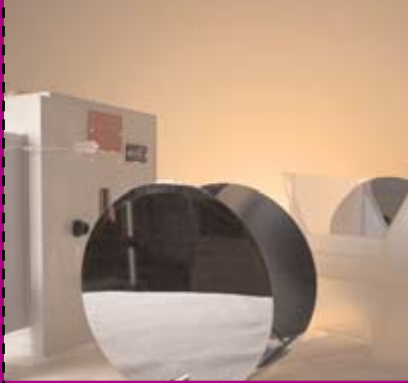


# SEMI F21-1102



## Cleanroom Air Monitoring Program

It is universally known that particle control is an essential part of the semiconductor and disk drive fabrication process. Cleanroom technology, which relies on the use of HEPA and ULPA filtration, has almost exclusively focused on control of incrementally smaller particles.

There continues to be an increasing awareness that Airborne Molecular Contaminants (AMC) play an important role in determining fabrication process yield. In response to this need, SEMI issued SEMI F21-1102 standard, "Classification of Airborne Molecular Contaminant Levels in Clean Environments," to classify clean environments with respect to four classes of molecular contaminants, including:

- Molecular Acids (MA)
- Molecular Bases (MB)
- Condensable Organic Compounds (Molecular Condensables) (MC)
- Molecular Dopants (MD)

Balazs<sup>™</sup> now offers a complete air analysis service for these airborne molecular contaminants. All analytical procedures and results are provided in accordance with SEMI standard F21-1102. Table I lists the general SEMI classification for these contaminants.

### General Sampling and Analytical Methodology

Sampling of cleanroom air is conducted over a 8-48 hour period using sampling systems that have proven efficient for capturing acids, bases, dopants, salts, trace metals and organics. All analyses are conducted using Balazs proprietary procedures and are performed by calibrated and standardized analytical equipment such as the Ion Chromatograph (IC), Inductively Coupled Plasma-Mass Spectrometer (ICP-MS), and Gas Chromatograph-Mass Spectrometer (GC-MS). Results are reported in pptm (parts per trillion molar) as defined by SEMI F21-1102 (see *Table 1 and Table 2*). Process improvement can be obtained by focusing on critical process steps and sensitivity levels to MA, MB, MC, or MD at each step.

### Impact on Process Yield

Airborne Molecular Contaminants can negatively affect semiconductor yields by contaminating wafers and virtually all process instrumentation and tools. Cleanroom air may be recirculated across different areas of the fab, leading to cross contamination. If these concentrations reach threshold levels (See *Table II* for typical limits for 0.25 micron process), yields can suffer. *Table III* provides a summary of documented process issues caused by AMC.

Material Category	1*	10*	100*	1000*	10,000*
Acids	MA-1	MA-10	MA-100	MA-1000	MA-10,000
Bases	MB-1	MB-10	MB-100	MB-1000	MB-10,000
Condensables	MC-1	MC-10	MC-100	MC-1000	MC-10,000
Dopants	MD-1	MD-10	MD-100	MD-1000	MD-10,000

Table 1: SEMI Classification (\*Concentration listed as parts per trillion (ppt)).

Process Step	Max Sit Time	MA*	MB*	MC*	MD*
Pre-gate Oxidation	4 hour	13,000	13,000	1,000	0.1
Salicidation	1 hour	180	13,000	35,000	1,000
Contact Formation	24 hour	5	13,000	2,000	100,000
DUV Lithography	2 hour	10,000	1,000	100,000	10,000

Table 2: Projected AMC Limits for 0.25µm Process

### Control of Airborne Molecular Contamination

This Air Program will provide results to improve your process and product. Features of the program include:

- Testing and reporting results on air in make-up, recirculation, exhaust, mini environments and in lithography and diffusion areas
- Assisting in setting a baseline
- Recommending a monitoring program

Acids & Bases	Condensables	Dopants	Metals *
Fab Corrosion	Adhesion Failure	Uncontrolled B, P Doping	Degradation of Electrical
Etch Rate Shifts	SiC Formation (after Pre-oxidation Clean)	Threshold Voltage Shifts	Properties of Si Substrate (e.g. Carrier Lifetime, Leakage Currents)
DUV Photoresist T-topping	High Contact Resistance	Resistivity Shifts	High Contact Resistance
Wafer and Optics Hazing	Gate Oxide Integrity Degradation	Nucleation Irregularities	Gate Oxide Integrity
Metallization Corrosion	Ineffective Cleaning	HEPA Filter Degradation or Outgassing of Boron and Phosphorus	Threshold Voltage Shifts

Table 3: AMC Related Process Issues (\*Molecular Metals (MM's) are not a SEMI F21-1102 class at this time).

### Additional Services

In addition to the SEMI F21-1102 Air Analysis package, Balazs can provide trace metal analysis (MM's), which is useful for both identifying sources of molecular metal contamination and for routine monitoring.

Molecular metals are not included in the SEMI F21-1102 standard; however, we recommend measuring, monitoring, and controlling them because trace metallic contamination can cause degradation of the device's electrical properties, and can adversely affect gate oxide integrity and threshold voltages.

We also offer Witness Wafer Analyses for all of these classifications and Organic Outgassing as supplementary analytical services to monitor your cleanroom air.