

Qualification of Lithography Tools



Analysis of Cleanroom Air and Compressed Gases are Required to Maintain Lens Warranty

In order to maintain full warranty coverage for steppers, manufacturers require tool owners to meet explicit air and purge gas contamination specifications. Additionally, periodic analyses of refractory compounds are also required. In order to fulfill these requirements, Balazs NanoAnalysis offers stepper environment analyses to meet ITRS and OEM requirements.

Four types of molecular contaminants are evaluated: acids, bases, dopants and organic compounds. Results from any of these analyses can be used to correlate yield problems with contamination in air and gases exposed to the wafer during processing.

Highlights

- Current detection limits exceed equipment manufacturer and ITRS specifications
- Balazs offers methods to ensure warranty compliance
- Balazs analyzes organic refractory compounds by GC-MS
- Sample collection bubblers have been studied and analyzed to optimize sample integrity and detection limits for fluoride and other ionics
- Related services ensure optimum performance and throughput

Analyte/test	Detection Limits	Equipment/Technique
Acids & Bases	Meets ITRS and stepper specifications; Fluoride reported to <10ppt	Bubblers, IC, GC-MS for amides
SO₂	< 0.1 ppbV	Proprietary bubbler and IC
Organic and Refractory Organics	< 0.1 ppbV	TD-GC-MS
N₂ Impurities (CO, CO₂, H₂, O₂, etc.)	Meets ITRS and stepper specifications	GC-MS, DID and specific tests

Acids and Bases

Chemicals used in the fab are present in the air and can contaminate wafers, ultrapure water sinks, chemical baths, and other areas within the fab. Acids can corrode metal and equipment or lead to hazing problems for wafers, reticles and optics. Bases, especially ammonia, amines and amides, may cause DUV resist "T-topping" and salicide defects. Some organic photoresist strippers are sources of amines. Monitoring chemicals is critical to reducing contamination on the wafers. Acids and bases are analyzed by ion chromatography (IC). Table 1 shows a list of applicable detection limits.

Analyte	Reporting limit	
	$\mu\text{g}/\text{m}^3$ in air	ppbv
NH_4^+	0.05	0.068
Br^-	0.05	0.015
Cl^-	0.02	0.014
F^-	0.02	0.026
NO_3^-	0.05	0.020
NO_2^-	0.02	0.011
PO_4^{3-}	0.05	0.013
SO_4^{2-}	0.05	0.013

Organic Compounds

Organic compounds in the cleanroom may adversely affect many processes in the fab, including cleaning, etching, oxide growth, high temperature processes and film deposition. Organophosphates in cleanroom air are known to counter dope silicon wafers. Identifying and monitoring sources of organics are becoming increasingly critical to yield enhancement. Balazs developed a method to trap and identify organic compounds, from C6 to C28. This method is useful for sampling air in makeup, recirculation, exhaust, and minienvironments.

- Molecular condensables (plasticizers, oils, curing agents)
- Molecular dopants (B and P organic compounds)
- Refractories (silicon)
- Halogen organics (Cl, F and Br containing organics)

Sample Collection and Analysis

Cleanroom Air and Lithography Purge Gases

For trace metals, acids, bases, and dopants, the Cleanroom Air Sampler is used. The Cleanroom Air Sampler is a modular unit manufactured using only cleanroom compatible materials. Purge gases are collected in a slightly different fashion since the gases are under pressure but the overall objective is the same.

For organic compounds, special stainless steel sampling tubes containing distinct beds of proprietary adsorbent materials are provided by Balazs to trap organic compounds in its gaseous state.

A blank (another sampling module that is treated in the same manner as the sample) accompanies the sample. This ensures that only contamination from the air or gas is quantified, not contamination generated by sampling, shipping, or handling.

Additional Resources

Balazs also offers a cleanroom air classification program per SEMI F21-1102 guidelines (please ask for Application Note APP0355). AMC Guidelines Balazs also offers the 2003 AMC Guidelines on CD, which define airborne contaminants, their sources and effects and recommend methods to identify and control them. The guidelines provide typical AMC levels in semiconductor cleanrooms for benchmarking, recommended testing by semiconductor process or environment, and a troubleshooting guide.

Witness Wafers

Balazs offers witness wafer analyses for correlating airborne contaminants to those that adhere to the wafer surface. Witness wafers are positioned for a defined period to collect a typical sample of contamination that adheres to the surface of the wafer. The wafers are packaged using a unique process to avoid contact contamination associated with shipping and handling. Upon arrival at the Balazs facility, the analysis for contaminants occurs in a wafer desorber.

Witness wafer programs also use blanks in order to confirm the integrity of the sample.