Model 2300XP

PSL & Process-Particle Wafer Deposition System

Deposit PSL spheres on wafers to create NIST-traceable PSL size standards for

- calibrating wafer inspection systems
- providing fab-wide and system-wide standard of particle size for wafer inspection, particle detection, and contamination control

Deposit uniformly-sized process-particles of Si, SiO_2, Al_2O_3, TiO_2, Si_3N_4, Ti, W, Ta, Cu, etc. on wafers to create process-particle standards for

- studying effect of particle refractive index on wafer scanner response
- providing wet-clean standards to improve performance of wafer cleaning tools for increased throughput and product yield

Features unprecedented DMA deposition range of 0.03 to 3.0 μm using MSP's unique dual-DMA and concentrator technologies

HIGHLIGHTS

The 2300XP high-performance particle deposition systems feature the most advanced atomization, electrostatic classification, and deposition technologies for creating NIST-traceable polystyrene latex (PSL) size standards for calibrating KLA-Tencor, Applied Materials, TopCon, Hitachi, and ADE wafer inspection systems. The 2300XP can also deposit uniformly sized process particles on wafers to create process-particle and wet-clean standards to study the effect of particle refractive index on wafer scanner response and to improve wet-clean system performance. Significant efficiency and throughput improvement in the device fab is possible with these advanced particle deposition tools from MSP.

When uniformly-sized process particles such as Si, SiO_2, Al_2O_3, TiO_2, Si_3N_4, Ti, W, Ta, Cu, etc. are deposited on a wafer, they provide realistic particle/wafer adhesion for evaluating performance of wafer-cleaning tools. Wafer loading and unloading is manual with the XP1, while the XP2 features automatic wafer transfer from open cassettes permitting truly hands-off, fully automatic operation. Both the 2300XP1 and XP2 systems feature recipe control and Automatic Sequential Deposition (ASD) to create multi-spot and multi-size particles on a given wafer.

FEATURES

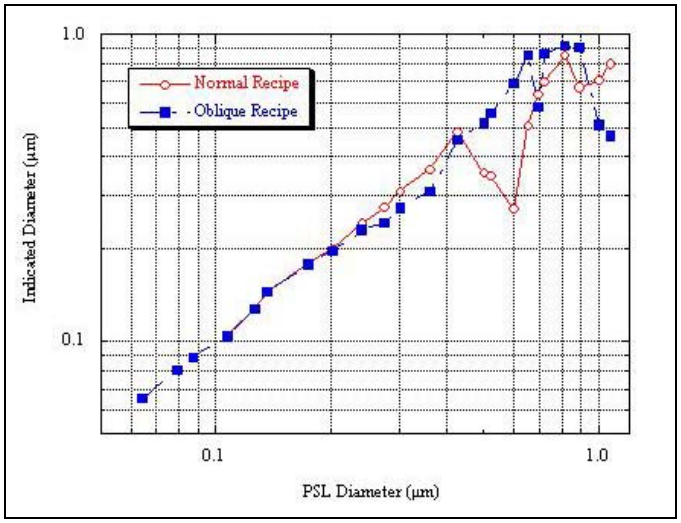
- Differential Mobility Analyzer (DMA) to filter out doublets, triplets and haze particles to prevent them from depositing on wafers
- Temperature- and pressure-compensated DMA to provide accurate PSL and process particle size to
  - create NIST-traceable size standards for calibrating wafer inspection systems
  - depositing uniformly-sized process particles on wafers to study the effect of particle refractive index on wafer scanner response

and for cleaning system evaluation and performance improvement

- CE Mark, SEMI S2, S8, S14 compliant for Asian, European, USA equipment requirements
- Recipe-controlled, deposition-process monitoring
- NIST-Traceable DMA deposition range:
  - Standard Single DMA: 0.08 -1.0 μm
  - Dual DMA option: 0.03 -1.0 μm
  - 2 μm option: 0.03 – 2.0 μm
  - 3 μm option: 0.03 – 3.0 μm
- PSL direct deposition range:
  - Standard: 0.08 – 2.0 μm
- Four (4) built-in sonicating atomizers to keep particles suspended to provide stable aerosol output to insure count repeatability and sizing accuracy during a DMA scan and to deposit different particle sizes in a given run
- XP1 Automated Sequential Deposition (ASD)
- Automatic spot depositions of 1-4 PSL sizes anywhere on the wafer; up to 8 spots can be easily deposited on each wafer.
- XP2 Robotic Wafer Handling, 200mm Open Cassette interface

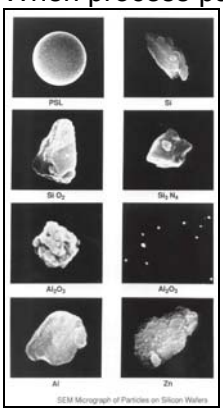
APPLICATIONS

The 2300XP1 and XP2 can deposit PSL spheres and process particles on bare silicon wafers, film-layered wafers and patterned wafers. PSL wafers are used as calibration standards for wafer

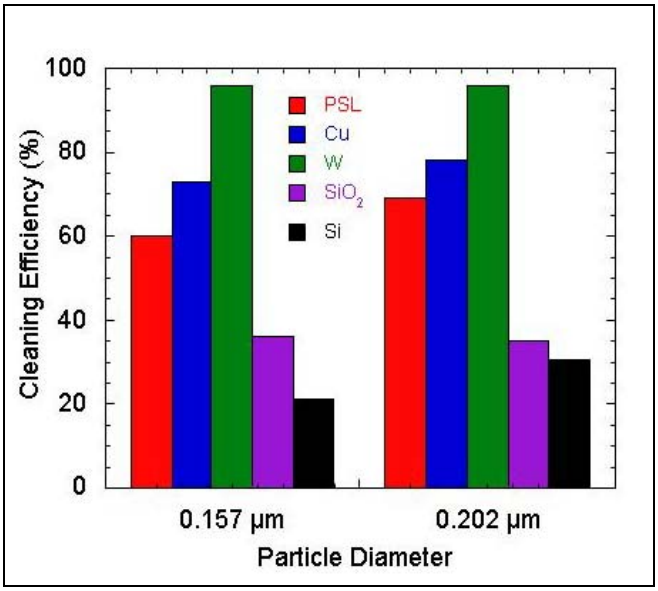


inspection systems. When deposited on film-layered and patterned wafers, the deposited PSL spheres will show the size response of the wafer inspection system and the influence of wafer surface property on the optical response of the wafer inspection system. With process particles, the influence of particle refractive index on the system optical response can also be determined.

When process particles are deposited on wafers as



wet-clean standards, they create realistic real-world adhesion forces between particle and the wafer surface so that wafer-cleaning tools can be realistically evaluated to determine their particle removal efficiency. Wet-clean standards are particularly useful in supporting cleaning process development. They are useful for fine-tuning cleaning system performance, including CMP cleaning and copper processes for increased throughput and product yield.



A common method to challenge wet/dry clean stations for cleaning efficiency measurement is to use dipped wafers. The number of particles as well as their size are not well controlled. The repeatability is often poor. The cleaning efficiency of a wet/dry clean station is a strong function of particle size, type and number of particles to be removed. The dipped wafer method tends to give ambiguous cleaning efficiency results. It is also difficult to identify whether particles from the cleaning solutions are contaminating the wafer during the cleaning process or particles have migrated from one location to another on the wafer during cleaning.

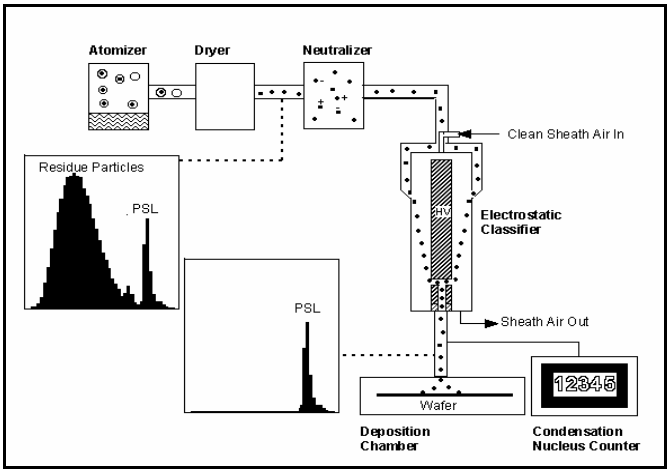
When using wet-clean standards created with process particles of a uniform size deposited on the test wafers with the Models 2300XP1 or XP2 tool, different deposition patterns can be automatically created. Particle removal, migration and/or subsequent re-deposition can be easily detected. Standard patterns include multiple-spot pattern and full surface deposition. Other custom patterns may also be provided upon customer request. The pattern size, its location, and particle number can be independently and automatically controlled. Available materials include, Si, SiO_2, Al_2O_3, TiO_2, Si_3N_4, Ti, W, Ta, Cu, etc. Other materials can also be supplied upon request.

Repeatability with the spot or full wafer deposition is excellent. The cleaning efficiency of a wet/dry cleaning station can be easily and precisely determined, monitored, and improved. The uncertainties in cleaning efficiency are greatly reduced. The XP2 allows a batch of wafers to be deposited in support of different process developments in the fab.

SYSTEM DESCRIPTION

The 2300XP series wafer deposition system offers the most advanced Differential Mobility Analyzer (DMA) technology in the industry exceeding SEMI Standards for deposited PSL sphere size accuracy and distribution width.

MODEL 2300XP1 - The system operates by atomizing a PSL or process particle suspension to form an aerosol of PSL spheres or process particles suspended in air or dry nitrogen. After drying and charge equilibration, the aerosol is electrostatically classified with a Differential Mobility Analyzer (DMA) to filter out particles of un-wanted size and small particles that can cause background haze. The monodisperse PSL spheres, or uniformly-sized process particles from the DMA, then enter a deposition chamber for enhanced electrostatic deposition on the wafer surface. The DMA is temperature and pressure compensated to provide true volumetric flow control and allow for the creation of accurate NIST-traceable particle sizes for deposition on the wafer.

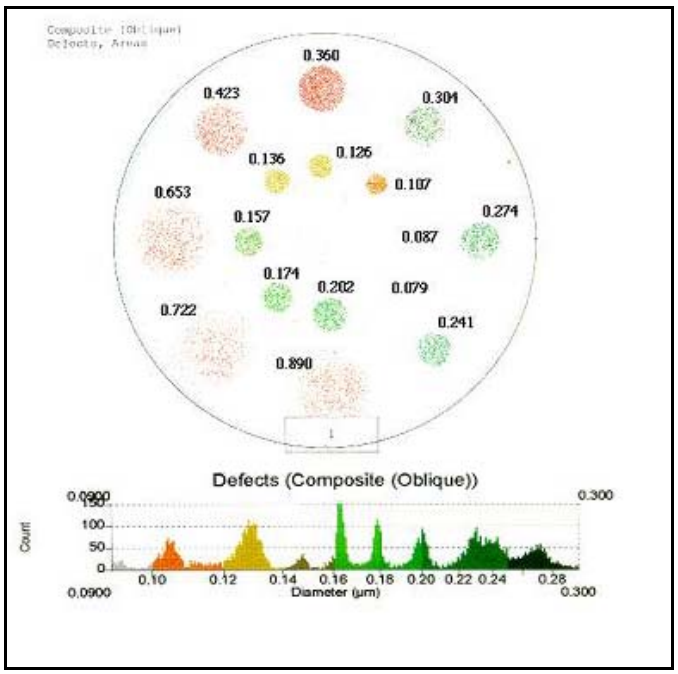


The XP1 features user-friendly recipe-controlled software. A NIST traceable calibration sub-routine allows the operator to automatically calibrate the system using Standard Reference Material (SRM) from the National Institute of Standards and Technology (NIST). Deposition shapes in the form of spots and full-wall depositions can be selected via recipe control. Other custom deposition patterns can also be supplied upon customer request.

Recipe-controlled, multiple-spot depositions are especially useful to Metrology Managers desiring to produce multiple PSL sphere sizes on a single wafer to calibrate the size response characteristics of wafer surface inspection systems at several different sizes with a single wafer. Wafer inspection tools from KLA-Tencor, Applied Materials, Inspex, Hitachi, etc are easily calibrated with the 2300XP systems. Multiple-spot depositions of process particle of different sizes are useful as wet-clean standards for wet cleaning station efficiency measurement and cleaning process development. Cleaning efficiency at several different particle sizes can be measured in a single run with the multi-size, multi-spot wet-clean wafers.

Four sonicating atomizers in the deposition system keep the PSL and process particles suspended in solution. Up to four (4) PSL sphere sizes can be selected in a recipe for automatic deposition on a

single wafer without operator intervention. Multiple recipes may be used in succession to deposit additional PSL sizes. Automatic wafer rotation and deposition nozzle positioning allows multiple particle-size spots to be deposited under



recipe control. Each spot deposition is preceded and followed by self-clean to minimize cross-contamination. Precision control is provided for deposition location, deposited PSL/process-particle size, deposited PSL/process-particle size distribution, deposition spot diameter, and count. With robotic wafer handling, the Model 2300XP2 offers full automation capabilities, including automatic wafer transfer from open cassettes and subsequent multi-spot, multi-size depositions.

- Temperature- and pressure-compensated, high resolution, NIST (National Institute of Standards and Technology) traceable DMA sizing and classification exceed proposed SEMI E52 protocol for PSL size accuracy and size distribution width.
- Automatic deposition process provides multiple spot deposition on one wafer, followed by self-clean and purge.
- CE Mark, Semi S2, S8, S14 compliant, SEMI standards compliant
- Four sonicating atomizers for effective and rapid deposition of up to four different PSL sizes and four different process particle materials.

The sonicating atomizers in the 2300XP provides stable aerosol output to insure sizing accuracy during a DMA scan—a feature not possible with simple nebulizers used in more conventional DMA deposition systems. DMA temperature- and pressure-compensation insures true volumetric flow control for sizing accuracy that is unaffected by fab elevation and atmospheric pressure or temperature changes.

DUAL-DMA OPTION - The standard XP1 is provided with a single DMA to cover the size range from 0.08 to 1.0 μm. With the Dual-DMA option, the lower limit of the DMA is extended to 30 nm, for an overall DMA size range of 0.03 to 1.0 μm. This Dual-DMA option makes it possible to deposit both PSL spheres and process particles of a narrow size distribution for size calibration of wafer inspection systems and cleaning system performance evaluation. The deposited PSL sphere sizes are narrower in distribution than commercially available PSL spheres, providing more precise and accurate size calibration of wafer inspection systems in the nanometer size range.

2.0 μm AND 3.0 μm OPTIONS - These options use unprecedented modification to the DMA technology to facilitate NIST-traceable PSL size measurement, calibration, and classification of PSL spheres up to 2.0 or 3.0 μm for wafer deposition. Advanced concentrator technology makes it possible to deposit such large particles on wafers at high deposition rates.

MODEL 2300XP2 - The Model 2300XP2 combines features of the XP1 with robotic wafer handling for 200mm open cassette architecture. The Model 2300XP2 is directed towards Wet- and Dry-Clean/Wet-Etch Managers, who have a strong interest in improving device yield through improved efficiency for particle removal. A wide variety of particle material (SiO_2, Al_2O_3, TiO_2, Si_3N_4, Si, Ti, W, Ta, Cu, etc.) is available so that wet/dry cleaning stations can be evaluated using process particles with realistic

particle/wafer adhesion forces and uniform particle sizes to improve throughput and yield.

SPECIFICATIONS

MSP Corp. reserves the right to make changes at any time prior to purchase order.

Model 2300XP1 Specifications (Software Version 5.00, September 2003).

Wafer Size	150 mm, 200 mm, or 300 mm
Particle Types	PSL Spheres & Process Particles: Si, SiO_2, Al_2O_3, TiO_2, Si_3N_4 TiN, Ti, Cu, W, and Ta
Deposition Modes	a) PSL–DMA (Spot or Full Deposition) b) NIST–DMA (Spot or Full Deposition) c) PSL–Direct (Full Deposition Only)
Deposition Types	1) Spot Deposition • Up to 8 spot depositions per wafer using a single recipe • Up to 4 different PSL sphere sizes per recipe • Recipe control of radial and angular deposition positions on wafer surface • Recipe control of deposition voltage for adjustment of spot diameter 2) Full Deposition
Particle Size Range.	a) PSL–DMA Deposition: • Single DMA: 0.08 to 1.0 µm • Dual DMA: 0.03 to 1.0 µm • 2-µm Option: 0.03 to 2.0 µm • 3-µm Option: 0.03 to 3.0 µm b) NIST–DMA Deposition: • Single DMA: 0.08 to 1.0 µm • Dual DMA: 0.03 to 1.0 µm • 2-µm Option: 0.03 to 2.0 µm • 3-µm Option: 0.03 to 3.0 µm c) PSL–Direct Deposition: • Standard: 0.08 to 2.0 µm
Particle Size Accuracy	i) Single DMA: • <0.25 µm: ±5% (peak diameter) • ≥0.25 µm: ±2% (peak diameter) ii) Dual DMA (including 2-µm and 3-µm Options): • <0.15 µm: ±3% (peak diameter) • ≥0.15 µm: ±2% (peak diameter) Peak diameter is defined for a Gaussian curve fit to the measured number size distribution (i.e., count vs. particle diameter) that is output by the DMA. Size accuracy is defined as the difference between the particle size indicated by the control software prior to deposition and the peak (centroid) of the Gaussian distribution, divided by the peak (centroid) particle size. This specification is valid only if the DMA(s) have been properly calibrated with NIST SRM PSL spheres using the NIST Calibration routine. Not valid for NIST-DMA depositions of PSL spheres of unknown size.
Particle Size Distribution Width	Dependent on DMA sheath/aerosol flow ratio: • 10/1 flow ratio: ≤12% FWHM • 20/1 flow ratio: ≤7% FWHM • 40/1 flow ratio: ≤4% FWHM FWHM (full-width at half-maximum) is defined for a Gaussian curve fit to the measured number size distribution (i.e., count vs. particle diameter) that is output by the DMA. It is defined as the difference between the two particle sizes for which the associated counts are 50% of the counts associated with the peak (centroid) of the Gaussian distribution, divided by the peak (centroid) particle size.

Deposition Count Accuracy	Count accuracy may be optimized for a fixed particle size, deposition type, deposition flow rate and deposition voltage by programming an appropriate Count Correction Factor in the Advanced Options dialog screen in the control software. The Count Correction Factor is defined essentially as the total particle count measured by a wafer surface scanner with 100% counting efficiency (for all deposited sizes) divided by the target count.
Deposition Count Repeatability	1) Spot Deposition: • <1.0 µm: ±5% plus variation from counting statistics • 1.0 to <2.0 µm: ±10% plus variation from counting statistics • 2.0 to 3.0 µm: ±25% plus variation from counting statistics 2) Full Deposition: • <1.0 µm: ±10% plus variation from counting statistics • 1.0 to <2.0 µm: ±20% plus variation from counting statistics • 2.0 to 3.0 µm: ±50% plus variation from counting statistics Each specified value is the standard error (standard deviation/mean) of the total count for a sample consisting of five identical, consecutive depositions. Total count is defined as the total number of particles deposited, irrespective of particle size. Specified errors are valid only for a minimum deposition time of 30 seconds. PSL–DMA and NIST–DMA depositions only.
Operating Temperature	10 to 30 °C (50 to 86 °F)
Electrical Supply	100/120 Volt at 50/60 Hz, 1Φ (single phase), 7 A 220/240 Volt at 50/60 Hz, 1Φ (single phase), 5 A