UltraPure Water Testing Services

Consistent High Quality Water for Optimized Production Yields

Careful monitoring of UltraPure Water (UPW) at the point-of-distribution (POD) for contaminating constituents such as ions, metals, bacteria, organics, silica and particles is critical in order to produce high quality water consistently and optimize production yields. However, UPW systems consist of many dynamic components causing continuous water quality fluctuations.

By expanding the monitoring program from the POD to include the incoming feed water and each of the major processing components, contaminants can be detected early, before they negatively impact the critical fab supply location. In addition, monitoring the return location provides a check on the health of the overall distribution system returning to the water plant.

Critical Anions, Cations and Trace Metals

The International Technology Roadmap for Semiconductor (ITRS), ASTM and Balazs UPW Water Guidelines specify parts per trillion (ppt) levels for critical anions, cations and metals in UPW to control advanced technological processes. Monitoring a UPW system for ions and trace metals can help to quickly detect changes in ion exchange resin performance or failures from stainless steel components such as pumps or valves.

Table 1. Key Tests for Anions, Cations and Metals
Low level anions[1]
Low level mono and divalent Cations[2]
30 elements by ICP-MS[3]
30 ultra low level elements by HR-ICP-MS[3]
68 elements by ICP-MS[4]
PPQ analysis of 36 elements[5] 0.5ppt

[1,2,3,4,5] notes on page 2

Although online resistivity is useful for determining large changes in ionic activity, it does not provide specific ion information and is not able to detect trace metals, such as chromium, iron and nickel generated from stainless steel components.

Ions, such as, ammonium and sulfate can be indicators of resin oxidation, while sodium and chloride can point to an inadequate regeneration or a resin cross contamination issue. It is important to build a database through baselining of “normal” ion and metal levels in order to track the source of offending ions or metals when they occur.

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Bacteria

Bacteria will proliferate in low flow or stagnant areas of a UPW system or process tool. Bacteria growth in a water system can clog filters and can foul reverse osmosis membranes and ion exchange resins. At the wafer point-of-use (POU), bacteria not only act as a particulate contamination, but can increase ionic, metallic, and organic material on the wafer surface. Prevention and frequent monitoring is crucial to controlling bacteria. Balazs NanoAnalysis analyzes bacteria using culture techniques, epifluorescence microscopy, Scan RDI, and scanning electron microscopy (SEM).

Table 2. Key Tests for Bacteria
ASTM F1094-87 method with 48 or 72 hours incubation (viable)
Rapid turnaround RDI scan (viable)
Total (viable and nonviable) by epifluorescence microscopy

Organics

Organic contaminants are deleterious to wafers. Organic levels have been monitored online, real-time using total oxidizable carbon (TOC) analyzers. However, TOC analyzers may not detect large, difficult to oxidize compounds and most do not identify specific organic compounds. Building a database of "normal" organics is helpful in determining the source of increased TOC levels. Balazs offers the following analyses to supplement on-line analyzers: Resin Amines, Trihalomethanes (THM), Organic Acids, Urea and Semi-Volatile Organics.

Table 3. Key Tests for Organics
Total oxidizable carbon (TOC) 5ppb
Trihalomethanes (4THMs-GC) 0.5ppb
Organic acids 0.5 - 1ppb
Urea 2ppb
Semi-volatile organics by GC-MS 25ppt
Resin amines by IC 50ppt

Silica and Boron

Silica exists in both a soluble (dissolved) and non-soluble (colloidal or particulate) form. Colloidal silica in UPW is not removed by ion exchange resin and may be too small to be captured by final filtration. Dissolved silica and boron breakthrough are key indicators of ion exchange resin exhaustion and should be monitored closely.

Table 4. Key Tests for Silica and Boron
Dissolved silica 1ppb
Low level dissolved silica 0.1ppb
Ultra-low dissolved silica 0.05ppb
Non-dissolved (includes colloidal and solid)
Total silica 0.5ppb
Low level total silica 0.2ppb
Boron 10-50ppt

Particles

Balazs offers two particle analyses: optical particle counting and SEM, to augment on-line particle monitoring. Optical particle counting is useful for mass scanning during a catastrophic UPW system failure (filter by-pass or resin bed failure). Scanning Electron Microscopy Direct Count Method (SEM-DCM) is excellent for monitoring the overall efficiency of a UPW system over time. Using SEM-DCM, it is also possible to obtain elemental composition of the particles by Energy Dispersive X-Ray (EDS). The particle count and elemental information are useful for baselining, and for troubleshooting suspected excursions.

Table 5. Key Tests for Particles
SEM/DCM (includes Bacteria) filter pore sizes: 0.05, 0.1, 0.2µm
Particle identification by EDS >0.1µm

Consulting Services

In addition to state-of-the-art water analysis, Balazs also offers highly qualified technical team for client support. Consulting services are available for resolving microcontamination issues, assisting with data interpretation and recommending site specific sampling programs. Ultrapure water processing and analysis training seminars are also available.

Notes for Table 1

1. Anions: F^-, Cl^-, NO_2^-, Br^-, NO_3^-, HPO_4^{2-}, SO_4^{2-}
2. Monovalent and Divalent Cations: Li^+, Na^+, K^+, NH_4^+, Ca^{2+}, Mg^{2+}
3. 30 Elements: Al, As, Sb, Ba, Bi, B, Cd, Ca, Cr, Co, Cu, Ga, Ge, Fe, Pb, Li, Mg, Mn, Hg, Mo, Ni, K, Ag, Na, Sr, Sn, Ti, W, V, Zn
4. 68 Elements: Al, As, Sb, Ba, Be, Bi, B, Cd, Ca, Ce, Cs, Cr, Co, Cu, Dy, Er, Eu, Gd, Ga, Ge, Au, Hf, Ho, In, Ir, Fe, La, Lu, Pb, Li, Mg, Mn, Hg, Mo, Nd, Ni, Nb, Os, Pd, Pt, K, Pr, Re, Rh, Rb, Ru, Sm, Sc, Se, Si, Ag, Na, Sr, Ta, Te, Tb, Tl, Th, Tm, Sn, Ti, U, W, V, Y, Yb, Zn and Zr
5. PPQ Elements: Li, Na, Mg, Al, K, Ca, Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Sn, Ba, Pb, Be, V, Ga, Ge, Sr, Zr, Nb, Mo, Ag, Cd, In, Sb, La, Ta, W, Pt, Tl, and Bi