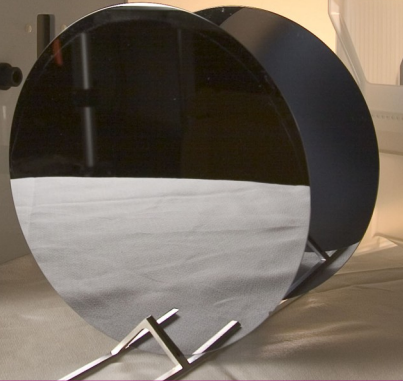


# SEMI F21-1102 AMC Classification



## Cleanliness Classification for Cleanrooms and Other Critical Environments

Airborne Molecular Contaminants (AMC) can negatively affect manufacturing yields by contaminating IC wafers, solar cells, LEDs, FPDs, lasers, printed circuit boards, hard drives and virtually all process components and tools. The increasing awareness AMC plays in achieving fabrication process yield has resulted in SEMI issuing a SEMI F21-1102 standard, “Classification of Airborne Molecular Contaminant Levels in Clean Environments.” This document classifies the cleanliness of critical environments with respect to four classes of molecular contaminants, namely:

- Molecular acids (MA)
- Molecular bases (MB)
- Molecular condensables (MC)
- Molecular dopants (MD)

Balazs™ NanoAnalysis offers a complete air analysis service for detecting these airborne molecular contaminants. Our air testing program will provide results to improve your process and product. Features of the program include:

- Testing and reporting results of air - make-up, recirculation, exhaust, in mini-environments and in lithography and diffusion areas
- Testing before and after AMC filters and purifiers
- Recommending a monitoring program
- Establishing a cleanliness baseline

### SEMI F21-1102 standard

The general cleanliness class classifications for AMC contaminants are shown in Table 1 in concentrations of parts per trillion (ppt).

*Table 1. SEMI classification*

Material Category	1	10	100	1000	10,000
<b>Acids</b>	MA-1	MA-10	MA-100	MA-1000	MA-10,000
<b>Bases</b>	MB-1	MB-10	MB-100	MB-1000	MB-10,000
<b>Condensables</b>	MC-1	MC-10	MC-100	MC-1000	MC-10,000
<b>Dopants</b>	MD-1	MD-10	MD-100	MD-1000	MD-10,000

## Impact on Process Yield

Cleanroom air may be recirculated across different areas of the fab leading to cross-contamination. Table 2 provides a summary of documented process issues caused by AMC. Yields can suffer when these concentrations reach threshold levels that are set by equipment manufacturers, fabs or the ITRS.

*Table 2. AMC related process issues*

Acids and Bases	Condensables	Dopants	Metals *
Fab materials corrosion	Adhesion failure, thin film defects	Uncontrolled B and P doping	Degradation of electrical conductivity
Etch rate shifts	SiC formation (after preoxidation clean)	Threshold voltage shifts	Properties of Si substrate (e.g. carrier lifetime, leakage currents)
DUV photoresist T-topping	High contact resistance, Cu voids	Resistivity shifts	High contact resistance
Wafer and optics hazing	Organic hazing on wafers and optics	Nucleation irregularities	Gate oxide integrity (GOI)
Metallization corrosion	Ineffective cleaning or wetting	ULPA filter degradation or outgassing of B and P	Threshold voltage shifts

\* Molecular Metals (MM's) are not a SEMI F21-1102 class at this time

## Analytical Methodology

Sampling of the cleanroom air is conducted over a 8-24 hour period using sampling systems that have proven efficient for capturing acids, bases, dopants, salts, trace metals and organics. All analytical tests using Ion Chromatography (IC), Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) and Gas Chromatograph-Mass Spectrometry (GC-MS) are conducted using Balazs™ proprietary procedures and are performed by calibrated and standardized analytical instruments. Results are reported in pptm (parts per trillion molar) as defined by SEMI F21-1102 (see Table 1). Process improvement can be obtained by focusing on critical process steps and sensitivity levels to MA, MB, MC, or MD at each step.



*Figure 1. Specially prepared wafers for SMC monitoring*

## Additional Services

In addition to the SEMI F21-1102 air analysis package, Balazs™ can provide trace metal analysis (MMs), that 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, but are included in the ITRS. 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.

Balazs™ also offers tests beyond F21-1102 including a witness wafer analysis program for all of these classifications per ITRS guidelines. Witness wafers can determine contamination from handling, storage, boxes, cassettes, chucks, cleaning baths, processes and equipment.

Organic outgassing testing of cleanroom construction materials (IEST RP-CC-031.3) and components to determine sources of molecular condensables (MCs) detected in your cleanroom air, mini-environments or glove boxes.