CONTAMINATION MANAGEMENT SOLUTIONS

Perfect solutions for airborne molecular contamination management and particle contamination monitoring
Contamination challenges

Contamination such as particles or molecules can impact devices with or without packaging during the manufacturing or storage operations.

Our know-how

With more than 10 years of experience in contamination management, Pfeiffer Vacuum provides innovative monitoring and containment solutions that are used notably in the following fields of application:

- Microelectronics
- Optics
- Display manufacturing
- Photovoltaics
- Pharmaceutical industry

Our solutions

Our products have been qualified by technology leaders and have demonstrated quantified results such as:

- Yield enhancement
- Quality improvement
- Manufacturing flexibility

Our solutions cover wafer carrier (FOUP, FOSB) monitoring from airborne molecular contamination (AMC) to particle counting (down to 10 nanometers) as well as vacuum decontamination processes. Our latest tool introduced on the market is the innovative monitoring device AMPC for clean room as well as EFEM monitoring.
Customer benefits

- Collaborative customer-oriented solutions
- Highly skilled team with worldwide knowledge and experience in contamination management
- Innovative and high-performance equipment
- From R&D to production
- High throughput (25 FOUPS/h for APA 302 LD)
- Upgradeable tools (latest analyzers, particle counters)
- Tool communication with semi fab host (SECS-GEM)
Pod Analyzer
In-line FOUP monitoring and airborne molecular contamination tracking

APA 302

Sub-ppbv levels of contamination such as acids can degrade process performance and decrease product yield.

Fab airborne molecular contamination (AMC) requirements have been defined, but AMC at the equipment and FOUP level needs to be understood and defined as stated by the ITRS\(^1\).

The APA 302 is a unique patented solution to monitor and track in-FOUP AMC in a production environment with or without wafers.

APA range can be considered as a technical platform offering different technologies for AMPC monitoring. The following options can be added according to customer needs:

- Extra analyzers can be placed into an optional cabinet option for increased compound monitoring APA 302 C (Cabinet).
- A APA 302 LF (LabInFab) option can also be used to go deeper into molecule identification.
- APA 302 platform is also used for FOUP leak check monitoring (APA 302 LD).

**APA 302 performances**

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Technology</th>
<th>Scale</th>
<th>Limit of detection</th>
<th>Response time within 2 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH(_3)</td>
<td>CRDS</td>
<td>0-10,000 ppb</td>
<td>0.4 ppb</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td>HF</td>
<td>CRDS</td>
<td>0-500 ppb</td>
<td>0.1 ppb</td>
<td>&gt; 70% (1)</td>
</tr>
<tr>
<td>HCl</td>
<td>CRDS</td>
<td>0-1,000 ppb</td>
<td>0.1 ppb</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td>Total sulfur</td>
<td>UV fluorescent</td>
<td>0-1,000 ppb</td>
<td>0.4 ppb</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td>Total acids</td>
<td>IMS</td>
<td>0-200 ppb</td>
<td>0.2 ppb</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td>Total amines</td>
<td>IMS</td>
<td>0 – 200 ppbv</td>
<td>0.2 ppbv</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td>Total VOC</td>
<td>FID</td>
<td>0-99 ppm</td>
<td>&lt;25 ppb</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td>H(_2)O</td>
<td>Hygrometer</td>
<td>0 – 100 % RH</td>
<td>5 %</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td>NO(_x)</td>
<td>UV fluorescent</td>
<td>0-1,000 ppb</td>
<td>0.2 ppb</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td>VOC</td>
<td>PTR-TOFMS</td>
<td>0-1,000 ppb</td>
<td>&lt; 0.04 ppb (Toluene)</td>
<td>Depends on compounds</td>
</tr>
</tbody>
</table>

\(^1\) ITRS: International Technology Roadmap for Semiconductors
Pod Analyzer
In-line FOUP monitoring and airborne molecular contamination tracking

APA 302 S
Equipped with two load ports, the APA 302 S is designed to track and monitor AMC in FOUP down to sub-ppbv levels.

FOUP can be processed manually or automatically by semi fab automation. Measurements are displayed and stored for each FOUP locally. Threshold management can also be activated and sent to semi fab host.

Customer benefits
- Upgradeable tool: Cabinet and LabInFab options.
- Small footprint under OHT1)

APA S features
- 26 U of room for analyzers
- Space under OHT1) 1,300 mm

Customer benefits
- No FOUP modification needed
- Throughput > 16 FOUP per hour (with full automation OHT1)
- Real time measurement
- High sensitivity (even for HF)
- SECS-GEM communication
- Can integrate latest VOC analyzers
- Upgradeable tool, extra analyzers, offline measurement
- Threshold compounds management

1) OHT: Overhead Hoist Transportation (automatic loading through fab robot)
Pod Analyzer with cabinet option
In-line FOUP monitoring and airborne molecular contamination tracking

**APA 302 C (Cabinet) version**
This solution is specifically designed for semi fabs willing to add more analyzers for extra compound monitoring. The room available on this frame can manage up to eight extra analyzers.

**Customer benefits**
- The cabinet option can be assembled onto existing APA 302 tools.
- Can integrate a large portfolio of analyzers

**APA 302 C features**
- Room available = 30 U
- 1 standard 19” analyzer (NH₃) = 4 U
- PTR MS analyzer = 23 U

**APA 302 C dimensions**
APA 302 LF (LabInFab)

Pod Analyzer with LabInFab option
In-line FOUP monitoring and airborne molecular contamination tracking

APA 302 LF

To go further in molecule identification, the APA 302 LF option enables the fab operator to safely trap FOUP and wafer contamination on site which can be analyzed in a second step with best-in-class instruments (chromatography etc.).

Customer benefits

■ Automatic compounds trapping systems
■ Production tool with R&D options

LabInFab configurations

<table>
<thead>
<tr>
<th>Number of traps per FOUP</th>
<th>Sampling flow per trap</th>
<th>Ease of use &amp; sampling reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 (standard)</td>
<td>Up to 1,500 sccm</td>
<td>Automatic leak test</td>
</tr>
<tr>
<td>8 or 12 (option)</td>
<td></td>
<td>Custom recipe (duration, line purge, flow selection, etc...)</td>
</tr>
</tbody>
</table>

FOUP measurement with standard recipe

![Image of APA 302 LF Pod Analyzer with LabInFab option](image1)

![Graph showing FOUP and ambient measurements](image2)

FOUP sampling with LabInFab recipe

![Image of APA 302 LF Pod Analyzer with LabInFab option](image3)

![Images of VOC trapped by Tenax tubes and AMC collected by impingers](image4)
Pod Analyzer with large capacity of analyzers integration.
In-line FOUP monitoring and airborne molecular contamination tracking

APA 302 L version

APA 302 L is especially designed for semi Fabs that wish to monitor a large variety of compounds.

Designed with the same footprint under OHT as APA 302S, APA 302 L offers a big capacity for analyzers storage. (up to 88 U)

The FOUP can be processed manually or automatically by semi fab automation. Measurements are displayed and stored for each FOUP locally. Threshold management can also be activated and sent to semi fab host.

APA 302 L dimensions
Customer benefits

- Small footprint under OHT\textsuperscript{1)}
- Could gather up to 20 analyzers

APA L features

- Space under OHT\textsuperscript{1)} 1,300 mm
- High throughput > 16 FOUP per hour
- 88 U for analyzers

\textsuperscript{1)} OHT: Overhead Hoist Transportation (automatic loading through fab robot)

Example of APA 302 L configuration

<table>
<thead>
<tr>
<th>Analyzer</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTR TOF</td>
<td>23 U</td>
</tr>
<tr>
<td>HF/HCL</td>
<td>4 U</td>
</tr>
<tr>
<td>NH\textsubscript{3}</td>
<td>4 U</td>
</tr>
<tr>
<td>SO\textsubscript{2}</td>
<td>4 U</td>
</tr>
<tr>
<td>T amines</td>
<td>4 U</td>
</tr>
<tr>
<td>Gas generator</td>
<td>2 U</td>
</tr>
<tr>
<td>NOX analyzer</td>
<td>4 U</td>
</tr>
</tbody>
</table>

Acids and VOC monitoring with APA 302 L for process qualification

- Process 2 generates less acid and VOC contamination
- Higher yield obtained with process 2: introduced in production
Pod Analyzer
In-line-FOUP monitoring for leak detection tracking

APA 302 LD version

The APA 302 LD is an advanced platform that analyzes FOUP air tightness. This is important to prevent wafer contamination from particles and AMC (e.g. humidity, compounds) to enter inside a FOUP. As most advanced fabs use N₂ purge, the APA 302 LD can also ensure purge efficiency.

APA 302 LD dimensions
Customer benefits

- FOUP qualification (old and new)
- Control FOUP aging
- Ensure a good N₂ purge efficiency

APA LD features

- Space under OHT\(^1\) 1,343 mm
- Conductance Range:
  - Low range recipe: 0.1 up to 5 l/s
  - High range recipe: 1 up to 100 l/s
- High throughput > 25 FOUP per hour
- No FOUP modification needed
- SECS-GEM communication
- Threshold management.

\(^1\) OHT: Overhead Hoist Transportation (automatic loading through fab robot)

Measurement principle

The conductance leakage of a FOUP door is linked to the pressure curve. The pressure decay recipe is split into four steps.

1. FOUP preparation
2. Pressure rise
3. Pressure decay, data logging
4. Data post processing

Results & applications

Evaluating and monitoring FOUP conductance (FOUP life time)

FOUP conductance and particle correlation

<table>
<thead>
<tr>
<th>FOUP</th>
<th>Conductance (l/s)</th>
<th>Particles issue on wafer</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOUP 1</td>
<td>0.254 l/s</td>
<td></td>
</tr>
<tr>
<td>FOUP 2</td>
<td>1.06 l/s</td>
<td></td>
</tr>
<tr>
<td>FOUP 3</td>
<td>1.403 l/s</td>
<td></td>
</tr>
<tr>
<td>FOUP 4</td>
<td>2.375 l/s</td>
<td></td>
</tr>
</tbody>
</table>

Customer PASS/FAIL threshold

\(n_{p} \) part > 0.1 µm
AMPC RANGE

Ambient Multi Port Controlling
Clean room, equipment front end module monitoring (EFEM)

AMPC

Airborne molecular contamination (AMC) in IC fabs is known as the major factor of yield loss. To control and understand where contamination comes from, Pfeiffer Vacuum now brings a unique solution to the semiconductor market to monitor clean rooms as well as EFEM (Equipment Front End Module).

Customer benefits
- Real-time compound measurement (acids, bases, organic compounds)
- Innovative software to manage sampling lines priority, quality check (QC) and alarms
- 96 samplings lines gathered onto one tool (up to eight analyzers)
- High throughput (analyzing and cleaning within three minutes)
- No cross-contamination from one sampling line to another
The AMPC gathers the most advanced analyzers to detect and quantify acids, bases and organic compounds in up to 96 locations in a fab thanks to an innovative and integrated valves design.

AMPC range includes two tools: AMPC S and AMPC L where external dimensions, number of lines and options are different.

### AMPC performance of analyzers

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</table>

### AMPC features

<table>
<thead>
<tr>
<th>AMPC Configuration</th>
<th>Number of lines</th>
<th>Room for Analyzers</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMPC S</td>
<td>From 16 to 64</td>
<td>39 U</td>
<td>Canister</td>
</tr>
<tr>
<td>AMPC L</td>
<td>From 16 to 96</td>
<td>39 U</td>
<td>Canister or/and continuous pumping</td>
</tr>
</tbody>
</table>

### AMPC Extension Frame
The AMPC Extension Frame includes 39 U for extra analyzers. This can be used for upgrades of existing AMPC units or added to new AMPC S and AMPC L units.

### Extension Frame (EF)
- Room available = 39 U
- 1 standard 19” analyzer (NH₃) = 4 U
- PTR MS analyzer = 23 U
AMPC S / AMPC L

Ambient Multi Port Controlling
Clean room, equipment front end module monitoring (EFEM)

AMPC dimensions

AMPC S

AMPC L
Recipe

Chose sampling lines to be monitored

Alarm and quality check management

Possibility to set different threshold/alarm depending on compounds for each sampling line.

If an alarm is activated, the software allows to define specific actions: Repeat measurement, clean analyzer, make a blank, redefine new threshold.

Scheduler

Manage automatically: Recipe/quality control/blank running. Possibility to cycle many recipes or the same recipes many times.

AMPC software
Pod Regenerator
Yield enhancement and airborne molecular contamination management

Moisture and airborne molecular contamination (AMC) such as evaporated fluorine are released in the FOUPs slot-to-slot space during queue times. These elements can generate crystal growth or other defects on patterned wafers which leads to yield loss and performance degradation.

APR 4300 is the unique patented solution to remove AMC from wafers and FOUP during queue time.

Customer benefits
- Flexible configuration
- SEMI S2 compliance
- 4 FOUPs/cycle
- Yield enhancement up to 7%
**Process description**

1. Conditioning to working pressure (~ 5 min)
2. Vacuum purge process: P < 0.1 mbar
3. N₂ purge to atmospheric pressure

**Vacuum purge duration**
ADPC 302

Dry Particle Counter
Unique particle monitoring inside FOUPs and FOSBs

The ADPC 302 is the unique dry system for monitoring particle contamination inside transportation carriers. The fully automated process localizes and counts particles on the inner surfaces of FOUPs or FOSBs, including the doors.

With cycle times of only 7 minutes, the ADPC 302 is the ideal in-line system to considerably improve the quality control of wafer production processes.

Customer benefits

- Particle detection from 0.1 to 5 μm (other options available)
- Fully automated monitoring of carriers (shell and door)
- Throughput: 8 up to 14 carriers per hour depending on recipe types (with OHT\(^1\))
- 10 nanometers counter (Condensation Particles Counter)
- SEMI & SECS/GEM compliance

\(^1\) OHT: Overhead Hoist Transportation (automatic loading through fab robot)
Dimensions

Carrier characterization

Number of particles

CLEAN

PROD

DIRTY

Threshold A

Threshold B

Particles < Threshold A

Particles > Threshold A

Particles < Threshold B

Particles > Threshold B

*Thresholds are set up according to customers needs

Carrier ID

Cleaning strategy optimization

Cleaning quality check

Particles level of 1 FOUP

=
VACUUM SOLUTIONS FROM A SINGLE SOURCE
Pfeiffer Vacuum stands for innovative and custom vacuum solutions worldwide, technological perfection, competent advice and reliable service.

COMPLETE RANGE OF PRODUCTS
From a single component to complex systems:
We are the only supplier of vacuum technology that provides a complete product portfolio.

COMPETENCE IN THEORY AND PRACTICE
Benefit from our know-how and our portfolio of training opportunities!
We support you with your plant layout and provide first-class on-site service worldwide.

Are you looking for a perfect vacuum solution?
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