Nanoparticle Monitoring in Ultrapure Water

TSI Nano LPM™ System Frequently Asked Questions

Rev A

Question

Why is detecting silica so important as compared to other optical-based technologies?

Answer

Silica is a dissolved inorganic material that causes significant damage to wafers. Semiconductor manufacturers spend millions of (Dollars, Euros, Won...) to filter UPW and remove silica, because if silica is in the UPW it easily causes wafer defects. The Nano LPM™ System is the ONLY liquid particle monitor that can detect silica in UPW, so customers can take action before it affects product quality.

Question

How does the TSI Nano LPM™ System fill a technology gap that current optical Liquid Particle Counters (LPCs) cannot meet?

Answer

Detection of nanoparticles below 20nm is only possible by using CPC (Condensation Particle Counter) technology. The TSI Nano LPM™ System utilizes a patented aerosolizer that provides 10 nanometer detection not possible with optical instruments, providing critical information to enable customers to make data driven decisions on the quality of their UPW.

Question

Why is there only 1 channel?

Answer

The Nano LPM™ System monitors nanoparticles continuously and reports particle concentration, not size distribution information. Monitoring changes and differences in particle concentrations are preferred when detecting nanoparticles that cause wafer defects.

Question

What about instrument-to-instrument repeatability and reproducibility?

Answer

Over two years of testing in semiconductor UPW sites has demonstrated that two instruments, side-by-side, sampling the same UPW source far exceeds repeatability and reproducibility data as compared to optical-based liquid particle counters.

Question

Has TSI performed any stability testing between an optical Liquid Particle Counter (LPC) vs a Nano LPM™ System?

Answer

Data comparison of optical Liquid Particle Counters (LPCs) vs. TSI Nano LPM™ System technologies does not provide quantifiable results. LPC data is affected by several factors including low first-channel counting efficiencies (~3% at 20 nm), optical contamination, bubble counts (i.e. false counts), and index of refraction challenges.

LPC's ability to distinguish between materials of very similar index of refraction is challenged too. For example, the index of refraction for silica (1.46) and UPW (1.33) are close, meaning silica appears invisible to the LPC.

In contrast, the TSI Nano LPM™ System has 100% counting efficiency at 20 nm and, since the particles are removed from the UPW, there are no optical surfaces to contaminate, no bubbles, and the Nano LPM CPC is not influenced by the index of refraction difference, so silica and other particles are easily detected.

Question

Can the TSI Nano LPM™ System detect small differences in UPW resistivity (e.g. 18.2 MΩ-cm versus 18.1, 18.0 or more broadly, 18, 17, 16…)?

Answer

The Nano LPM™ System does not report UPW resistivity, but our system has shown to be far more sensitive and responsive than resistivity meters.

At TSI's testing labs, our UPW system is not as refined as semiconductor UPW. Regardless, when a breakthrough of the main mixed bed filtration occurs, the TSI Nano LPM™ System counts drift upward, so it detects change long before (sometimes days) before commercially available resistivity meters report a change.

Question

What checks can we perform to ensure the Nano LPM™ System is correctly operating?

Answer

You can directly inject a particle challenge into the Nano LPM™ System's injection port. Within minutes, you will see a response that assures you the Nano LPM™ System is working as designed. Also, the Nano LPM Software (included) monitors the Nano LPM™ System's health —pressures, temperatures, flows and pump status are some of the key parameters monitored.

Question

Is there any customer-required maintenance?

Answer

TSI suggests replacing the Wicks in the Nano LPM CPC every 6 months. Other than that, the Nano LPM™ System will follow an annual calibration schedule.

Question

LPCs can detect gold 20 nm particles, but what about other particle types below that?

Answer

TSI calibrates the Nano LPM™ System with 20 nm silica nanoparticles. Then, we apply a detection efficiency calibration factor to the system, so it counts 100% of particles at 20 nm.

At 10 nm, the same calibration factor as above applies—but, the actual detection efficiency for silica particles at 10 nm may vary slightly from system to system. The Nano LPM CPC's d50 (first-channel counting efficiency) is calibrated using 10 nm sucrose nanoparticles.

Question

Can customers send UPW samples with/without known contamination to TSI headquarters for analysis?

Answer

Handling and storing samples will contaminate them, so the system may detect the contaminants of the storage vessels and not the actual contaminants of your UPW. It is best to directly measure samples from the source.

You can take a small sample from a different UPW source and directly inject that sample into the Nano LPM™ System's injector system. The reported data may still be skewed by the vessel's contamination and transport to the Nano LPM™ System, so this test should not be considered a highly accurate representation of UPW cleanliness.

Question

How much volume is needed for batch samples and, per injection, for three (3) tests to demonstrate repeatability? How long does it take to do the samples?

Answer

Typically, a sample of ~100 mL of UPW is enough, the injected sampled delivered to the Nano LPM™ System will be ~1 mL. The sample must be prepared, perform the injection, and wait for the response. The total time to batch sample could be accomplished in under 20 minutes.