



Static Charge Control in SRDs with Ion Systems Ionization

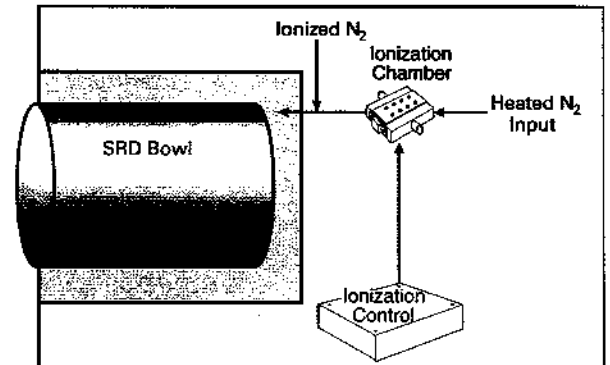
Controlling Static Charge in Process Equipment

As mini-environments and process tools become more complex, the potential for static charge problems increases. Room ionization systems are used to control static charge, but they cannot reach the inside of equipment or mini-environments, since the walls and filters serve as barriers to ionized air. Without effective static charge control inside equipment, products and carriers can become charged. When the charged products and carriers exit the equipment, they may cause an electrostatic discharge (ESD)—resulting in equipment operating problems or product damage.

Manufacturers of semiconductors, disk drives, and flat panel displays, as well as those in the electronics test and assembly industries, have turned to Ion Systems for years for solutions to static problems in equipment. Successful applications include photolithography steppers, vertical diffusion furnaces, metrology tools, E-beam machines, chip handlers, cassette transfer systems, flat panel defect measuring equipment, pick and place handlers, and many more.

Spin Rinser Dryers (SRDs)

The characteristics of the spin rinsing and drying processes make them responsible for many problems associated with static charge. In the turbulent environment of an SRD chamber, highly insulative deionized water



Ion Systems In-line Ionization in an SRD

Feature

- **IsoStat® Technology**

Benefit

Patented technology ensures fast discharge performance. Intrinsic balance eliminates the need for calibration.

- **No Exposed Emitter Points**

Protected emitter points ensure wafers are not exposed to high electric fields and reduce performance degradation from moisture build-up near solvents and cleaners.

- **Single Crystal Silicon Emitter Points**

Class 1-compatible emitter points ensure the cleanest alternative in static charge control.

- **Power and Failure Alarms**

Power and failure indicators ensure immediate notification if there is any problem with your static control system.

shears across silicon and Teflon surfaces, creating high levels of static charge. Driving water from these surfaces and drying them with hot nitrogen creates even higher static levels. Since static charge is known to attract and bond particles to wafer surfaces, high static levels in the SRD lower the SRD's efficiency in removing particles. Once the charged wafers and cassettes leave the SRD they continue to attract contaminating particles from the cleanroom ambient. In today's high technology industries, even a single additional particle-related defect is unacceptable.



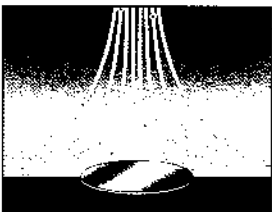
Static Charge Effects and Solutions

Static Charge Effects

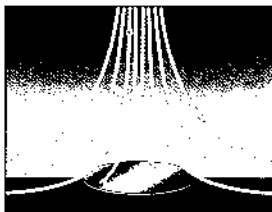
The effects of static electricity in cleanroom manufacturing are summarized by three acronyms: ESD, ESA and EMI.

Electrostatic Discharge (ESD)

An ESD event is the uncontrolled transfer of static charge from one object to another. Although the amount of static charge transferred is usually small (nano Coulombs), a discharge deposits its energy into a very small area of the device. This results in vaporization of the metal lines or silicon, punching through the oxide layers, and other damage mechanisms. ESD events can also damage production tools, such as photomasks and reticles, and occasionally the production equipment.



Wafer with no static charge



Wafer charged to 500V



Wafer charged to 4000V

ESA & Contamination

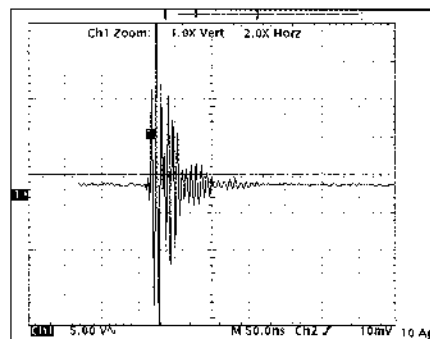
When a wafer or cassette becomes charged, the resulting electric field attracts particles in the air through electrostatic attraction (ESA) in much the same way that a television screen attracts dust. Welker¹ demonstrated that the particle deposition rate to the surface of wafers charged to 5000 volts in a class 1 cleanroom was the same as the sedimentation rate to uncharged wafers in a class 100 cleanroom.

Electromagnetic Interference (EMI)

The most subtle effect of static charge is the interruption of a process due to EMI resulting from ESD. This is particularly true of equipment controlled by microprocessors. The equipment occasionally stops (lock-up) and must be rebooted to return to normal operation. Sometimes the process is interrupted and product must be removed and reprocessed or scrapped. This static charge effect can be the most serious obstacle to profitable operation of a cleanroom facility, as it reduces tool availability and product throughput.

EMI from an ESD Event—Generating Tool Lock-up

Discharging 40 V in 90 ns, this ESD event released ~1 amp of current.

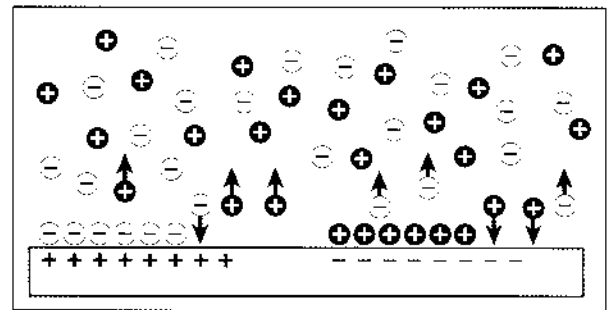


Static Charge Control Methods

It is usually impossible to totally eliminate static electricity from work areas, but with proper use of equipment and remedial procedures, most static problems can be controlled.

Grounding Conductors and Static-Dissipative Materials

When charge can be conducted through a material, the solution to static charge problems is to provide a path for the charge to flow to ground. This solution works only on conductors and static-dissipative materials. While charge is mobile in a conductor or static-dissipative material, in insulators charge is not mobile, and the only effective means of eliminating the static charge is through air ionization.



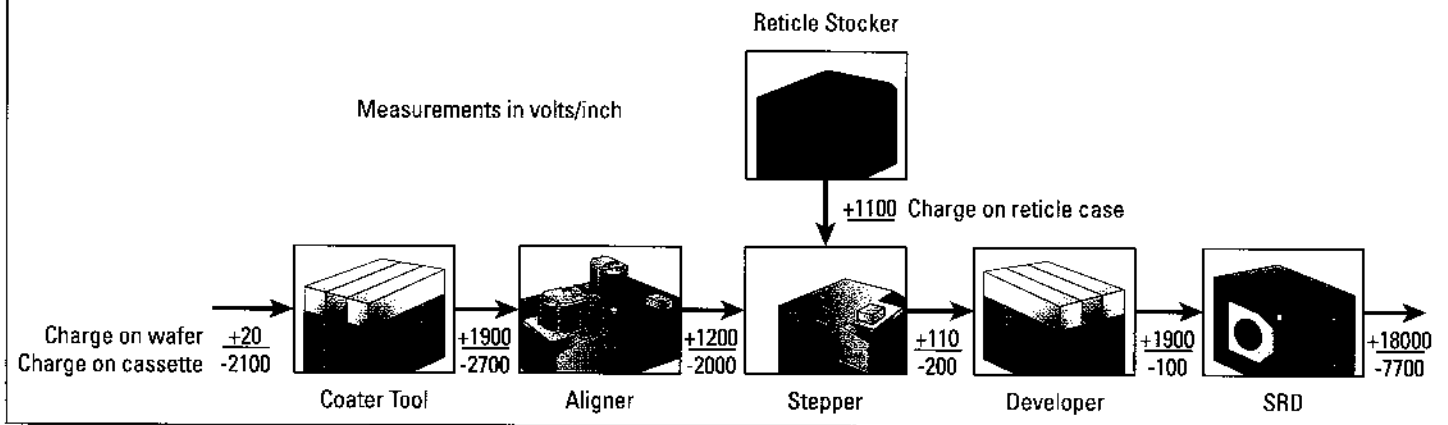
Bipolar Air Ionization

Air Ionization

Ions are molecules of the gases in air (nitrogen, oxygen, water vapor, and carbon dioxide) that have lost or gained electrons. Ionization systems work by increasing the conductivity of the air with the ionized gas molecules. When ionized air comes in contact with a charged surface, the surface attracts ions of the opposite polarity. As a result, the static electricity is neutralized. This process is shown in the figure above.

¹ Welker, Roger. "Equivalence Between Surface Contamination Rates and Class 100 Conditions". *Proceedings—Institute of Environmental Sciences* May (1988): 449-454.

Sample Static Charge Levels Found on Products and Carriers Between Process Steps



Static Charge Control & SRDs (continued from p. 1)

Once the charged wafer cassette and wafers leave the SRD, they can cause ESD if they come close to a grounded object. The discharge can produce electromagnetic interference (EMI), which affects surrounding production equipment. Providing effective static control in the SRD can reduce problems in surrounding process tools, in addition to reducing contamination during and after the SRD process itself. As shown in the figure above, static charge is generated by operations in most process tools, but the highest levels occur in the SRD.

Ion Systems In-line Ionization Kit

To eliminate these concerns, Ion Systems and Rhotech have brought effective static control to the SRD. Ion Systems has designed a custom In-line Ionization Kit to address the specific static control needs and environmental constraints of spin rinser dryers.

Reliable, Low Maintenance Ionization

When an ionization system is located inside an SRD, it is critical to ensure reliable operation with very little maintenance. The In-line Ionization Kit uses Ion Systems' patented, intrinsically balanced IsoStat Technology, ensuring electrical neutrality of the ionization provided to a process tool. IsoStat is based on the Law of Conservation of Charge, which dictates that ionizers incorporating extreme electrical isolation will always remain in balance. This technology is only possible with an ionizing method that isolates the ionizer emitter points from the interior of the SRD. Ionizers incorporating IsoStat never need calibration, although Ion Systems recommends a 3-year service interval. All Ion Systems ionization systems used in an SRD are covered by a two-year warranty.

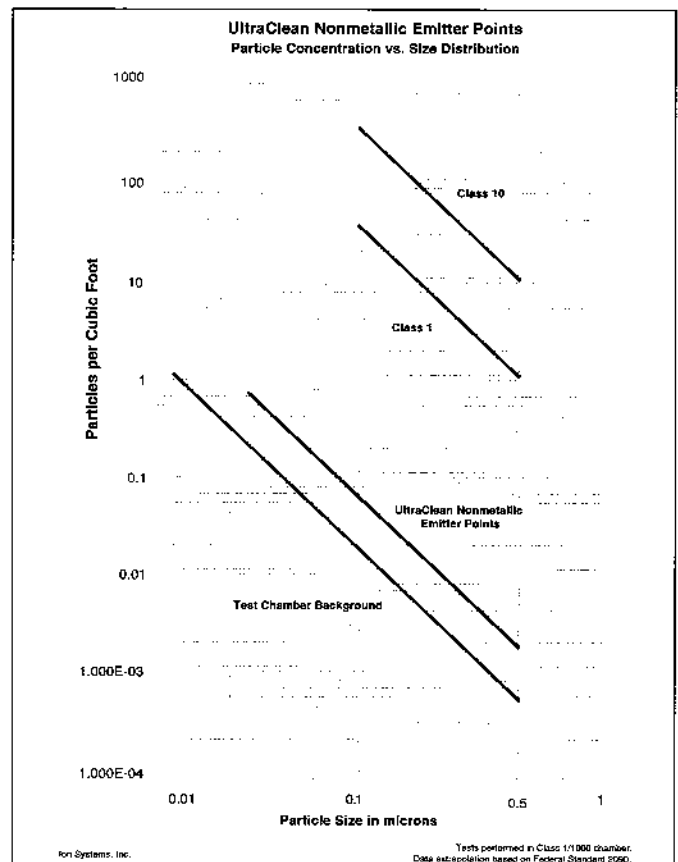
No Exposed Emitter Points

The interior chamber of the SRD is a small, confined space. It is a wet, and occasionally chemically active environment. In such an environment, exposed ionizer emitter points (particularly contaminating metallic points) and ionizing bars are impractical. Ion Systems In-line Ionization Kit uses a different method, isolating the ionization process outside the SRD chamber, and then piping the ionized gas into the SRD for balanced charge neutralization. It bathes the product and carriers with both polarities of ions to

neutralize static charge. Ionized gas is delivered to the SRD chamber during the drying process to neutralize any charge that has built up. This method both protects the wafers from exposure to high electric fields from the emitter points and reduces ionizer performance degradation from moisture build-up near solvents and cleaners.

Ultraclean

When supplied from an ultraclean gas source, Ion Systems In-line Ionization Kit typically produces fewer than 1/10th the number of particles allowable in a Class 1 cleanroom. To virtually eliminate particle emissions, its design includes tightly controlled emitter point shape, corona voltage and current. Careful selection of materials for internal compo-



nents, including single crystal silicon emitter points, and control of internal ionizing chamber geometry ensure ultraclean ionized gas delivery. Efficient ionizing chamber design allows operation at a low current at the emitter point, which further decreases erosion and possible particle generation. Since emitter points are not exposed in the SRD chamber, there are no ion losses to the chamber walls and no emitter point degradation from moisture build-up or corrosive solvents.

Worry-free Operation

To ensure the SRD process is protected, an alarm relay output, which can be connected to any light or control panel for easy viewing, provides immediate information. The system is equipped with two types of alarms. The first occurs if, for any reason, the system is not receiving power. The second occurs in the rare case that there is a catastrophic failure in a high voltage power supply or in the control circuitry.

Static Charge Levels Found After an SRD Cycle: With & Without Ionization

No Ionization	Cassette:				Wafers:	
	Front	Back	Left	Right	Wafer 1	Wafer 12
Sample 1	-17000	-20000	-18000	-18000	-20000	-12000
Sample 2	-20000	-18000	-19000	-19000	-18000	-16000
Sample 3	-20000	-18000	-19000	-19000	-19000	-14000
Average:	-19000	-18667	-18667	-18667	-19000	-14000
With Ionization	Cassette:				Wafers:	
	Front	Back	Left	Right	Wafer 1	Wafer 12
Sample 1	-640	-600	-870	-900	-770	-870
Sample 2	-900	-780	-930	-1200	-960	-890
Sample 3	-1140	-1070	-1750	-1700	-1350	-1470
Sample 4	-400	-740	-1000	-1000	-700	-1150
Sample 5	-1500	-1200	-2200	-2000	-1900	-1600
Average:	-916	-878	-1350	-1360	-1136	-1196

Average Reduction of Static Charge: 94%

Specifications

IN-LINE IONIZER

Ion Balance: ±25 V at specified flow and pressure; Measured at 6" from CPM; Tested in accordance with Ionization Standard ANSI EOS/ESD S3.1-1991.

Discharge Performance: Typical reduction of static charge on wafers is better than 90%, measured with a 775 fieldmeter before and after processing (see chart above).

Discharge Time: < 10 sec., measured at the output of the ionizer block and held 6" from the CPM; airflow rate of 120 SCFH (2 SCFM)

Ion Emission: Steady-state DC

Emitter Points: Single crystal silicon; replaceable; estimated 5-year life

Input Power: 120 VAC, 50-60 Hz, approximately 2 watts; 100 and 230 VAC models available

Gas Flow Rate: Minimum: 2 SCFM
Maximum: set by manifold back pressure

Input Pressure: 10-50 psi safe range; Unit is NOT designed to withstand high pressures. It should be installed downstream from any valves, with the output open to atmospheric pressure.

Gas Connectors: 1/4" NPT female Teflon fittings, at both gas input and output

CONTROLLER

Line Power: 120 VAC, 3.6 watts; 230 VAC option available

Output Voltage: 10.6 kV

Load Current: 13.7 microamps

Indicators: Power: Normally Open relay contacts rated at 1 Amp/30 VDC, 0.3 AMP/110 VDC, 0.5 Amps/125 VAC; Open: Off, Closed: On
Alarm: Normally Open relay contacts rated at 1 Amp/30 VDC, 0.3 AMP/110 VDC, 0.5 Amps/125 VAC; Open: No Alarm, Closed: Alarm On

Chassis: Stainless Steel

Mounting: 2 x 10-32 pem nuts on bottom

SYSTEM

Dimensions: Ionization Chamber: 3.16"W x 2.65"D x .82"H
Inlet/Outlet fittings: 1" x 0.75"
Controller: 6.0"W x 4.3"D x 2.0"H

Weight: 4 lbs. (complete system)

Maintenance: 3 year interval, with intermittent operation

Warranty: 2-year limited warranty

Certifications: CE (pending)

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