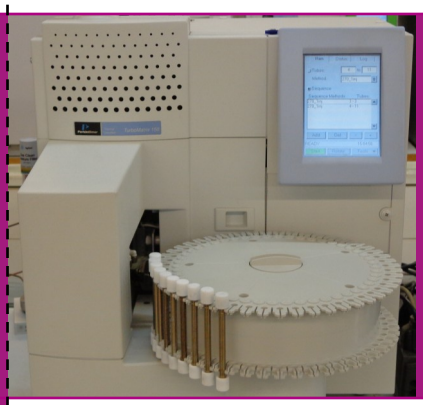
Gas Chromatography for Organic Testing



Identification and Quantification of Volatile Organics in Liquids, Gases and Solid Materials

Organic contamination is a concern to many industries because an organic residue may form after the contaminated surface is processed and thereby affect subsequent processing steps. In the semiconductor industry, for example, organic residue causes poor film adhesion and delamination. Volatile organic compounds (VOC) from packaging materials and carriers can outgas and affect the product's integrity.

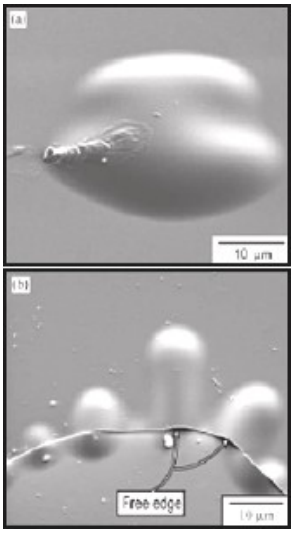


Figure 1. Delamination examples

Balazs™ NanoAnalysis is equipped with several gas chromatography tools such as GC-MS, GC-FID, GC-TCD, GC-DID and TD GC-MS. When they are used in conjunction with FTIR, Raman, SEM-EDS, TMA, TGA and DSC they provide valuable solutions to organic contamination problems. Our experience extends across many industries including semiconductor, solar photovoltaic, LED, optoelectronics, laser, aerospace, biomedical and biotechnology, plastic and polymer, hard-drive and flat panel display.

Key Applications

- Identifying and quantifying volatile organic compounds
- Characterizing surfactants, solvents and lubricants
- Material outgassing studies
- Evaluating plastics and polymers
- Identifying organic contaminants on wafers and films
- Detecting organics in air and gases
- Delamination examples

Figure 2. Assorted materials for outgassing

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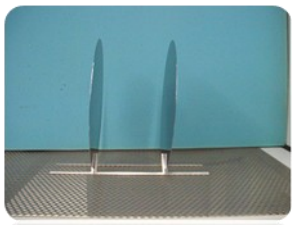
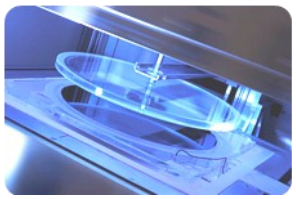
Gas Chromatography Techniques

- Gas chromatography (GC), is used to analyze complex organic material and separate it into pure components which are identifiable by their unique mass spectrum.
- Gas chromatography-mass spectrometry (GC-MS) is a method that combines the features of gas chromatography and mass spectrometry to identify different substances within a test sample. Applications of GC-MS include the identification of unknown liquid or gas samples. The GC-MS has been widely heralded as the gold standard for substance identification because it can be used to identify an isolated compound.
- Thermal desorption GC-MS is used to test materials for their outgassing characteristics. A portion of the material is placed into stainless steel desorption tubes and outgassed at elevated temperature per IEST RP-CC031 method.
- Outgassing of materials can also be performed using IDEMA M11-99 or other proprietary test methods.



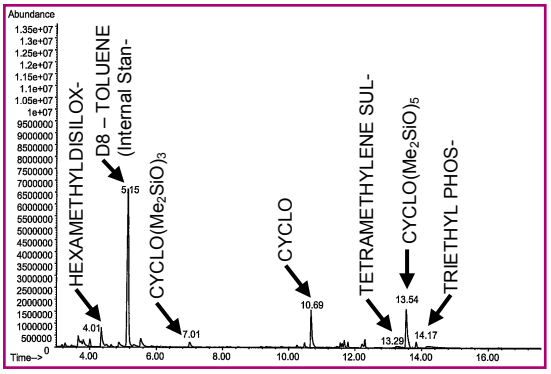
Organic-free witness wafers for AMC-MC monitoring



Full wafer desorption chamber

GC-MS Analysis of Gas and Air

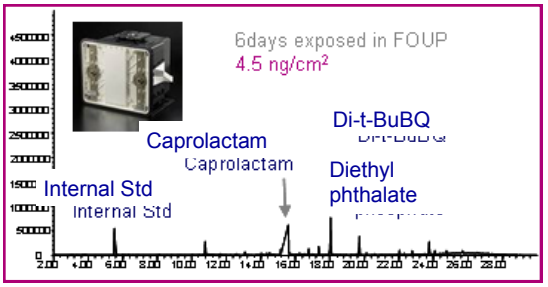
- Refractory organics including S, P and Si compounds are detectable to <100 pptV in only 6 hrs
- ITRS limits
  - 100 pptV detection may be achieved
  - Si as HMDSO (hexamethyldisiloxane), $C_6H_{18}OSi_2$
  - S as tetramethylene sulfone, -cyclic ($-C_4H_8SO_2$)
  - P as TEP (triethyl phosphate), $(EtO)_3P=O$
- Alternatively, air sample can be collected over 4 to 24 hrs using a Summa canister for very volatile organics
- A cryo-focus GC-MS is used to analyze for volatiles to sub-ppbV levels



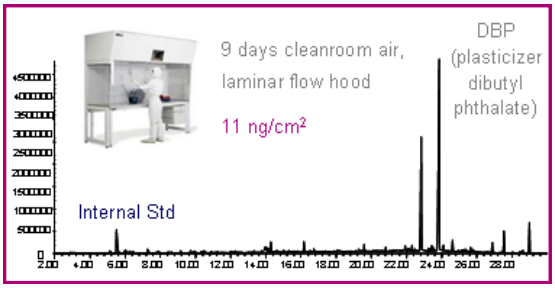
GC-MS chromatogram of TEP (triethyl phosphate) found in semiconductor cleanrooms

Full Wafer Outgassing and TD GC-MS

- Organic-free witness wafers exposed to different clean environments
- Wafers analyzed using TD GC-MS, SEMI MF 1982-1103 Method-B
- ITRS recommended surface molecular organics concentration is 2 ng/cm²; this represents ~0.1 monolayer



Contaminants found on a wafer after six days in a FOUP



Organic contaminants found in a cleanroom hood

Low organic outgassing wafer carrier