Coupons and Parts Cleanliness Testing

Cleanliness Testing for Tool Performance

For the sub-100 nm technology node even minor differences in the components of identical tool chambers can influence yield and mean time between failures (MTBF). This places greater challenges on original equipment manufacturers (OEMs) to develop coupons, first articles and parts cleanliness specifications and on precision cleaning vendors to meet these stringent requirements.

Balazs™ NanoAnalysis has developed non-destructive cleanliness test methods for coupons, tool components and assemblies to quantify surface metals, ionics, organics and particles. These tests may be used to qualify vendors, certify cleaning processes and provide lot-to-lot quality control.

Balazs™ has over 20 years of experience testing build of materials (BOM) used in process tools. Packaging is an integral component of the BOM and the cleanliness test methods in Table 1 are also applicable to their selection and cleanliness qualification.

Table 1. Build of Materials in Process Tools

Metals	Al	Ni	SST	Mo	Ti	Ta	Cu/Cu alloys
Coatings	Ni plating	Au plating	Powder coating	Paint	Alodine	Anodized	Zn
Plastics	PEEK	PTFE	Polyimide	Polyethylene	Kapton	Viton	Calrez
Ceramics	Alumina	Glass	Saphire	DLC	Quartz		
Assemblies	Welded aluminium	Welded steel alloys	Brazed	Bonded	Flex circuit		

Process tools

- Surface preparation and cleaning
- Thermal anneal furnaces
- Doping
- Etch
- Deposition

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Metal Contamination

Surface metal extraction of parts and coupons using UPW or dilute acid may be utilized to qualifying cleaning vendors and quantifying surface metal contamination. Specialty wipes provided by Balazs™ may be used to evaluate surface metals by wiping any surfaces such as tool chamber walls, components and even working surfaces. The metals collected on the wipes are then extracted and quantified by ICP-MS.

Figure1. ICP-MS in Class 100 laboratory

Organic Contamination

Organics on surfaces may be characterized directly using XPS and TD GC-MS, indirectly using solvent extraction with $MeCl_2$ or hexane followed by pre-concentration and GC-MS or FTIR for analyzing the non-volatile residue (NVR), or for total organic carbon (TOC) of the UPW extract. Target surface level for organics is 2 ng/cm^2 (ITRS 2005-2009) that represents ~0.1 monolayer or about 1x10^{14} Carbon atoms/cm^2. Adhesion and delamination may result from the presence of >10 ng/cm^2 on the surface of the interface.

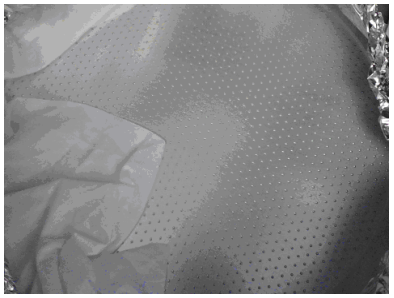

Figure 2. All tests described are applicable for ceramic showerhead

Ionic Contamination

Time-dependent haze (TDH), also known as degradation haze, may be characterized by UPW extraction followed by analysis of the extract solution using ion chromatography. Extraction test conditions for time and temperature can be varied depending on the part's application.

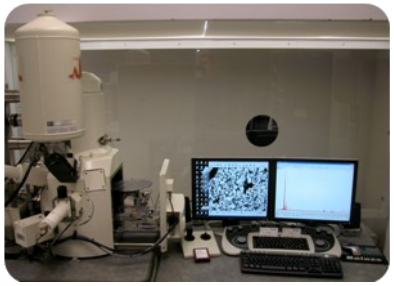

Figure 3. SEM-EDS for elemental mapping and imaging

Particle Contamination

Particles may cause defects in process tools. They may be extracted from the surfaces by submerging the complete part or coupon in UPW and applying external energy such as orbital shaking or megasonic to dislodge the particles. The particles may be counted and sized (>0.1 µm) using a laser particle counter (LPC) and/or collected on a filter for imaging and characterization by EDS, FTIR or Raman.

Packaging Qualification

Packaging is an integral component of the part, assembly or coupon. The rule of thumb for the cleanliness level of packaging film is it should be at least 3-5 times lower than the cleanliness specifications of the part to be packaged. Natural and antistatic polyethylene (PE) generally exhibit acceptable levels of ionic cleanliness and are generally shown to also be oil and amine-free. Most available films, including natural PE, are not adequate for packaging tool parts requiring very low levels of hydrocarbon contaminants. Identifying the purest materials through testing reduces added contamination from packing.