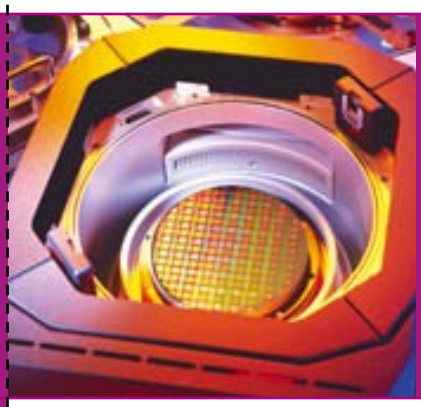
BALAZS™ nanoAnalysis

Surface Cleanliness Testing



Improving Yield Through Tool Parts Cleanliness Validation

Tool cleanliness is a prerequisite for achieving high yield processing of advanced technology node devices. Cleaning procedures, handling protocols, packaging and the cleanliness of the environment are key parameters that can affect the cleanliness of the part. Verification of the part's cleanliness is important to:

- Ensure the new or used parts meet their surface cleanliness specification after precision cleaning
- Determine the part's cleanliness shelf time

Inspecting a ceramic ring before installation

Packaging can outgas and contaminate the part

Balazs™ NanoAnalysis offers non-destructive test methods to characterize the surface of tool parts, components and assemblies for metal, organic, ionic and particle contamination. Our experience with parts qualification extends over 20 years.

We have collaborated with tool OEMs, precision cleaning houses, machine shops, materials development scientists, wafer handlers, valve and manifold manufacturers and packaging suppliers.

Table 1. Non-Destructive Surface Cleanliness Tests

Metal	Acid Extraction and ICP-MS
	UPW Extraction and ICP-MS
	Drop Scan Etch and ICP-MS
Organic	Solvent Extraction and GC-MS
	Solvent Extraction and NVR/FTIR
Ionic	UPW Extraction and Ion Chromatography
Particle	UPW Extraction and LPC (SEM-EDS)

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AIR LIQUIDE ELECTRONICS

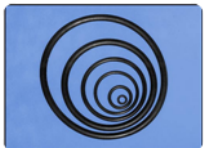
Applications

Tool Part, Component and Assembly

Cleaning tool parts is a highly complex process that requires process control steps throughout the entire cleaning cycle. Cleanliness specifications are required for FEOL and BEOL tools as well as for advanced packaging. The number of cleaning steps continues to grow, each requiring different selectivity and defectivity requirements. This is further complicated by the stringent requirements of the ITRS roadmap for enhanced tool performance and the introduction of new materials particularly at 45 nm technology and below. Surface cleanliness verification may be performed on coupons, first articles or directly on tool components. Common materials requiring surface characterization include:

- Ceramics: quartz, alumina, glass and sapphire
- Metals: aluminum, stainless steel, molybdenum and copper
- Plastics: polyimide, PEEK, PTFE, Kapton and Viton
- Coatings: plating, anodizing and powder coating

Ceramic coupons



O-rings

Cleaning Process Evaluation

- Wet benches require contamination and efficacy testing. Most wet benches use SC1 (ammonium hydroxide and hydrogen peroxide) and SC2 (hydrochloric acid and hydrogen peroxide). However, at 65 nm technology and below, increasingly tight defectivity allowances and oxide/Si loss requirements will require altering SC1 etch characteristics to mitigate material loss or devising a new chemical solution. Witness wafers may be used to determine the cleanliness of the process (chemicals) and efficacy for wafer front side, backside and bevel cleaning.
- Spray tools may be used for large surface cleaning and rinsing. Non-uniform dispensing of chemicals and UPW across the surface may result in residue water marks and hazing on the surface after drying. Surface cleanliness tests may be applied to solar panels, photomasks and wafers.

Non-Destructive Surface Cleanliness Tests

Metals

- Acid extraction and ICP-MS
  - Perform extraction over the whole surface or on one side of the part
- Drop scan etch and ICP-MS
  - A specialized acid extraction procedure for a localized area
- UPW extraction and ICP-MS
  - Perform extraction over the whole surface or on one side of the part. The collection efficiency of UPW is less than using an acid on the same surface. This method is used when a cosmetic stain cannot be tolerated.

Organics

- Solvent extraction and GC-MS
- Solvent extraction followed by NVR (non-volatile residue) measurement and FTIR analysis for organic identification
- UPW extraction and TOC (total organic carbon) analysis

Ionic

- UPW extraction and ion chromatography for ions such as Cl^-, F^-, SO_4^-, PO_4^-, NO_2^- and Br^-

Particle

- UPW extraction with agitation using an orbital shaker or megasonic energy followed by liquid particle counting (LPC)
- Particle characterization may be made using EDS for elemental identification and Raman/FTIR for organic identification