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WHITE PAPER

SEMICONDUCTOR CLEANROOM AMC MONITORING

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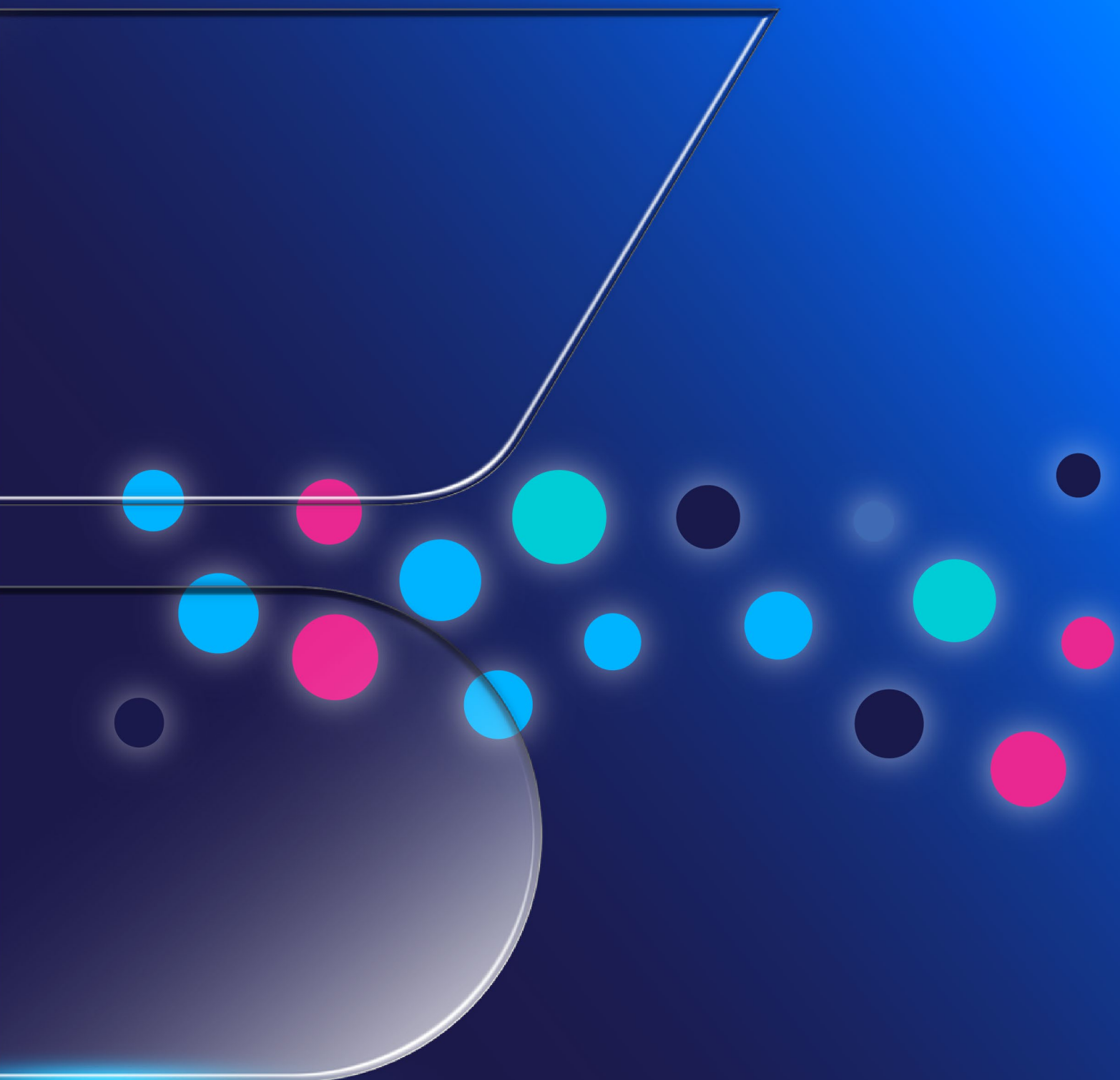

ABSTRACT

Reliable, speciated measurements of airborne molecular contaminants are essential for critical decision making in semiconductor fabrication plants to ensure operational efficiency and maximization of yield. Here, we demonstrate the application of selected ion flow tube mass spectrometry (SIFT-MS) products for real-time, continuous monitoring of a broad range of volatile organic and inorganic compounds (VOCs/VICs). Unlike traditional methods such as ion mobility spectrometry and chromatography techniques that lack specificity or require complex sample preparation and extensive lab analysis, SIFT-MS provides accurate, near-instantaneous measurements. With limits of detection relevant to semiconductor manufacturing, as low as pptV, and purpose-built software for data visualization, SIFT-MS enables rapid response to contamination events.

AIRBORNE MOLECULAR CONTAMINANTS: A HIDDEN THREAT TO SEMICONDUCTOR YIELD

Airborne molecular contaminants (AMCs) reduce wafer yield in semiconductor manufacturing plants, also known as fabs. Research has shown that specific AMCs react with the surface of both process tools and semiconductor wafers. This causes defects that adversely affect process yields and equipment performance, significantly impacting manufacturers' revenue (Lu, 2022).

AMCs in semiconductor manufacturing environments encompass a broad range of volatile and semi-volatile chemical compounds. Different AMCs are known to interact with different processes that are used during the processing of the silicon wafers into finished products. Acids, as well as reactions of NO_x, SO_x and alkali or metallic elements have been observed to cause corrosion to wafers (Fontaine, 2009). Phthalates and plasticizers have been found to cause wafer deformation (Hattori, 1996, 2001). The reaction of trimethylsilanol and other siloxanes through the formation of organosilicon compounds on the surface of wafers can cause undesirable electrical impacts (Pey, 2007). Boron-containing compounds can also cause deleterious electrical effects (Gabhale, 2022). Acids and other volatile organic compounds (VOCs) such as PGMEA, can cause salt formation on wafers, a process known as hazing (Pic, 2010).

Cleanroom ambient air is the primary source of AMCs. These can come from facility leaks in gas lines, faulty or expired filters, construction materials, or on-site staff. If not addressed, these contaminants can penetrate front opening unified pods (FOUPs), used to transport semiconductor wafers, and cause damage to these products. Studies have also shown that clean wafers can be impacted when they enter the contaminated FOUP (Nyugen, 2013) (Jeong, 2019). With inadequate filter efficiency, AMCs can also be recirculated throughout a cleanroom and impact the yield of multiple wafers if the contamination source is not identified. This means that there is

the potential for widespread losses across a fab environment, not just at the source of the contamination itself.

To efficiently identify and proactively address contamination events, and ensure wafers are not exposed to AMCs during transport between manufacturing processes, efficient monitoring methods across multiple cleanroom locations is essential. Effective defect prevention depends on speciated analysis - the ability to distinguish and quantify a wide range of chemically diverse and reactive compounds - to pinpoint sources and identify which processes, and therefore which wafers, will be affected. Measuring a broad range of defect-causing compounds with high temporal resolution enables accurate ambient concentration assessments and rapid response. Incumbent technologies have critical limitations for breadth and speed of analysis, in addition to lacking specificity. For example, ion mobility spectrometry cannot speciate individual compounds within a class. This does not allow for determination of which specific acid bath is leaking within the manufacturing process. Liquid chromatography requires manual collection of samples and highly trained analytical users to extract the results from these tests. Gas chromatography (GC-MS) involves complex pre-concentration and sample preparation steps. These labor-intensive technologies significantly delay the time to results, with additional downtime required to monitor the entire suite of damaging chemicals.

SIFT-MS, on the other hand, is easy to install, simple to operate, easy to maintain, requires fewer interventions, and provides high frequency data with broad chemical coverage and speciation. This application note describes the application of SIFT-MS to cleanroom AMC monitoring. The data presented demonstrates the capability of SIFT-MS to provide a complete solution for this application, measuring the breadth of critical contaminants required in a semiconductor fab with the sensitivity, specificity, repeatability, speed, and accuracy which provides reliable results.

TECHNOLOGY OVERVIEW

SIFT-MS uses soft chemical ionization reactions coupled with mass spectrometric detection to rapidly quantify VOCs in real time from whole-gas samples. Up to eight standard chemical ionization agents (or reagent ions) are used (H_3O^+, NO^+, O_2^+, OH^-, O^-, O_2-, NO_2^-, NO_3^-). These reagent ions are mass selected and react with trace VOCs and inorganics in very well controlled ion-molecule reactions but do not react with the major components of air, allowing SIFT-MS to analyze whole air for trace VOCs and inorganics to pptV levels. Switching of reagent ions on a millisecond timescale enables real-time, single-scan differentiation of interfering compounds. This characteristic allows synchronous concentration measurements of one analyte to be made with several reagent ions and/or various compounds be detected with different reagent ions. SIFT-MS is a direct ionization technique, meaning the sample

analysis happens immediately when the sample enters the inlet. This speeds sample throughput and provides rapid quantification. Use of multiple reagent ions also greatly reduces interferences, markedly increasing the specificity of SIFT-MS compared with most other whole-gas analysis techniques. Quantitation with SIFT-MS is based on an expandable library of known reaction rates and branching ratios that currently contains 1000 organic and inorganic compounds. This library, when combined with automated daily instrument performance tune, gives precise analytical results without the need for calibration.

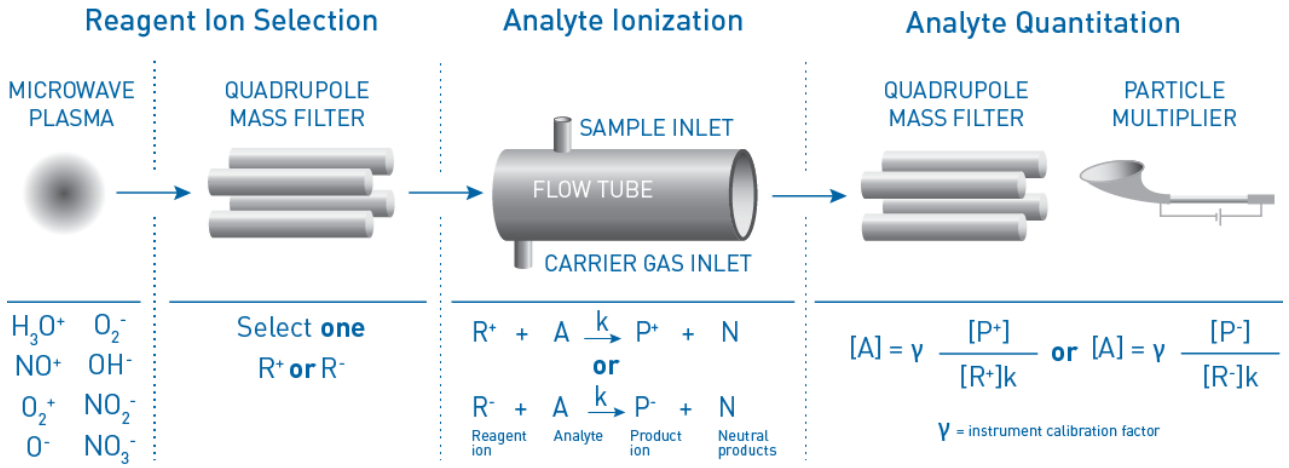

Figure 1. Schematic of SIFT-MS technique.

PRODUCT OVERVIEW

Syft products have been used in the semiconductor industry for over 10 years. Syft Tracer, built from the instrument platform, provides real-time, sensitive, selective, stable, and direct analysis of a broad range of compounds. A contamination control monitoring network can be configured throughout a semiconductor fab using a combination of the Syft AMC Guardian to measure at multiple fixed locations across different areas and levels of the manufacturing site, while the Syft AMC Explorer can be deployed to the location of concentration events to identify the source of the contamination.

Figure 2. Syft AMC Guardian.

Syft AMC Guardian provides multiport analysis that enables continuous, 24/7 stationary contamination monitoring. This product integrates the Syft Tracer with up to 32-port sampling ports to measure across a semiconductor fab. The hardware and software support internal integration of up to 2 additional analyzers, such as an ozone analyzer, and/or CRDS. Syft AMC Guardian is designed for continuous, high sample transmission, ensuring efficient and accurate data collection.

Figure 3. Syft AMC Explorer.

Syft AMC Explorer is a mobile device that can be used by engineers to pinpoint contamination sources, offering a 1.5-hour battery life for extended use. The product integrates the Syft Tracer, onboard gas supply, and long-lasting battery life to achieve mobile capability. This feature allows users to make concentration measurements at hard-to-reach locations around a semiconductor fab.

Syft AMC Guardian and Syft AMC Explorer include additional hardware features specific to a semiconductor cleanroom environment, such as a light tower and emergency off button.

Syft software allows users to set up methods, complete data acquisition, and interpret results for fast decision making. This is achieved by centralizing product status and control into a unified user interface, with an intuitive software interface that provides real-time data visualization, while maintaining a consistent data structure for integration into existing fab management systems. To provide a simple workflow in a complex manufacturing environment, product-specific software is developed to ensure that the SIFT-MS technique does not require highly trained users.

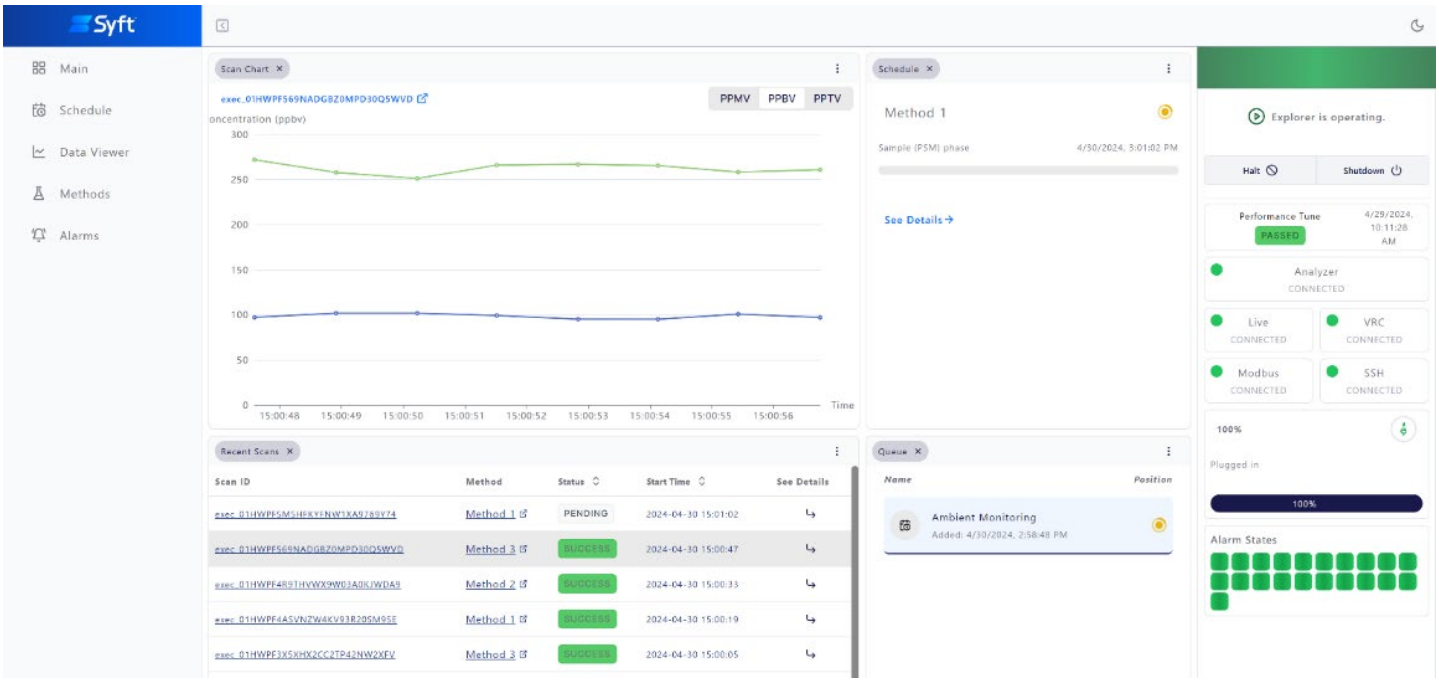

Figure 4: Syft software interface used for control and analysis of SIFT-MS measurements.

SIFT-MS CAPABILITIES

In the semiconductor industry, chemical contamination engineers work to ensure maximization of yield. Low limits of detection are crucial for identifying trace contaminants that can affect yield, while repeatability ensures consistent results for process control. Specificity allows accurate identification of target substances. Instrument comparability ensures consistency across fabs and global operations. Breadth of analysis enables detection of a wide range of contaminants. Linearity ensures accurate quantification over varying concentrations. Fast response times allow timely interventions. In the following sections, we discuss our capabilities for each of these critical parameters. Effective service and support are critical to ensure high up time in a challenging environment.

1. Detection Limits

In the cleanroom environment at a semiconductor fab, it is vital to measure critical compounds of interest at levels that are relevant for causing wafer defects. For example, boron compounds have been found to show negative electrical impacts at levels as low as pptV (Anderson, 2005). SIFT-MS provides accurate quantitation, achieved by high sensitivity, at concentration levels relevant for defect prevention in wafer manufacturing processes.

Detection limits were calculated in a clean dry air (CDA) matrix for a subset of critical AMCs to monitor in a cleanroom environment, most being measured for < 5s. Detection limits can be further optimized for faster or a more precise analysis per

compound by increasing or decreasing measurement time. Representative detection limits displayed in Table 1 were evaluated using the 3σ (three standard deviation) method for 20 repeats.

Compound	LOD (pptV)	Compound	LOD (pptV)
acetic acid	50	methanol	100
acetone	150	MIBK	50
ammonia	200	nitric acid	50
butyl acetate	50	nitrogen dioxide	50
cyclohexanone	20	nitrous acid	500
D3	20	NMP	20
D4	<10	PFTBA	50
D5	<10	phosphoric acid	50
diglycolamine	20	propylene glycol	20
dimethylamine	200	PGME	20
DIPA	<10	PGMEA	50
EEP	<10	sulfur dioxide	100
ethyl lactate	20	sulfuric acid	100
ethanol	150	tricresyl phosphate	100
formaldehyde	25	triethyl borate	100
formic acid	500	TEOS	<10
heptanone	20	triethyl phosphate	20
HMDS	50	trimethylamine	50
hydrogen bromide	50	trimethylsilanol	25
hydrogen sulfide	100	toluene	25
isopropyl alcohol	100	xylene + ethylbenzene	50

Table 1. Example limit of detection values for a subset of critical AMCs in a semiconductor fab, using SIFT-MS.

2. Breadth of Analysis

AMCs that impact semiconductor wafer yield belong to diverse chemical compound classes. SIFT-MS is a complete solution that can perform concurrent measurements of a broad range of compounds across the compound classes without requiring hardware changes. Compounds including VOCs, dopants, refractory, condensable and molecular acids/bases, can be measured simultaneously, as shown in Figure 5.

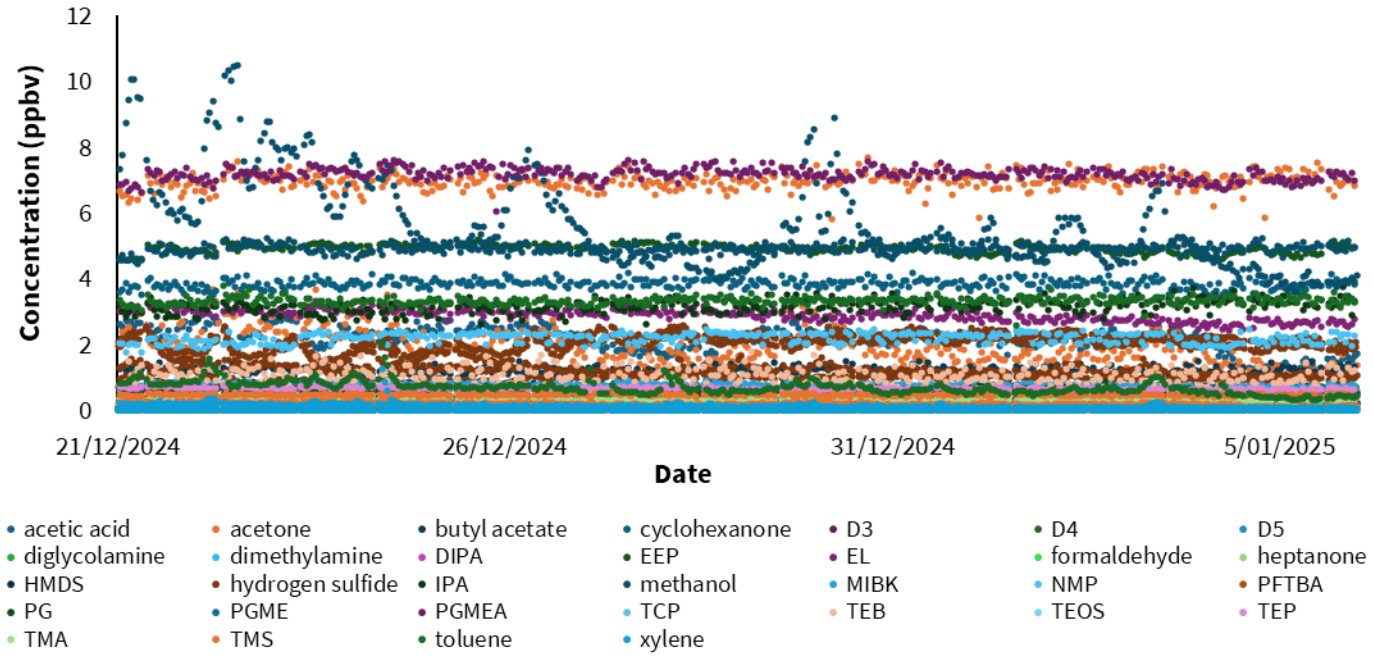

Figure 5. Simultaneous volatile organic compound (VOC) measurements using SIFT-MS.

3. Repeatability

Repeatable measurements using SIFT-MS ensure reliable data which can support operational decisions. Figures 6a-c contain data obtained by delivering a gas standard of AMCs to a SIFT-MS instrument while continuously measuring a selection of compounds with similar functionalities. Repeatability is demonstrated with the instrument response rising to the same level on each addition of AMC. SIFT-MS instrument stability is shown by the low percentage relative standard deviation (% RSD) calculated for each period of sample introduction.

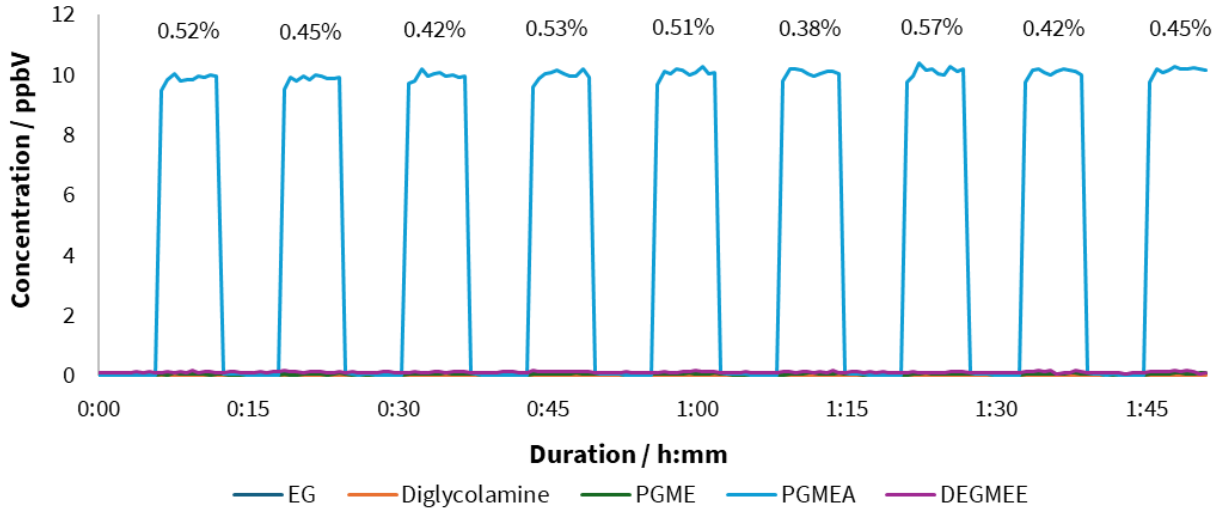

Figure 6a. Selective measurement of PGMEA gas standard in addition to other glycol compounds using SIFT-MS.

Instrument precision, enabled by high sensitivity, is demonstrated with low signal percentage relative standard deviation (%RSD), while the sample is delivered at concentrations as low as 1 ppbV (trimethylsilanol, Figure 7).

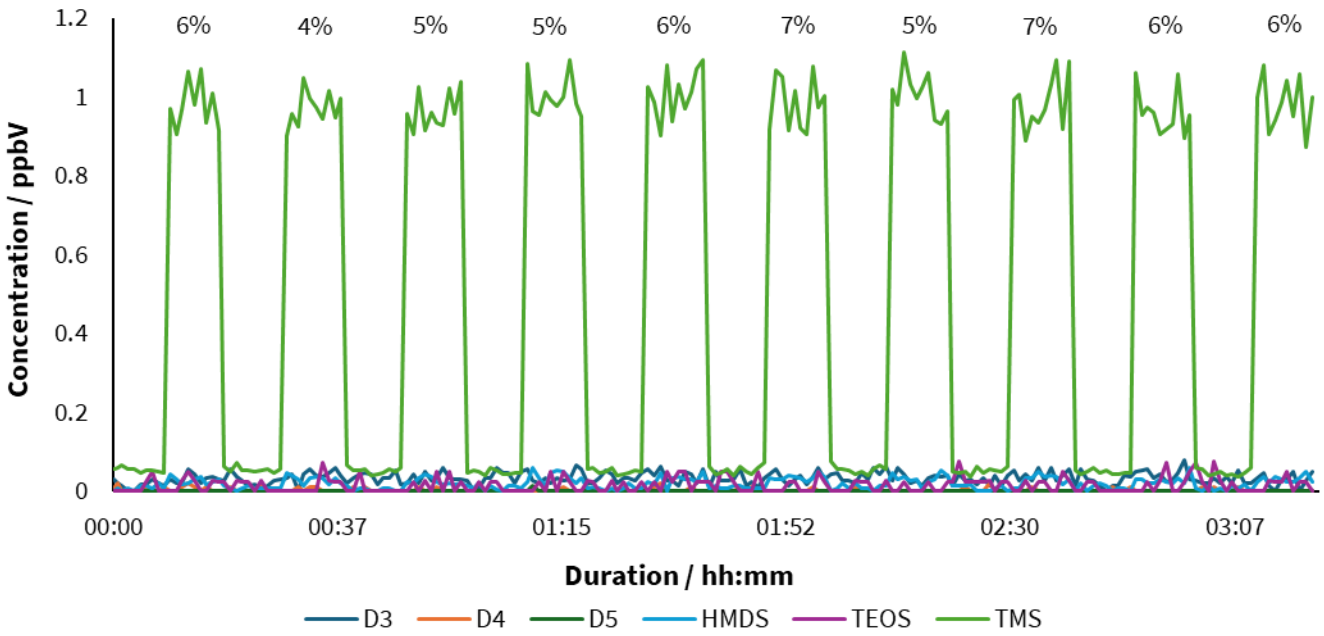

Figure 6b. Selective and precise, low concentration measurement of TMS gas standard in addition to other silicon-containing compounds using SIFT-MS.

4. Specificity

Instrument users in a semiconductor environment require specificity in their measurements to ensure that they can use this data to make operational decisions. Robust data acquisition is enabled by SIFT-MS's soft ionization, which results in minimal fragmentation and selective measurements of the analytes of interest. Multi-compound SIFT-MS measurements, conducted in 30 second increments, are shown in Figures 6a-c. Specificity is demonstrated as substantial and rapid concentration changes do not affect the measurement of other, similar compounds which remain stable at low background levels.

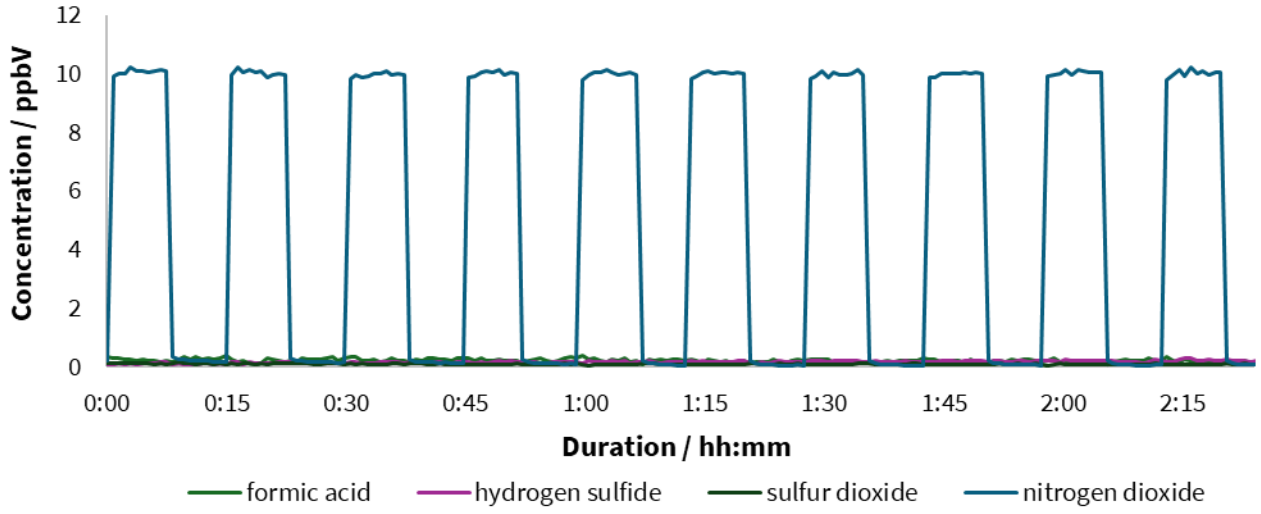

Figure 6c. Selective measurement of nitrogen dioxide gas standard, in addition to sulfur and nitrogen-containing compounds using SIFT-MS.

5. Instrument Comparability (Reproducibility)

Comparable results across an instrument fleet provides consistent results across an ambient monitoring framework. This means that ambient concentration measurements from different tools and across different areas within a fab can be used to identify concentration events to be addressed. Syft's AMC products have been evaluated for cleanroom AMC monitoring and leak detection in a fab environment. Table 2 shows the agreement of ambient measurements for two SIFT-MS tools. Clean dry air measurements are shown to represent instrument background levels.

Compound	Tool 1 (ppbV)	Tool 2 (ppbV)	Absolute difference (ppbV)	Percentage difference (%)
acetic acid	2.17	2.26	0.09	4.17
PG	0.59	0.59	0.00	0.02
TMS	0.16	0.17	0.01	7.33
toluene	0.70	0.66	0.03	4.83
VOCs	Uncalibrated, using known concentration standard			< 20 %

Table 2. Instrument comparison for two SIFT-MS instruments, shown by ambient air concentration differences of four compounds.

Clean dry air (CDA) and ambient measurements presented in Figures 7a-d demonstrate the reproducibility of results across SIFT-MS instruments. To highlight the low concentration precision achievable with SIFT-MS, sub-ppbV concentration measurements are shown for both trimethylsilanol (TMS) and propylene glycol (PG).

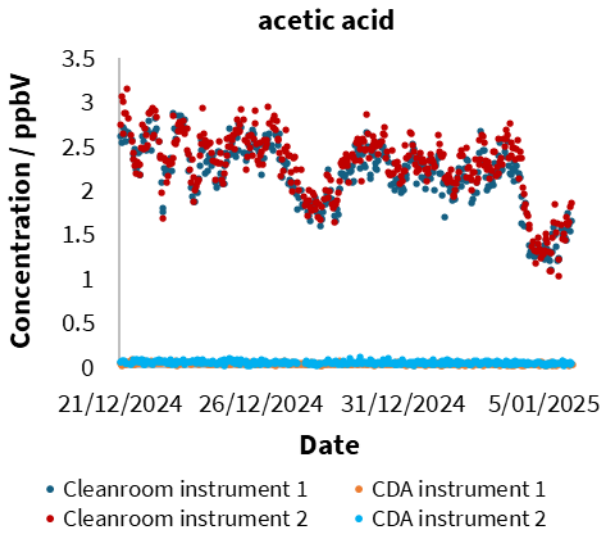

Figure 7a. Comparison of acetic acid concentration measurements in cleanroom ambient air and clean dry air (CDA) matrices.

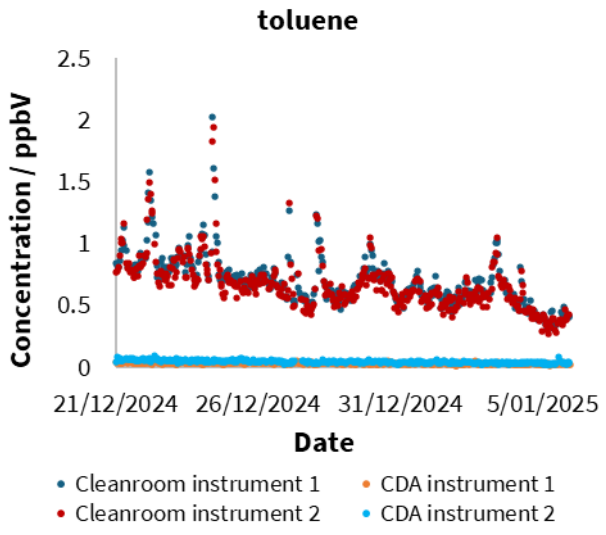

Figure 7b. Comparison of toluene concentration measurements in cleanroom ambient air and clean dry air (CDA) matrices.

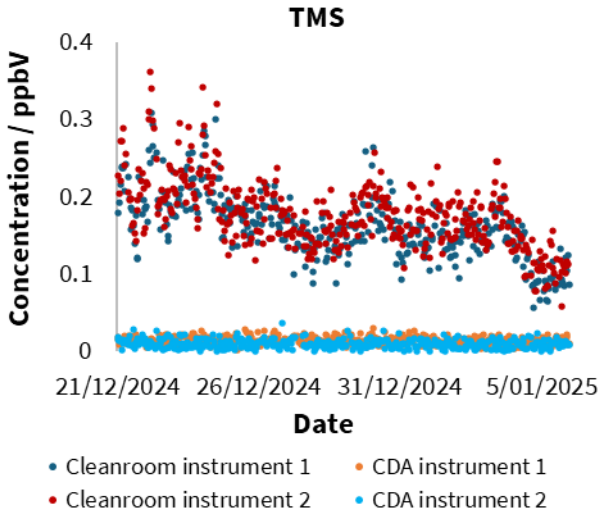

Figure 7c. Comparison of trimethylsilanol (TMS) concentration measurements in cleanroom ambient air and clean dry air (CDA) matrices.

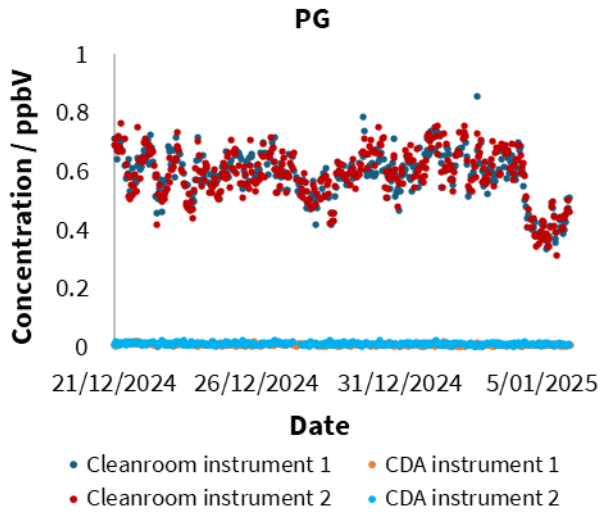

Figure 7d. Comparison of propylene glycol (PG) concentration measurements in cleanroom ambient air and clean dry air (CDA) matrices.

6. Concentration Linearity

Linearity across a wide dynamic range ensures accuracy of measurements. This provides concentration measurements which customers can trust to use for making critical decisions. Figures 8a-g, below and Table 3 show the calibration response of five SIFT-MS instruments. The results are highly linear and closely aligned, demonstrating both repeatability and comparability for key analytes.

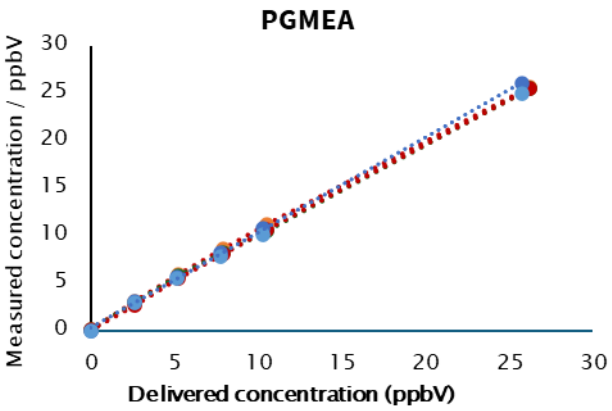

Figure 8a. SIFT-MS linearity data for PGMEA.

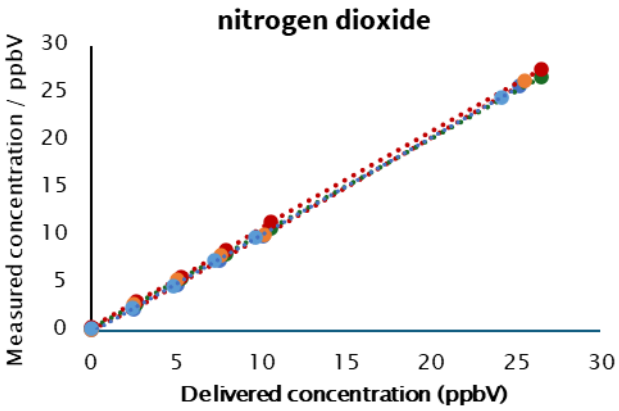

Figure 8b. SIFT-MS linearity data for nitrogen dioxide.

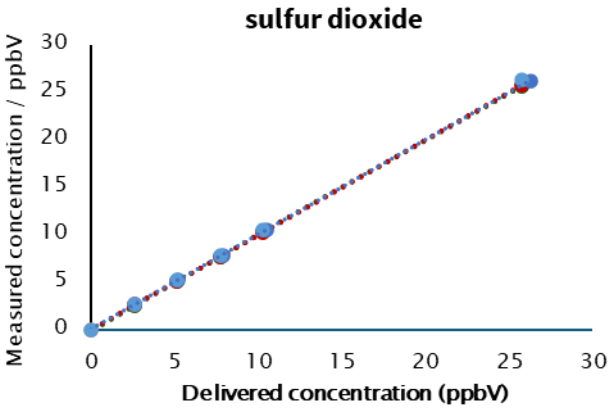

Figure 8c. SIFT-MS linearity data for sulfur dioxide.

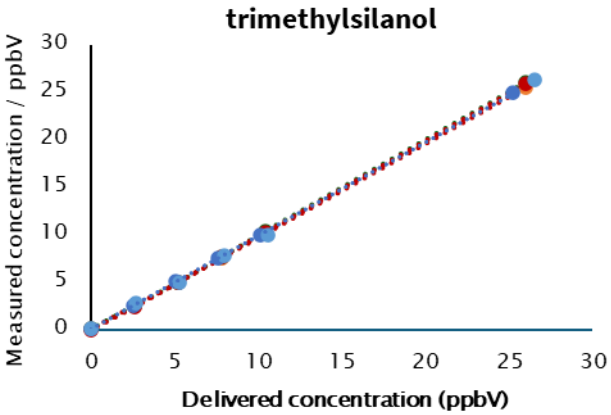

Figure 8d. SIFT-MS linearity data for trimethylsilanol.

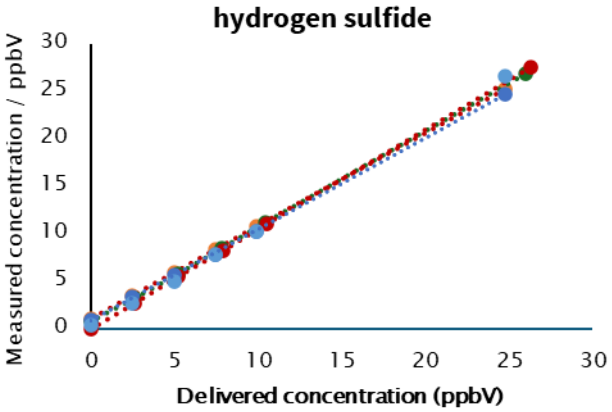

Figure 8e. SIFT-MS linearity data for hydrogen sulfide.

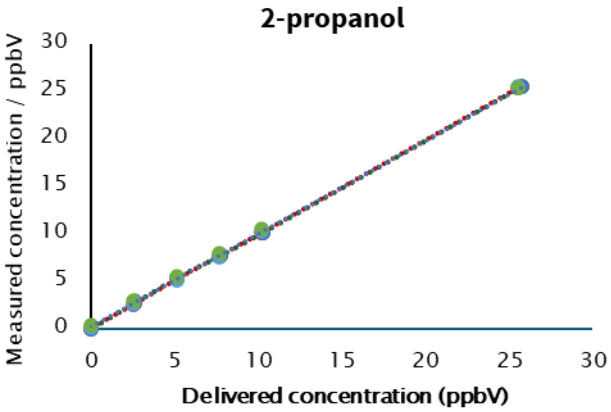

Figure 8f. SIFT-MS linearity data for 2-propanol.

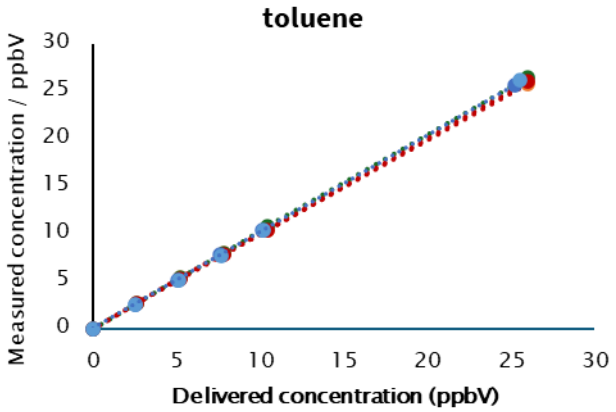

Figure 8g. SIFT-MS linearity data for toluene.

Compound	Average R^2
PGMEA	0.9992
nitrogen dioxide	0.9997
sulfur dioxide	0.9999
trimethylsilanol	0.9998
hydrogen sulfide	0.9998
2-propanol	0.9999
toluene	0.9999

Table 3. Average Pearson's linear regression coefficient (R2) for displayed fleet calibration data using SIFT-MS.

7. Fast Response Times

Compound	t_{10} (s)	t_{90} (s)
PGMEA	< 2	<2
toluene	< 1	<1
nitrogen dioxide	< 1	<1
trimethylsilanol	< 2	< 2
TEOS	< 5	< 5
VOCs	<5	<5

Table 4. Instrument response times (t10 and t90 values) for a subset of AMCs/VOCs using SIFT-MS.

Given that exposure to cleanroom air for only 1 hour can result in organic contaminants adhering to the surface of wafers, quick turnround time to analytical results is critical (Sugimoto, 1999). Syft Tracer provides short instrument response times, which enables fast identification of sources of contamination in a semiconductor fab. Instrument response times (t_{10} and t_{90} values) for selected AMCs are shown in Table 4.

8. Service and Support

Effective monitoring programs require instrumentation which can be delivered with a service and support program that is executable. Ongoing service is required to ensure optimum uptime and usability for all precision analytical techniques.

Syft products are designed for service, with minimal consumables, and have been installed as part of global monitoring programs for over ten years. With offices across all major regions of semiconductor manufacturing worldwide, this provides timely 6- and 12-month instrument preventative maintenance. A tiered support system, combining the skillset of onsite team members, a global service and support team and product development enables efficient troubleshooting resolution.

CONCLUSIONS

- The combination of application-specific software with both stationary multiport and mobile solutions gives customers flexible setup options and ensures user-friendly operation in semiconductor fab environments.
- SIFT-MS technology enables accurate, repeatable speciated measurements with limits of detection at sub-ppbV levels, relevant to the cleanroom environment. This provides trustworthy results which can be used to pinpoint and identify compound concentration events which can impact wafer yield.
- A fleet of SIFT-MS instruments can be configured throughout the footprint of a manufacturing site to ensure comprehensive analysis of the cleanroom air. With comparable concentrations across an instrument fleet, contamination control teams can use this data to compare locations and processes throughout their fab.
- Real-time data acquisition is achieved, with short response times. Accurate measurements which high temporal resolution allows contamination control engineers to draw data-driven conclusions with confidence regarding potential impacts on semiconductor production.
- SIFT-MS simultaneously measures the breadth of compounds that are critical for defect prevention in semiconductor manufacturing processes.
- Syft products are supportable in a semiconductor fab, with a global presence of service teams.

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Appendix

Details for all compounds presented in this white paper are tabulated below.

Analyte	CAS #	Molecular Weight ($gmol^{-1}$)	Reagent Ion	Product Ion Formula	Branching ratio (%)	Primary Product Ion m/z (Secondary)
1,3-butadiene	106-99-0	54.09	NO^+	$C_4H_6^+$	100	54
			O_2^+	$C_4H_6^+$	70	54
acetic acid	64-19-7	60.05	H_3O^+	$CH_3COOH_2^+$	100	61 (79)
			NO^+	$CH_3COOH_2.NO^+$	100	90
acetone	67-64-1	58.08	H_3O^+	$C_3H_7O^+$	100	59 (77)
			NO^+	$C_3H_6.NO^+$	100	88
NH_3 (ammonia)	7664-41-7	17.03	O_2^+	NH_3^+	100	17
butyl acetate	123-86-4	116.16	H_3O^+	$C_6H_{12}O_2H^+$	35	117
			NO^+	$C_3H_7^+$	15	43
				$C_6H_{11}O_2^+$	5	115
				$C_6H_{12}O_2.NO^+$	65	146
cyclohexanone	9003-41-2	98.15	H_3O^+	$C_6H_{11}O^+$	100	99 (117)
			NO^+	$C_6H_{10}O^+$	35	98
				$C_6H_{10}O.NO^+$	65	128
D3 (hexamethylcyclotrisiloxane)	541-05-9	222.46	H_3O^+	$^{28}Si_3O_3(CH_3)_6.H^+$	37	223
			NO^+	$^{28}Si_3O_3(CH_3)_5(OH_2)^+$	73	225 (243)
D4 (octamethylcyclotetrasiloxane)	556-67-2	296.63	H_3O^+	$C_8H_{25}O_4{}^{28}Si_4^+$	45	299
			NO^+	$C_7H_{21}O_4{}^{28}Si_4.H_2O^+$	67	299
D5 (decamethylcyclopentasiloxane)	541-02-6	370.77	H_3O^+	$C_9H_{27}O_5{}^{28}Si_5^+$	41	355 (373)
			NO^+	$C_9H_{27}O_5{}^{28}Si_5^+$	65	355 (373)
			O_2^+	$C_9H_{27}O_5{}^{28}Si_5^+$	63	355 (373)
diglycolamine	929-06-6	105.14	H_3O^+	$C_4H_{11}NO_2H^+$	100	106
			NO^+	$C_4H_{10}NO_2H^+$	100	104
			O_2^+	$C_4H_{10}NO_2^+$	28	104
				$C_4H_{11}NO_2^+$	72	106
dimethylamine	124-40-3	45.08	H_3O^+	$(CH_3)_2NH.H^+$	100	46
			NO^+	$(CH_3)_2NH^+$	95	45
			O_2^+	$(CH_3)_2NH^+$	70	45
DIPA (diisopropanolamine)	110-97-4	133.19	H_3O^+	$C_6H_{15}NH^+$	100	102
			NO^+	$C_5H_{12}N^+$	100	86
			O_2^+	$C_5H_{12}N^+$	100	86
EEP (ethyl-3-ethoxypropionate)	763-69-9	146.18	H_3O^+	$C_7H_{14}O_3.H^+$	100	147
			NO^+	$C_7H_{13}O_3^+$	100	145
			O_2^+	$C_4H_6O_3^+$	25	102
EL (ethyl lactate)	687-47-8	118.13	H_3O^+	$C_5H_{10}O_3.H^+$	83	119
			NO^+	$C_5H_{10}O_3.NO^+$	83	148
ethanol	64-17-5	46.07	H_3O^+	$C_2H_7O^+$	100	47 (65)
			NO^+	$C_2H_5O^+$	100	45 (63)
formaldehyde	50-00-0	30.03	H_3O^+	CH_3O^+	100	31 (49)
formic acid	64-18-6	46.02	O_2^-	$HCOO^-$	96	-45 (-63)
heptanone	110-43-0	114.18	H_3O^+	$C_7H_{14}OH^+$	100	115 (133)
			NO^+	$C_7H_{14}.NO^+$	100	144
			O_2^+	$C_7H_{14}O^+$	20	114
HMDS (hexamethyldisilazane)	999-97-3	161.39	H_3O^+	$^{18}Si_2NH(CH_3)_5(OH_2)^+$	35	164
			NO^+	$^{18}Si_2NH(CH_3)_5$	36	161
			O_2^+	$^{18}Si_2NH(CH_3)_5(OH_2)^+$	44	164
HBr (hydrogen bromide)	10035-10-6	80.91	NO_2^-	$^{79}Br^-$	50	-79
				$^{81}Br^-$	50	-81
HCl (hydrogen chloride)	7647-01-0	36.46	O_2^-	$^{37}Cl^-$	25	-37
HF (hydrogen fluoride)	62778-11-4	20.01	OH^-	F^-	100	-19
H_2S (hydrogen sulfide)	7783-06-4	34.08	H_3O^+	H_3S^+	100	35
			OH^-	H_3S^-	95	-33
IPA (isopropyl alcohol)	67-63-0	60.10	H_3O^+	$C_3H_7^+$	80	43 (61)
			NO^+	$C_3H_7O^+$	100	59 (77)
methanol	67-56-1	32.04	H_3O^+	CH_5O^+	100	33 (51)
MIBK (methyl isobutyl ketone)	108-10-1	100.16	H_3O^+	$C_6H_{12}OH^+$	100	101 (119)
			NO^+	$C_6H_{12}O.NO^+$	100	130
			O_2^+	$C_6H_{12}O^+$	25	100

Analyte	CAS #	Molecular Weight ($gmol^{-1}$)	Reagent Ion	Product Ion Formula	Branching ratio (%)	Primary Product Ion m/z (Secondary)
HNO_3 (nitric acid)	7697-37-2	63.01	H_3O^+	$H_2NO_3^+$	100	64
NO_2 (nitrogen dioxide)	10102-44-0	46.01	OH^-	NO_2^-	100	-46
HNO_2 (nitrous acid)	7782-77-6	47.01	H_3O^+	$H_2NO_2^+$	67	48
NMP (N-methyl-2-pyrrolidinone)	872-50-4	99.13	H_3O^+	$C_5H_{10}NO^+$	100	100
			NO^+	$C_5H_8NO^+$	70	99
PFTBA (perfluorotributylamine)	311-89-7	671.10	O_2^+	$C_6F_{14}N^+$	40	352
H_3PO_4 (phosphoric acid)	7664-38-2	97.99	NO_2^-	$H_2PO_4^-$	100	-97
PG (propylene glycol)	57-55-6	76.09	H_3O^+	$C_3H_7O^+$	95	59
			NO^+	$C_3H_7O_2^+$	100	75
PGME (propylene glycol methyl ether)	107-98-2	90.10	NO^+	$C_4H_9O_2^+$	100	89
PGMEA (propylene glycol methyl ether acetate)	108-65-6	132.20	H_3O^+	$C_6H_{12}O_3.H^+$	75	133
			NO^+	$C_6H_{11}O_3^+$	80	131 (133)
SO_2 (sulfur dioxide)	7446-09-5	64.07	O_2^-	$^{32}SO_2.O_2^-$	31	-96
H_2SO_4 (sulfuric acid)	7664-93-9	98.08	NO_3^-	$H^{32}SO_4^-$	95	-97
TCP (tricresylphosphate)	1330-78-5	368.37	H_3O^+	$C_{21}H_{21}O_3P.H^+$	100	369
			NO^+	$C_{21}H_{21}O_3P^+$	100	368
TEB (triethyl borate)	150-46-9	145.99	H_3O^+	$C_6H_{16}BO_3^+$	100	147 (247)
			O_2^+	$C_6H_{15}BO_3^+$	27	146 (246)
				$C_6H_{16}BO_3^+$	28	147 (247)
TEOS (tetraethyl orthosilicate)	78-10-4	208.33	NO^+	$C_8H_{19}O_4Si^+$	100	207
			O_2^+	$C_7H_{17}O_4Si^+$	72	193
TEP (triethyl phosphate)	78-40-0	182.15	H_3O^+	$C_3H_9PO_4.H^+$	100	183
			NO^+	$C_3H_9PO_4.NO^+$	100	212
TMA (trimethylamine)	75-50-3	59.11	H_3O^+	$C_3H_8^+$	10	58
				$(CH_3)_3N.H^+$	90	60
			NO^+	$(CH_3)_3N^+$	100	59
			O_2^+	$C_3H_8N^+$	65	58
				$(CH_3)_3N^+$	35	59
TMS (trimethylsilanol)	1066-40-6	90.20	NO^+	$^{28}Si(CH_3)_2(OH)(OH_2)^+$	88	93 (111)
toluene	108-88-3	92.14	NO^+	$C_7H_8^+$	100	92
			O_2^+	$C_7H_8^+$	100	92
xylene	1330-20-7	106.16	H_3O^+	$C_8H_{10}.H^+$	100	107
			NO^+	$C_8H_{10}^+$	100	106

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