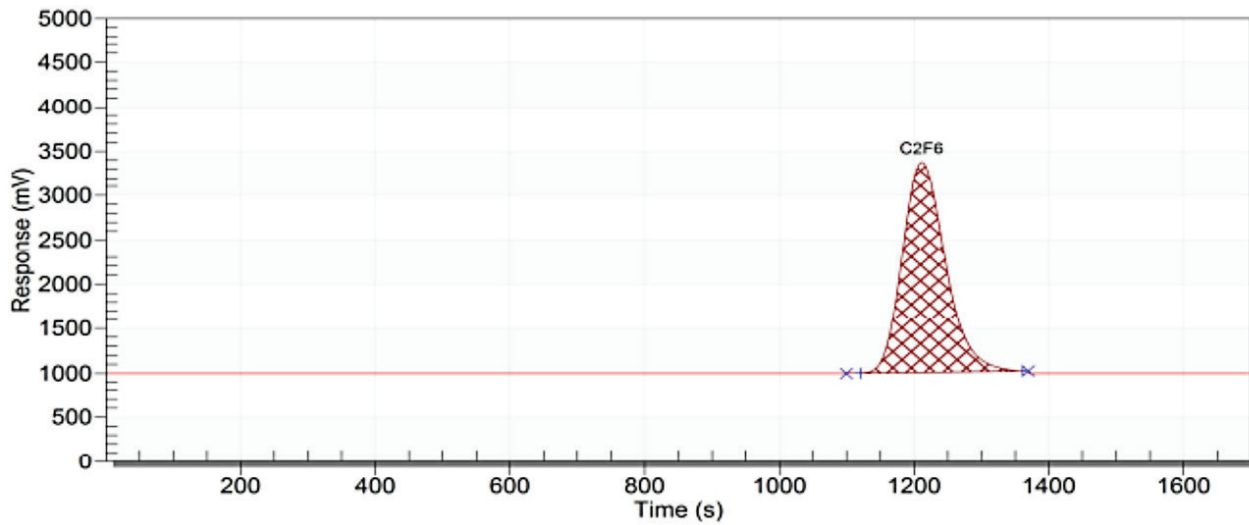
This application note is the standard approved requirement in the semiconductor industry for specialty gas Xenon. Other configurations and ranges/Idls are possible. The parameters mostly depend of the site production requirements and process.

RESULTS

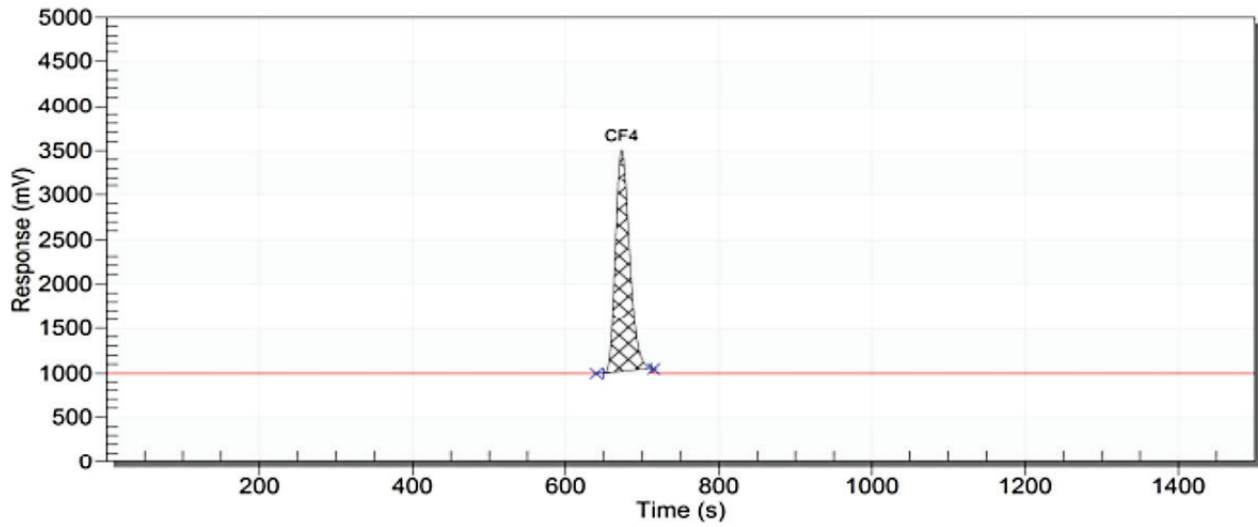
A series of chromatograms (Span calibration) of trace impurities Ar-C2F6-CF4-CH4-H2-O2-CO-CO2-Kr-N2-N2O-SF6 in balance gas UHP Xenon



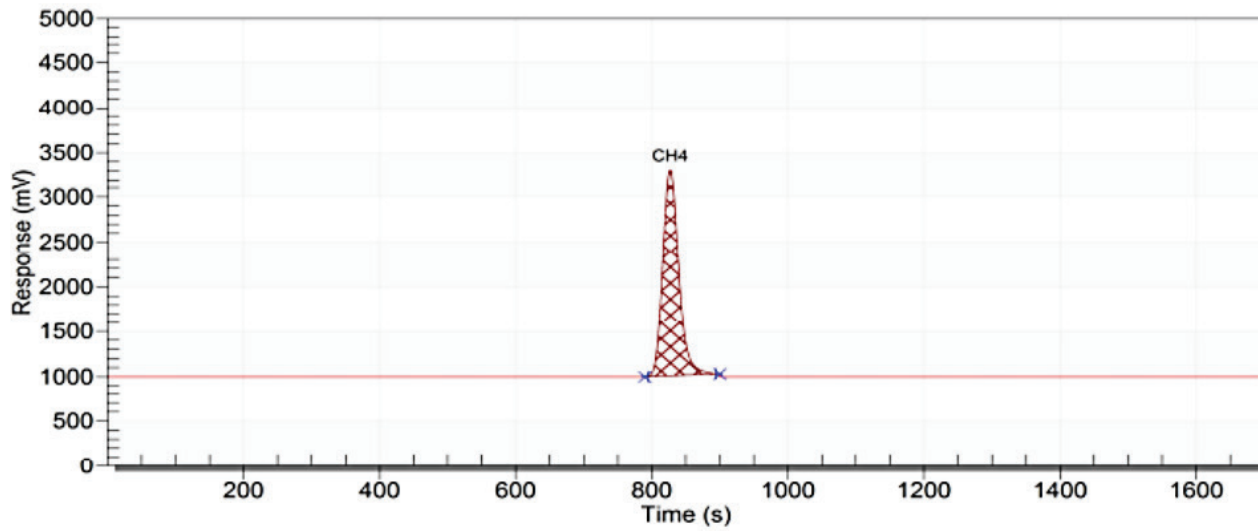
Peak	Unit	Calibration Value	_Area Counts
Ar	ppm	8.90	26516



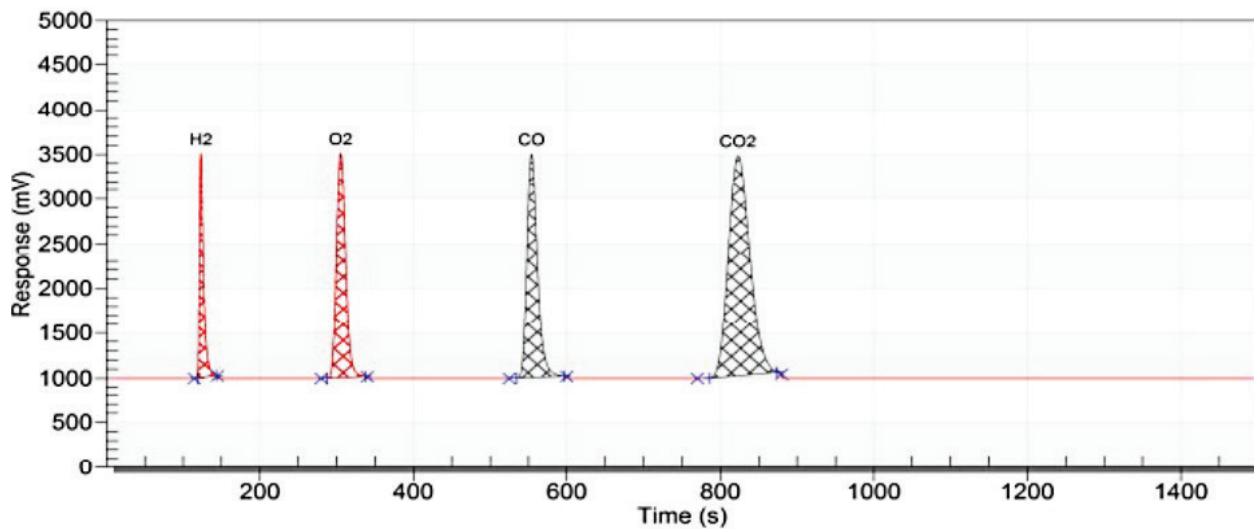
Peak	Unit	Calibration Value	_Area Counts
C2F6	ppm	10.00	174854



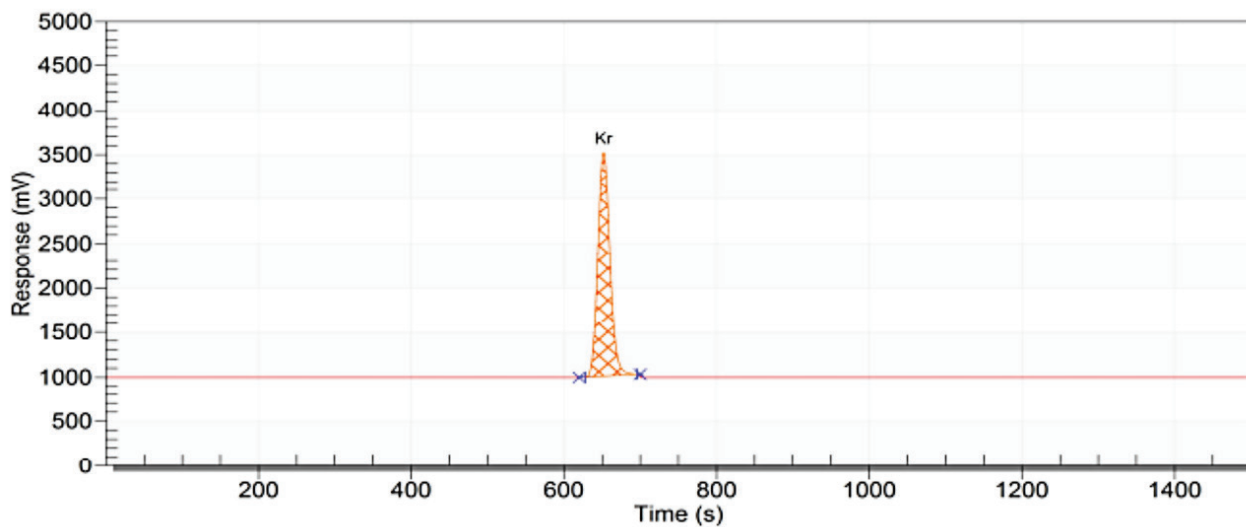
Peak	Unit	Calibration Value	_Area Counts
CF4	ppm	10.00	52493



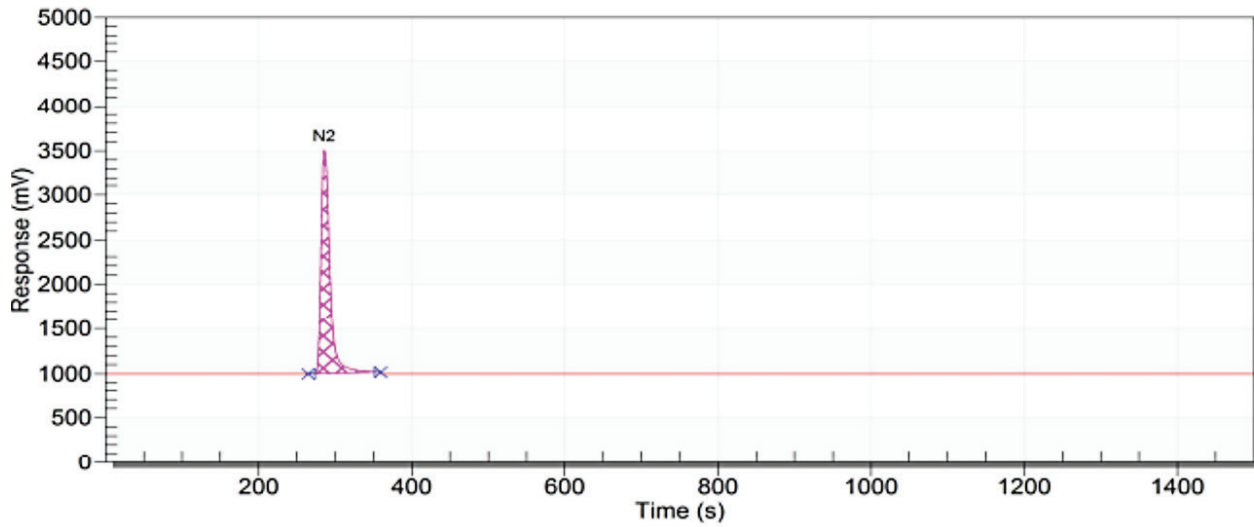
Peak	Unit	Calibration Value	_Area Counts
CH4	ppm	10.00	61978



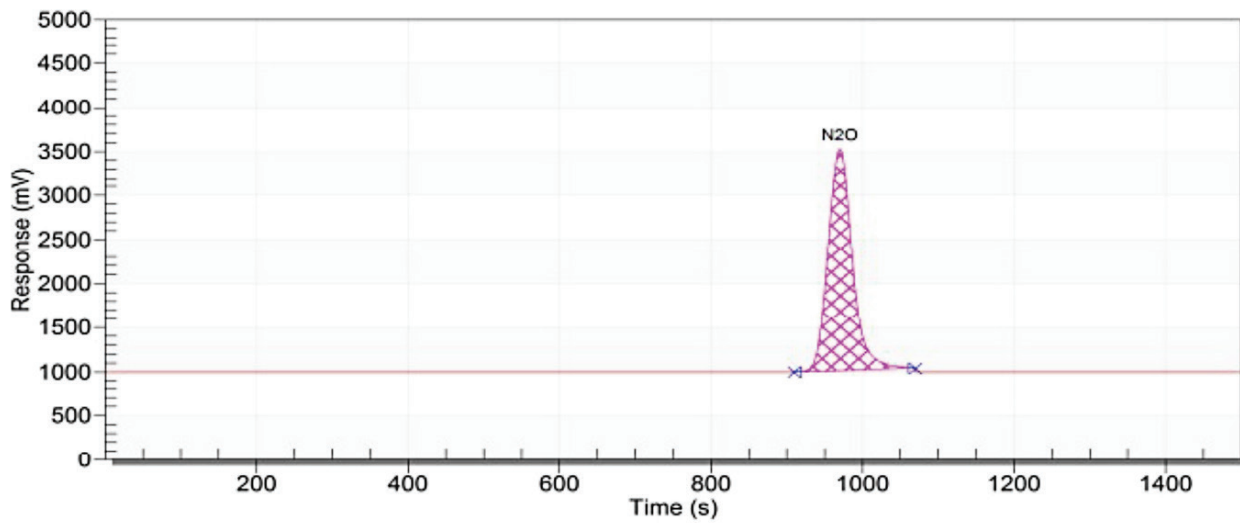
Peak	Unit	Calibration Value	_Area Counts
H2	ppm	11.00	14304
O2	ppm	11.00	32694
CO	ppm	11.40	39322
CO2	ppm	11.00	79527



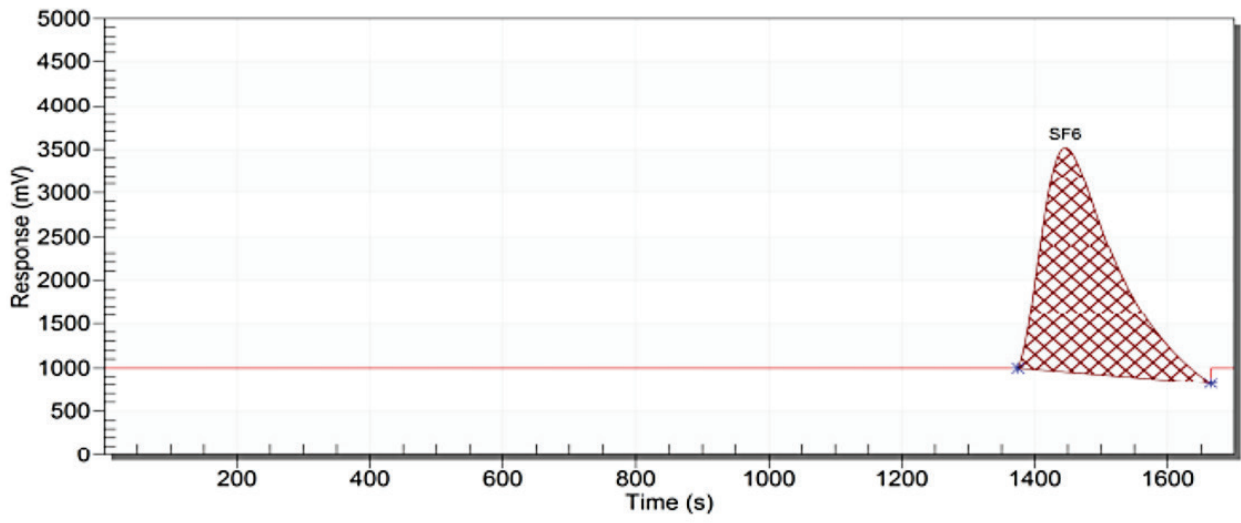
Peak	Unit	Calibration Value	_Area Counts
Kr	ppm	10.00	46459



Peak	Unit	Calibration Value	_Area Counts
N2	ppm	10.00	33053



Peak	Unit	Calibration Value	_Area Counts
N2O	ppm	10.00	92492



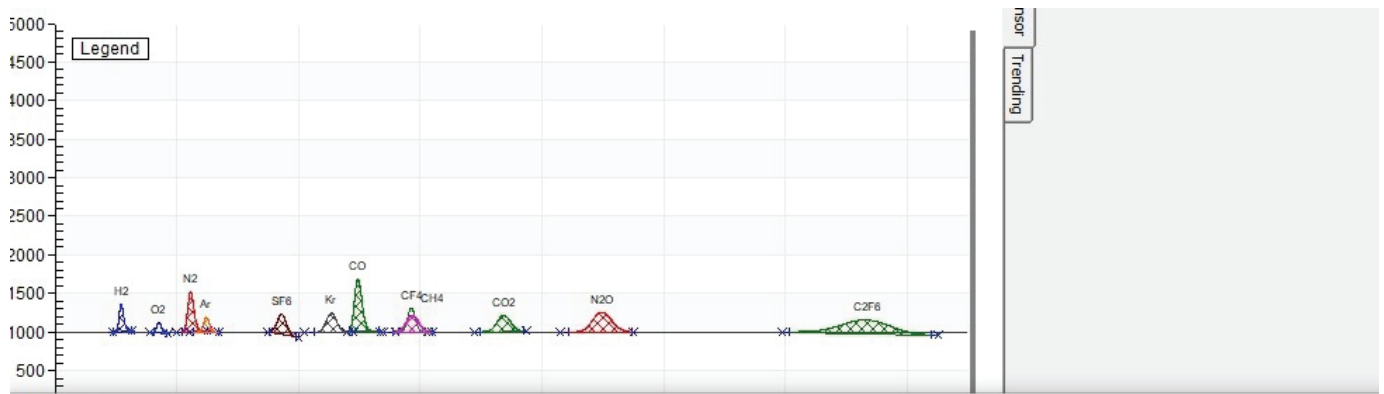
Peak	Unit	Calibration Value	_Area Counts
SF6	ppm	10.00	325396

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

COMPONENTS	CONCENTRATION (ppm)	PEAK HEIGHT	NOISE	LDL (3X NOISE)
Ar	8.9	2500mV	0.43mV	5ppb
C2F6	10.0	2388mV	0.36mV	5ppb
CF4	10.0	2501mV	0.51mV	6ppb
CH4	10.0	2455mV	0.59mV	7ppb
H2	11.0	2500mV	0.48mV	6ppb
O2	11.0	2500mV	0.46mV	6ppb
CO	11.4	2500mV	0.51mV	7ppb
CO2	11.0	2500mV	0.47mV	6ppb
Kr	10.0	2525mV	0.49mV	6ppb
N2	10.0	2506mV	0.37mV	4ppb
N2O	10.0	2500mV	0.47mV	5ppb
SF6	10.0	2500mV	0.69mV	8ppb

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

Typical chromatogram with Xenon method analysis showing low concentrations between 0.5ppm-1.6ppm of measured impurities in Xenon balance gas



Historic

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Historics Import Compare Rework Request Local

Import	Descripti...	H2	O2	N2	Ar	SF6	Kr	CO	CH4	CF4	CO2	N2O	C2F6
Wed, May-17-20...													
03:36:00		1.344	0.596	1.606	0.938	0.838	1.023	0.948	0.787	1.251	0.927	0.999	0.834
03:10:48		1.335	0.563	1.607	1.038	0.838	1.021	0.948	0.786	1.249	0.928	0.989	0.829
02:45:37		1.333	0.522	1.602	0.948	0.831	1.020	0.946	0.788	1.247	0.928	0.982	0.826

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 repeatability/linearity and accuracy standards.

CONCLUSION

The MultiDetek3 configured with PED can offers a good analytical solution for trace ppb/ppm impurities for quality and validation of UHP Xenon. The gas chromatograph is configured with standard industrial communication protocols and 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 rare gas applications. 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.

