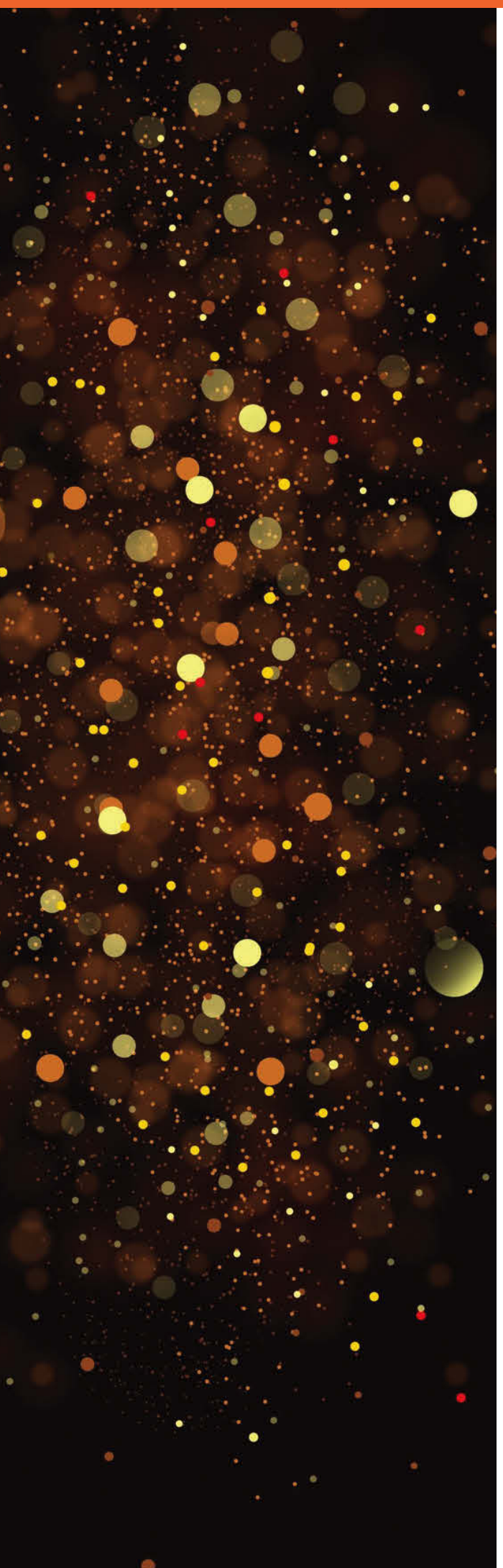
MONITORING AIRBORNE MOLECULAR CONTAMINATION IN INDOOR CLEANROOM AIR

Chromatotec® has established itself in the forefront of Airborne Molecular Contamination (AMC) analysis in cleanroom air. The latest enhancement of the airmoTWA range has augmented Chromatotec® solutions in this field.



AMC is a concern for any high technology manufacturing process, especially in the microelectronics industry. Organic contamination may cause adverse effects on production tools and consequently increase costs for high-tech companies.

The level of AMC contamination in cleanroom environments is predominately created by internal sources of solvents and acetic acid, re-entrainment of exhaust air, aromatic compounds from ambient air and return air as well as material outgassing.

Even more important, spills, leaks and mishandling have to be taken into account and can cause serious costs in terms of wafer loss and tool-down time.

Contamination-free manufacturing is a viable goal and is achieved by source control and source monitoring in combination with filtration solutions in air handling systems. Permanent monitoring of the AMC level helps identifying sources, stabilises production and prevents unexpected shortfalls of the service life of filtration units. To ensure people's safety and a good repeatability of industrial process, the analysis of cleanroom air is crucial.

Especially, electronic boards are produced in cleanrooms by complex lithographic processes using very reactive chemicals. The nature and concentration of volatile compounds can be different depending on the chemical process and can also vary rapidly. There is a need to analyse precisely and continuously the gas produced and by these processes which is ejected into the air with an instrument designed for industrial use. airmoTWA solutions give our customers the ability to perform online measurements over a long period of time without taking specific point-of-time samples. Nevertheless, the detection limit is as low as sub ppb level and can be down to 1 ppt.

Chromatotec® Solutions

For over 30 years, Chromatotec® has manufactured automated Gas Chromatography (autoGC) instruments, which are based on the online GC principles, to measure Volatile Organic Compounds (VOCs) at trace and ultra-trace levels in ambient air. Thanks to the advanced autoGC methodology, Chromatotec® airmoVOC analysers have been certified by Sira thanks to National Physical Laboratory (NPL) testing laboratory for Monitoring Certification Scheme (MCERTS) Performance Standards for Continuous Ambient Air Quality Monitoring Systems in the concentration range of 0.15 to 15 ppb. Following this, Chromatotec® airmoVOC has been selected by the National US Environmental Protection Agency (EPA) after laboratory evaluation for online VOCs monitoring in ambient air at sub ppb and low ppb level.

The airmoTWA system developed by Chromatotec® is the first rack mounted online GC-MS system for VOCs monitoring in the market. It is composed by a specific trap to concentrate the sample, a metallic capillary column for separation of chemicals and two detectors: a new micro Flame Ionisation Detector (FID) and a process quadrupole Mass Spectrometer (MS) for automatic quantification

airmoTWA demo unit

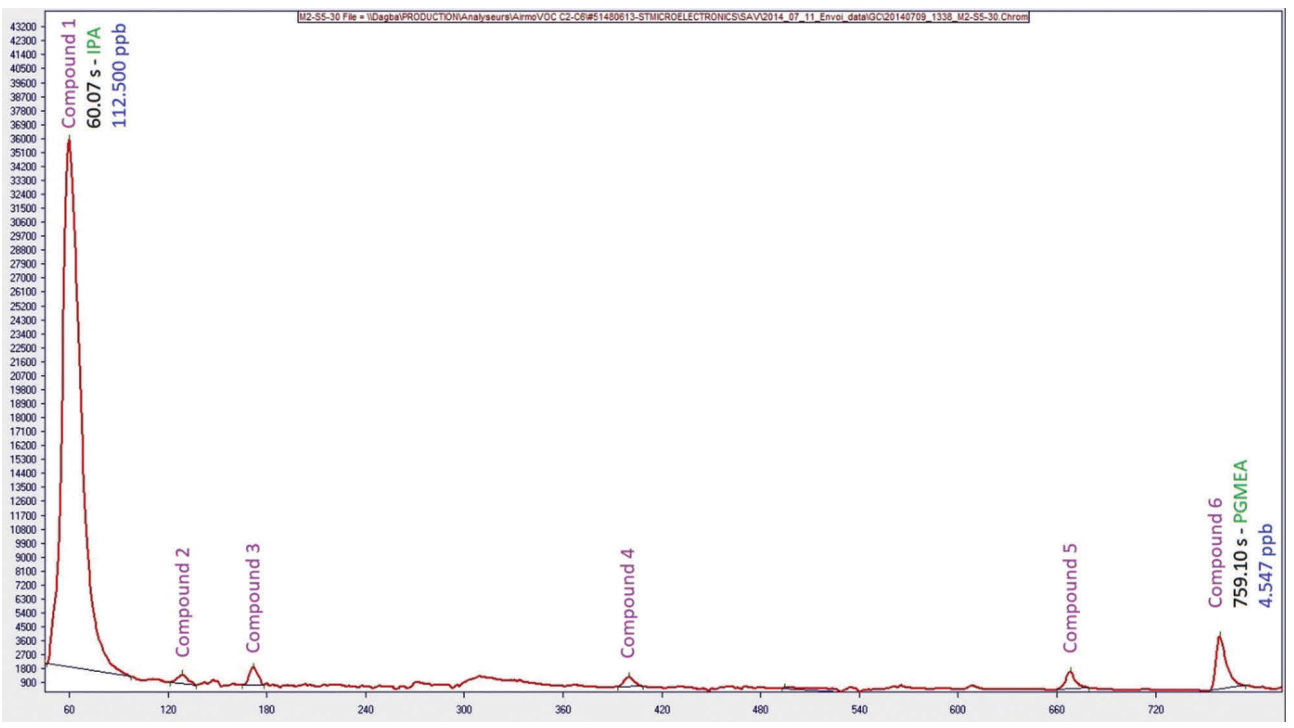
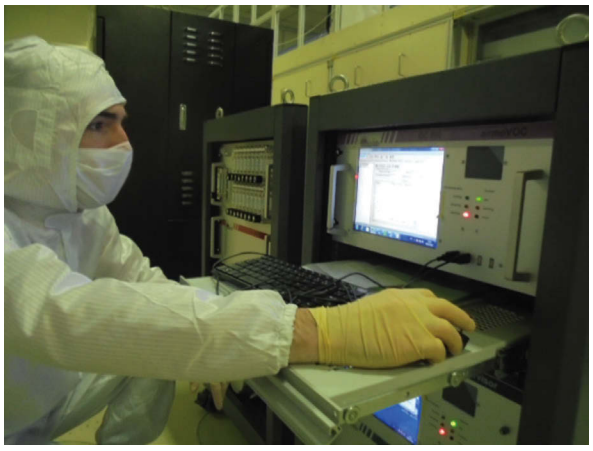


Figure 1: GC chromatogram representing the automatic identification of IPA and PGMA peaks respectively, the most representative VOCs monitored for semi-conductor applications.

at ppt and ppb in TRAP-GC-FID/MS mode and ppm or % levels in direct MS. The combination of these technologies brings the system to an expertise level which provides very high quality data, being capable to analyse from 1 to 16 streams automatically with full traceability on calibration and sample analysis.

Chromatotec® supervising software Vistachrom will provide automatically all concentrations for the listed compounds. Unknown compounds can be easily identified thanks to VistaMS identification function, linking the obtained mass spectrum to the NIST library.



GC-MS analyser in cleanroom in Taiwan

Leak Detection

Once high concentrations are measured in one location, shorter sequences of analysis can be used to detect the source of the leak faster. Length analysis can be reduced from 30 to 6 min performing the "6 minutes method" for the GC-MS configuration. The flexible probe is moved at different locations to find precisely the source of the leak without the need to move the instrument. This flexible probe can be up to 100 m long and allows fast leak detection.

It is also possible to measure the surrounding atmosphere in only 2 min per stream by using the direct inlet of the quadrupole MS. This detection mode can achieve a Low Limit Detection (LDL) of 500 ppb.

This feature allows identifying where the problem created by abnormal gaseous releases is and therefore to obtain VOCs concentration to the lowest level. In this way, decontamination would take place only in the affected area of the cleanroom, which helps to obtain longer lifetimes of Recycling Air Handler (RAH) filters.

Tracking the Origin of Contamination via Speciation

Many chemicals used in the manufacturing process often become the cause of contamination. Ammonia is a well-known contaminant in the lithography process. Among its possible sources is the Hexamethyldisilazane (HMDS) converted into Trymethylsilanol (TMSOH) and ammonia (NH3). With the capability to speciate and identify with expertise VOCs, the airmoTWA system is the right solution for tracking the time and the origin of the contamination process.

Cross-contamination represents another key issue in the cleanroom control. In fact, due to the air circulation pattern inside the cleanroom, a solvent used in a specific manufacturing area could become a dangerous contaminant in another area where a different process is run. Thanks to its capability to identify the specific organic compounds, the airmoTWA system offers a unique solution in determining cases of cross-contamination.

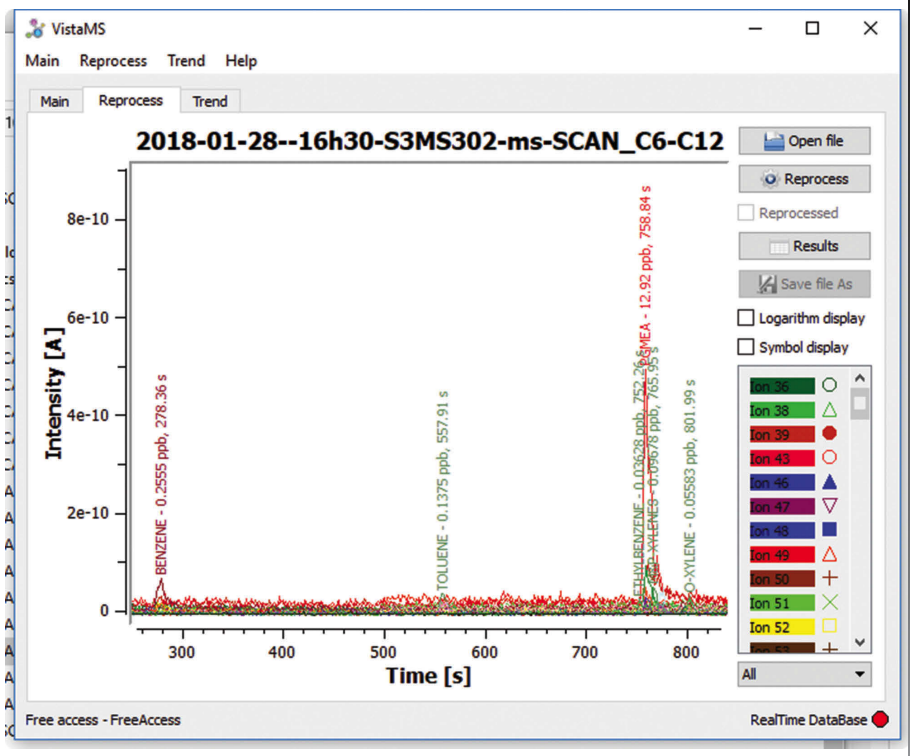


Figure 2: airmoTWA MS results in clean room

Checking the Filter Investment

The installation of chemical filters either on the recirculating air system of the cleanroom air or on the tools represents a big economic investment. Filter replacement according to a set maintenance scheme could unnecessarily increase an already high cost if working filters are changed too early or it could cause inadequate protection if exhausted filters are changed too late.

With up to 16 channels, the airmoTWA system allows monitoring both upstream and downstream of the filters. The sample point upstream detects when the incoming air is not within the filter specification, while the monitoring point downstream indicates when the absorbing capability is exhausted.

A Process Tool

The airmoTWA system has been designed to be an expert analytical process tool for continuous unattended operation. It automatically samples up to 16 points and for each of them different alarms can be set. Its capability to be transportable makes the airmoTWA system a very useful tool to understand contamination causes.

On board multipoint and multicomponent calibration is included to match the stringent quality control rules. With a cycle time from few seconds for leak detection to 30 minutes for high expertise, the airmoTWA will suit all customer needs.

Results are displayed in real time and expressed as concentration values, with no calculation to be run. Remote connection to the customer's network is provided as standard.

Mapping of the Chemical Composition of the Room

The airmoTWA system can perform a mapping of the chemical composition of the clean air room. Thanks to the multiplexer, up to 16 streams can be analysed automatically. The results obtained by GC-MS will be monitored and saved. It allows the measurement of volatile compound concentrations down to 1 ppt.

The automatic trend function of Vistachrom allows checking easily the variation of concentration over the time for a specific stream. Thanks to this function and the online analysis, the customer can identify and correlate a specific event in the production with a measured production.

Conclusion

AMC is one of the major degradation sources of photolithography process equipment, which leads to important costs. Therefore, VOC concentration in the working area must be decreased to reduce the frequency of RAH filter exchange and prevent equipment damage. These cost saving measures allow customers to finance the airmoTWA instruments.

The system presented is an approved solution for VOCs monitoring in indoor air which assures incredible sensitivity. This gold-standard in chemical analysis uses laboratory technology trap GC-MS for online analysis that do not require specialised operators. The airmoTWA instrument can monitor and record either high or low concentrations of a large number of molecules. Moreover, its security system allows setting alarms to inform on important changes of the surrounding atmosphere.

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