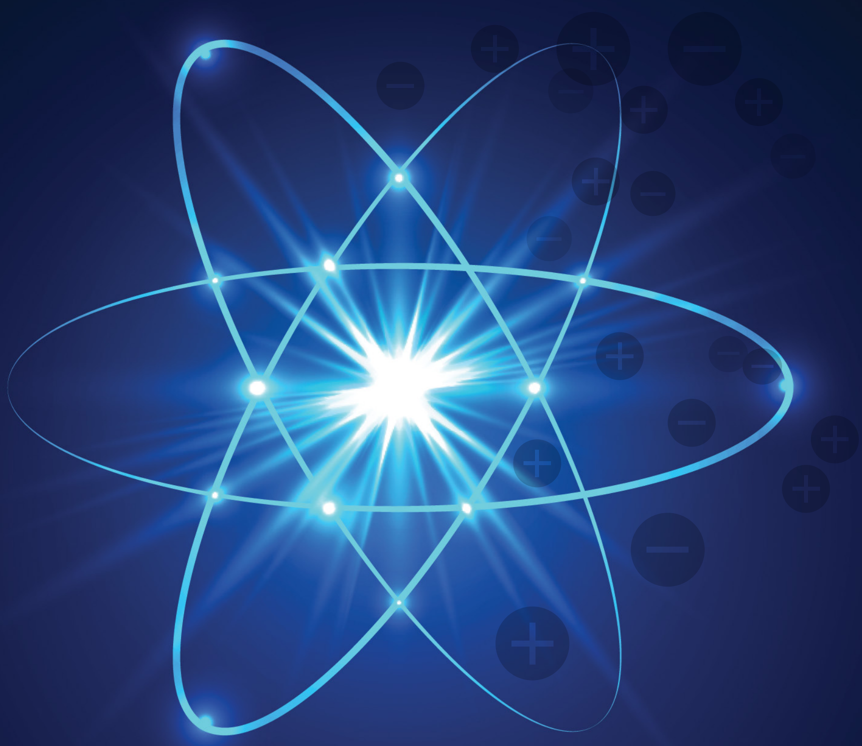
SIMCO ION™

An ITW Company

worldwide leaders in **static control**



Air Ionization

Theory and Practice

Static & Particulate Contamination Control Using Ionization Technology

Air Ionization: Theory and Practice

Overview

Anyone who has walked across a carpet and then touched a doorknob has felt the effects of static electricity. The "inconsequential" zap from the doorknob may have amounted to 5,000 volts on the person's body, and has the potential to melt the conductive pathways on many microchips.

Electrostatic discharge can easily damage sensitive electronic devices in a number of ways. Static charge attracts contamination particles to product surfaces such as semiconductor wafers. Often, microprocessor lock-up in robotic devices and material handling difficulties are attributable to the presence of static charge. The dollar loss due to static electricity is staggering and its effects are by no means limited to the electronics industry.

Static electricity affects production rates and product quality, thus reducing profitability. From component to finished product, the possibility of damage due to electrostatic discharge (ESD), contamination, or product-handling problems is always present. The cost of these problems increases as a product moves through its manufacturing cycle. Component damage that may not show up during production testing may cause failures in the field where reliability is a much more critical factor.

While electrostatic charge can't be totally eliminated, it can be controlled, and the purpose of this booklet is to explain how this control can be achieved.

Air Ionization, Theory and Practice is an overview of the basics of static electricity—what it is, how and why it is a problem, what remedial steps can be taken to counter its effects, and lastly, an examination of why air ionization must be included in any successful program for controlling static charge in the workplace.

Static Electricity

Static electricity is a familiar but often misunderstood phenomenon associated with stationary electric charge. The laws of nature attempt to maintain a balance of positive and negative charge, and ideally objects would remain neutral with no net charge. Static charging occurs when molecules on the surface of an object become charged or polarized. The charge may be either negative or positive, depending on whether the charged surface has an excess or deficiency of electrons.

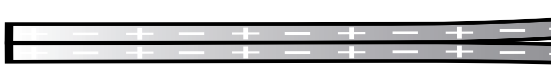
Materials that are characterized by their ability to allow movement of an electric charge are commonly referred to as conductive or static-dissipative materials. Non-conductive or insulative materials, by contrast, do not allow an electric charge to move. Tap water and most metals are excellent conductors of electricity, while plastic, quartz, and glass are examples of non-conductors. Any type of material can be charged with static electricity. The most common ways to generate static electricity are by induction and triboelectric charging.

Problems Caused by Static Charge

- *Contamination due to electrostatic attraction and bonding of particles to charged surfaces*
- *Destruction of sensitive devices due to an electrostatic discharge event (ESD)*
- *Malfunction or lock-up of microprocessors due to static discharge*
- *Product flow or manufacturing problems caused by static charge*

Triboelectric Charging

Whenever two surfaces in close contact are separated, one surface loses electrons and becomes positively charged. The other surface gains electrons and becomes negatively charged.



Charging Through Induction

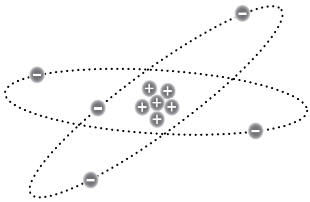
Inductive charging occurs when a charged object creates a stationary electrostatic field. It is difficult to charge non-conductors by induction. However, grounding a conductive object when it is in the field causes it to take on static charge of opposite polarity to the field without having touched the original charged object.

The electrostatic field from the original object attracts (or induces) opposite polarity charge to the surface of the new object placed within the field. If that object is then isolated from ground and removed from the field, it will hold an electrostatic charge.

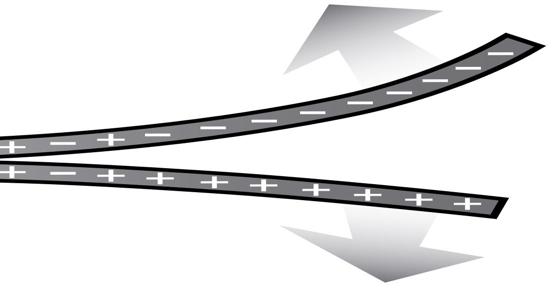
Triboelectric or Friction Charging

Friction is the primary means of generating static electricity. Whenever two surfaces in close contact are separated, one surface loses electrons and becomes positively charged while the other surface gains the same electrons and becomes negatively charged. The total charge on the two materials remains the same and may even be zero. After separation, however, each surface retains its positive or negative charge, unless the surface is conductive and a path to ground is provided.

Triboelectric charging occurs when rubbing or other physical forces cause electrons to leave their orbit and move from the surface of one material to the surface of another.



Any material (solid, gas, or fluid) whether a conductor or a nonconductor, can be charged triboelectrically. The magnitude and polarity of the charge depends on the characteristics of the two materials and is affected by several factors. The factors include surface condition, size of the area that is being rubbed or separated, pressure between the surfaces



and the speed of separation or rubbing. Generally, smoother surfaces, larger surfaces, and increased speed or pressure between surfaces generate higher levels of electrostatic charge.

The Triboelectric Series is a ranking of materials in order of their likelihood of becoming positively or negatively charged. If two materials listed on this chart are rubbed together, the one higher on the list becomes positively charged while the lower one takes on a negative charge. The better the insulator, the more easily it is charged by friction. Non-conductive materials such as Plexiglas™ or Teflon™ charge readily and can generate large amounts of static charge—sometimes in excess of 25,000V.

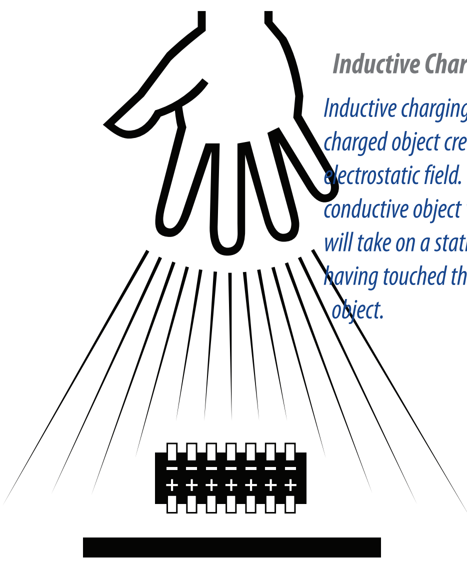
An insulator can be charged triboelectrically by contact and separation with a conductor, even if the conductor is grounded. The conductor, if it is isolated from ground, can be charged by separation from the non-conductor.

Triboelectric Series

Positive

- *Air*
- *Human hands*
- *Water*
- *Glass*
- *Mica*
- *Human hair*
- *Nylon*
- *Wool*
- *Lead*
- *Aluminum*
- *Paper*
- *Cotton*
- *Steel*
- *Wood*
- *Hard rubber*
- *Nickel and copper*
- *Brass and silver*
- *Gold and platinum*
- *Acetate rayon*
- *Polyester*
- *Polyurethane*
- *Polyethylene*
- *PVC (vinyl)*
- *Silicon*
- *Teflon*

Negative



Inductive Charging

Inductive charging occurs when a charged object creates a stationary electrostatic field. If you place a conductive object within the field, it will take on a static charge without having touched the original charged object.

Why is Static Charge a Problem?

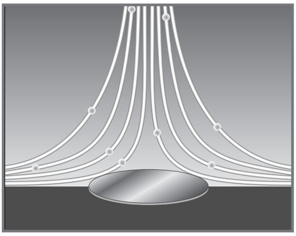
Anything and everything, including movement of people, the moving parts of machinery, and the flow of fluids, can generate static charge. If the presence of static is so extensive, why then is it such a problem?

When static charge builds up on a sensitive product, a work surface, equipment or a person, the result can be destructive. Products may be damaged, processes may become degraded and a long list of other—sometimes mysterious—problems may occur.

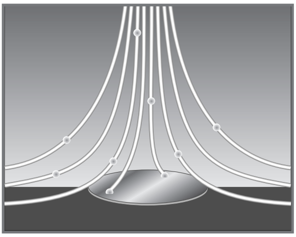
Contamination

A cleanroom is not entirely what its name implies. A cleanroom is a work area in which high efficiency air filtration systems remove particulate from the air as it enters the room. But a cleanroom also contains people, machines, and various types of process equipment—each contributing contamination to the environment.

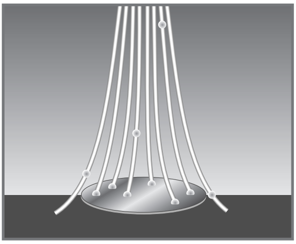
Materials typically used in the cleanroom—plastic, quartz, ceramics, glass, and silicon—are good insulators and become charged easily. Because the air entering the cleanroom is stripped of its normal ion content as it moves through the air filtration system, it loses its static-dissipative qualities. Thus, modern cleanrooms foster higher levels of static charge that remain on objects for long periods of time. The very nature of the cleanroom makes it difficult to apply antistatic measures because most surface treatments and many static-dissipative materials are not cleanroom compatible.



Wafer with no static charge



Wafer charged to 500V



Wafer charged to 4000V

The aerodynamic behavior of particles is strongly affected by static charge. Inoue's experiment uses a laser-enhanced photo technique to show how latex spheres behave as they are dispersed in a 100 fpm laminar airflow above a charged wafer. The experiment dramatically demonstrates how particles are pulled out of a laminar airflow and attracted to a charged wafer.

If a critical product surface becomes charged, as it often does during the production process, and if the charge isn't removed, the surface attracts airborne particulates in the cleanroom. Regardless of the filtration system, personnel, machinery, and processes can introduce particulates into the air. The electrostatic attraction affecting these particles is surprisingly strong. Once bonded to a charged surface, it is very difficult to remove the contamination. Contamination of this nature is a major contributor to product degradation and device failure.

Considerable research was performed in the late 1980's and early 1990's dealing with the phenomenon of the attraction of particles to charged surfaces. At the Institute of Environmental Sciences (IES) technical meeting in 1991, Roger Welker of IBM, San Jose, concluded that "use of air ions results in a significant decrease in surface contamination rates versus identical test conditions without air ions." In the cleanroom where the testing took place, the background airborne particle counts were quite low, only 2.0 particles 0.5 µm and larger per cubic foot.

In a paper published by Masanori Inoue ("Aerosol Deposition on Wafer," Inoue, et.al., 1988) and presented at the 1988 IES technical meeting, Inoue demonstrated that electrostatic charge in a cleanroom is the most important factor causing surface contamination by particles approximately 0.3 microns in size. Additionally, under his test conditions he observed that electrostatic charge was a 1000 times greater factor than diffusion or gravity in causing particle deposition on wafers.

A study done by D.W. Cooper, "Deposition of Submicron Aerosol Particles During Integrated Circuit Manufacturing: Experiments" (Cooper et. al., 1988), supports the observation made by Inoue. Cooper reviewed experiments in which wafers tend to become charged in an operating cleanroom, and found that electrostatic effects can be the dominant particle deposition mechanism for particles between 0.1 and 1.0 microns in diameter.

Another paper by Michael Yost, "Electrostatic Attraction and Particle Control" (Yost et. al., 1986), explores the physics of the attraction process and calculates the bonding force between a 1 micron particle and a 4" wafer with a surface charge of 1000 volts. The electrostatic forces holding a particle to a charged surface are very strong when compared to gravity or aerodynamic forces such as an air jet. The results clearly demonstrate that the static charge found in the cleanroom causes wafer surfaces to become contaminated and difficult to clean. An equipment-related paper by Long, Peterman, and Levit (Long et. al., 2006) demonstrated that removing the static charge from wafer surfaces significantly improved the cleaning efficiency of those surfaces.

Electrostatic Discharge (ESD)

There is no question that ESD causes electronic device failure during a number of the production, packaging, and testing processes. As the critical dimensions and tolerances of components and circuits become progressively smaller, they become less tolerant to ESD. In circuits designed to operate at lower and lower voltages, minute levels of charge can result in damage or destroy a device.

When failed devices are examined under a scanning electron microscope, the catastrophic effects of ESD become visible. Shorts due to oxide failures and vaporized metal lines are only two of the effects observed.

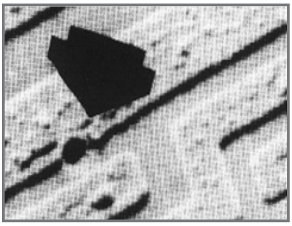
Recent studies have shown that static discharge can cause even more serious problems than just lowering of overall yields. Device degradation due to static discharge may not show up in component testing. If a device fails later in an assembly, it results in additional cost to rework or replace. But when a device fails in the field, the cost of repairing or replacing it can easily become 100 times more expensive than if it were detected during manufacture. According to industry estimates, for every ESD-related defect found in manufacturing, there are an additional two to five failures that occur in the field. Not only is ESD costing millions of dollars

Typical Charge Levels Found in the Cleanroom

Many objects common to the cleanroom can hold highly destructive levels of electrostatic charge.

Wafers	5 kV
Table tops	10 kV
Smocks	10 kV
Quartz ware	15 kV
Acrylic covers	20 kV
Storage cabinets	30 kV
Wafer carriers	35 kV
Plastic film	40 kV

in down time and product loss, but it is diminishing valuable user confidence. In a worst-case scenario, the failure of a critical device in military, aerospace, or medical application could be fatal.



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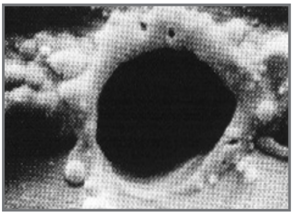


5000x

Damage due to ESD

A single ESD event can cause fatal damage to sensitive electronic devices. The arrow in the top photo shows the site of ESD damage on a semiconductor. The second photo provides a detailed view of the metal bridge that has been formed between the two metal lines by the ESD event.

SEM photos courtesy of 3M.

Microprocessor/Robotic Lockup

As devices themselves have become increasingly more complex and sophisticated, so has the equipment designed to produce and handle them. Almost all new production equipment have multiple microprocessors controlling them, and are therefore increasingly sensitive to ESD-related problems.

Microprocessors and robotic devices control the manufacturing of a growing number of components. The static levels that previously might have destroyed a single device on a wafer now has the capacity to destroy an entire batch of wafers. Even though robotic devices may be grounded, the products they manipulate often carry significant levels of electrostatic charge. It is possible that a single ESD event at one point along a robotic assembly line may be enough to shut down the entire operation. It is also possible, under certain conditions, for personnel to transmit high levels of static through a keypad to sensitive electronic devices within production equipment.

Material Handling

Static charge causes difficulty in handling a countless number of materials and can create problems in industries as diverse as printing and agriculture. Usually, a thin material that is processed in sheets or on webs and moved over surfaces creates a high level of electrostatic charge. For example, the plastic film used in photography is highly susceptible to what is commonly referred to as "static cling." Additionally, dust and link are electrostatically attracted to film, leaving behind tell-tale spots and specks on finished slides and prints. Static attracts dust and lint to cameras, scanners, and photo processing equipment resulting in costly remakes. In the printing industry, static charge in the press room can cause dust to adhere to plates and blankets, and paper to jam in presses.

More disastrous is the possibility of static problems in workplaces like grain elevators or petroleum processing plants. When pulverized materials pass through chutes or petroleum distillates flow through pipes, there is always the danger of static accumulation. Charged products cling to processing equipment, restricting flow. Worse still, electrostatic discharge in a combustible atmosphere may cause explosion and fire.

Static Control Methods

Grounding as a Solution

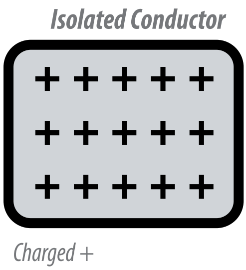
Personnel can be grounded through the use of static-dissipative suits, smocks, gloves, wrist and heel straps. Work stations can be protected with static-dissipative table tops, mats, and conductive floors. However, grounding does not have any effect on the charge on the surface of insulators.

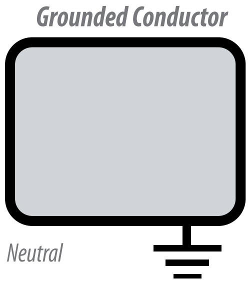
It is usually impossible to completely eliminate static electricity from production environments, but with proper use of equipment and remedial procedures, most static problems can be controlled. Many approaches to controlling static charge have been tried over the years. It is clear that no single method exists for controlling all static problems. An important consideration in selecting the proper method is whether the charged material is a conductor or an insulator. Static on a conductor can be easily controlled if the object can be grounded. Grounding simply provides a path so that charge can migrate to or from ground. When a conductor is grounded all of its charge is neutralized and it remains at ground potential. But because charges do not migrate on insulators, grounding does not work. Grounding an insulator neither removes the charge nor affects the ability of the insulator to become charged.

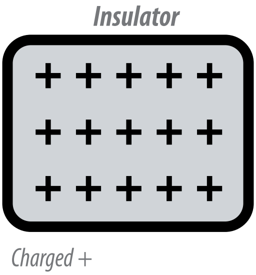
Providing they follow a strict routine, personnel can be grounded through the use of static-dissipative suits, smocks, gloves, and wrist/heel straps. Work-stations can be protected by static-dissipative table tops and mats and conductive floors. Materials and devices can be transported in protective bags, bins, and boxes made of conductive or static-dissipative materials. These "passive" procedures cannot always be employed and are subject to human error. Many objects used in production are made of materials such as Teflon™, quartz, or Lexan™. These materials are good insulators for which there is no "antistatic" substitute.

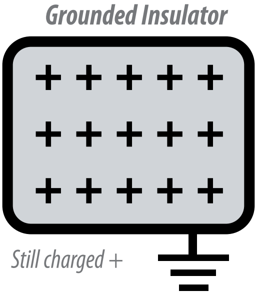
Antistatic or dissipative materials often contain additives that migrate to the surface of the material and attract a thin layer of water. This thin water layer makes the surface of the material conductive, allowing static charge to move from the surface to the ground. If the water layer is lost, the antistatic properties are lost and the material behaves like an insulator. Other static-dissipative materials are made by mixing conductive particles like carbon with non-conductive materials. However, these materials often suffer shedding and cause contamination problems.

Many of these methods have limitations when applied to the operations of a typical cleanroom facility. The manufacturing process often requires a great deal of movement of people and product between work stations, making the use of wrist straps impractical. Most antistatic or dissipative materials have additives that lead to contamination of the cleanroom.









A Word About Increased Humidity

Most common insulating materials such as fabric, wood, paper, and masonry contain a certain amount of moisture that is dependent on the relative humidity of the air. To some extent, the moisture content affects the conductivity of these materials and their ability to hold static charge. The higher the relative humidity (>50%), the higher the conductivity. Conversely, the lower the humidity (<30%), the more insulative these materials become and the more charge they hold. Logically, it would follow that high humidity would be an effective means of controlling static. However, this has proven to be a misconception. Even under high relative humidity, unacceptable levels of static charge can be generated and remain for long periods of time. Additionally, high humidity can contribute to other problems including oxidation and soldering difficulties. Using high humidity as a means to control static charge is slow, uncomfortable, expensive, and often ineffective.

Air Ionization– Conductive Air℠

Air ionization is increasingly being used to control or neutralize static charge found in critical environments. Ionizers actually make the air sufficiently conductive to dissipate static charge on both insulators and isolated conductors.

Air Ions and the Ionization Process

Air ions are air molecules that have lost or gained an electron. Ions are present in normal air but are "stripped" out when air is subject to filtration and conditioning. They are produced by radioactive emission, X-ray photons or by a phenomenon called "corona discharge" where a high voltage is applied to a sharp point.

All air ionization systems work by flooding the atmosphere with positive and negative ions. When ionized air comes in contact with a charged surface, the charged surface attracts ions of the opposite polarity. As a result, the static electricity that has built up on products, equipment and surfaces is neutralized.

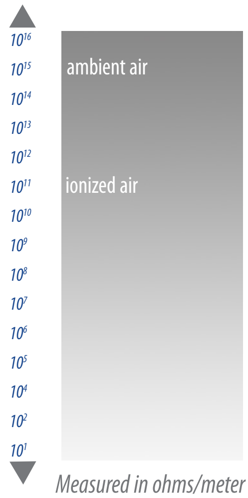
Typically, air is very insulative with a resistivity exceeding 10^{15} ohms/meter. By increasing the number of ions in the air it is possible to lower the resistivity of the air to 10^{11} ohms/meter, thereby making the air more conductive. Conductive Air℠ can neutralize static charge on every surface that it contacts. The field from a charged surface attracts ions of the opposite polarity until the charge on the surface is neutralized.

How Does Air Ionization Actually Work?

All air ionization systems work by flooding the atmosphere with positive and negative ions. When the ionized air comes in contact with a charged surface, the surface attracts ions of the opposite polarity. As a result, the static electricity that has built up on products and equipment is neutralized.

Continuum of Resistivity

By using ionization, the resistivity of ambient air is decreased by four orders of magnitude, thereby making the air more conductive.



Bipolar Ionization

Types of Air Ionization

- *Alternating Current (AC)*
- *Steady-state DC*
- *Pulsed DC*
- *Nuclear*
- *X-ray*

Ions of both polarity are required because both positive and negative charges are created in the work area. There are numerous ways to create and deliver bipolar air ionization, and there may be no single "best" method of ionizing for all situations. Deciding which method is best for a specific application depends on the environment, the problem to be solved, and the nature of the work being done in the area. Ions move by field and by air flow, and the effectiveness of a system depends on various environmental conditions.

Over the years, a number of systems have been developed to generate ions. A primary factor that distinguishes one from another is whether or not the system utilizes high voltage AC, DC, pulsed DC current, nuclear, or X-ray elements to create ions. These five types of systems vary in efficiency. Sometimes, problems with ion recombination and hot spots (areas with ion imbalance) need to be solved before a system works properly.

The following is a short description of the differences in ionizing technologies and a few examples of where each technology has been used.

Alternating Current (AC)

High voltage is applied to a number of closely-spaced emitter points, which cycle alternately- negative and positive- at the line frequency (50/60 Hz). AC technology is used in grids, ionizing blowers, guns and bars. Due to fast cycling and resultant ion recombination, AC systems must have high levels of air flow to blow ions away from emitter points.

Steady-state DC

With this method, separate emitter points are provided for each polarity. Positive high voltage is continually applied to one half of the emitter points while negative high voltage is continuously applied to the other half. Steady-state DC is used in room systems, laminar flow hoods, ionizing blowers and ionizing blow-off guns. Steady-state DC work with low as well as high air flow providing the emitter points are spaced far enough apart to reduce ion recombination, without creating hot spots.

Pulsed DC

Positive and negative emitter points are alternately turned on and off, creating clouds of positive and negative ions. Pulsed DC can be used in non-cleanrooms, as well as cleanrooms and laminar flow hoods. It is generally not used in ionizing blowers or ionizing blow-off guns.

The advantage of this system is its flexibility and versatility, as cycle timing can be adjusted to the specific airflow conditions. For example, in areas of low airflow, a longer time may be required to overcome ion recombination and to allow the ions to reach the work area. In certain kinds of environments, a greater proportion of one polarity might be needed over the other. Pulsed DC allows either polarity to be left on as long as needed. Some systems feature adjustable off times where neither polarity is on, thus permitting more effective dispersion of ions.

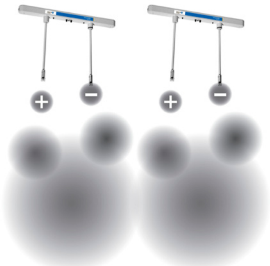
Nuclear

Designed for use in ionizing bars, guns, and blowers, nuclear ionizers usually contain polonium 210 as their radioactive source. The radioactive decay of polonium emits alpha particles that ionize the air. Nuclear ionizers are available only on a lease basis as federal regulations prohibit the outright sale of radioactive devices.

Pulsed DC Ionization

Pulsed DC systems use positive and negative emitter points that are turned on and off alternately to create clouds of positive and negative ions. Cycle timing and polarity can be adjusted to provide the required balance and level of static control needed in a specific environment.

Ceiling Emitter



Pulsed DC systems create clouds of positive and negative ions

X-ray

Designed for use inside production equipment, X-ray, or photon, ionizers use low energy X-rays to ionize the air. As the X-ray passes through the air inside a production tool it ionizes the air along a path of about one meter. No airflow is required to disperse the ions throughout the equipment ionizer. Federal regulations requiring shielding and electrical interlocks for x-ray sources with energies exceeding 5 keV. For sources below 5 keV, minimal controls are required, although common sense dictates that care is still exercised when the ionizer is in use.

Application Engineering

Dealing effectively with static charge can be a rather complex problem that requires a variety of solutions. When choosing an air ionization system there are a number of important factors to take into consideration.

Airflow

Some ionization devices require airflow to operate properly while others do not. If ionizers that require airflow are chosen, they must depend on available airflow or include fans in their design. It must be determined whether fans for distributing air ions are compatible with the work environment. Compressed gas ionizers will require a gas source (usually air or nitrogen) and filtration compatible with their use area.

Power Distribution and Control

Self-contained ionizers require 120 VAC power and provisions must be made for supplying this power to each ionizer. Larger systems distribute power from a central controller using either low or high voltage cabling. Control requirements vary with the application. Less critical situations may be satisfied with factory control settings or a single adjustment of an entire area by a central controller. In critical applications, or in areas that lack uniform conditions, the creation of small zones by fine-tuning each emitter point can provide accurate control of both ion balance and level. Feedback sensors provide monitoring and control in critical applications.

Engineering

Dealing efficiently with static charge can be a complex problem that requires a variety of solutions. When choosing an air ionization system there are a number of important issues that must be examined.

- *Airflow characteristics*
- *Power distribution*
- *Emitter point materials*
- *Installation considerations*
- *Reliability and maintenance*
- *Testing and evaluation*
- *Service and warranty*
- *System cost*

Emitter Point Materials

The conventional method used to create ions, corona discharge, can erode metallic emitter points. Although the particles lost through erosion are sub-micron in size, they may find their way onto product or equipment surfaces and cause defects. It has been discovered that emitter points made of single crystal silicon generate extremely few metallic particles, and these are unlikely to result in product defects. For the wide variety of ionizer applications it is important that a variety of emitter point materials be available, including single crystal silicon. The sensitivity of the manufacturing environment should always be considered in selecting emitter point materials. Single crystal silicon is the most appropriate emitter material for silicon wafer manufacturing. Metallic points should be avoided in this application.

Installation Considerations

The methods used for mounting and wiring the ionization device are important considerations and must be compatible with all safety codes and facility requirements. If installation will be done in an operating cleanroom, it must not interfere with ongoing production or compromise the integrity of the environment.

Reliability and Maintenance

All ionization devices require periodic maintenance. Normally, maintenance consists of a simple emitter point cleaning procedure performed every three to twelve months. The frequency of such maintenance depends on the emitter point tip material, its geometry, the operating parameters, and most importantly, the concentration of airborne molecular contaminants (AMCs) in the air. This maintenance can be performed by end users or by the manufacturer’s personnel. Long-term reliability and stability is essential for equipment that is in constant use.

Testing and Evaluation

Often an evaluation system in the actual work area is the only way to determine required performance levels and to establish specifications. It is critical to choose a manufacturer who will assist in writing meaningful specifications for a particular application.

Service and Warranty

Manufacturers must provide assistance in specifying air ionization, on-site installation of an evaluation system, performance certification upon completion of an installation, and follow-up service and maintenance if required.

Most ionization equipment in covered by a factory warranty. Always determine warranty length, what it covers, and what is required to keep it in force.

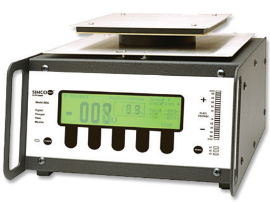
Cost

The user should compute the total cost of ownership when comparing ionization systems. The total cost of ownership includes the equipment, installation, operation, and maintenance costs. It is important to examine the cost of not installing an air ionization system. Often the cost of product loss due to static-related problems is many times greater than the actual cost of the system.

Ionization Standards

Standards

Both the ESD Association and the Institute of Environmental Sciences and Technology have drafted ionization standards that specify a methodology for comparing air ionization systems. Using a charged plate monitor (CPM), the time required to reduce a 1000V charge to 10% of its initial value can be measured accurately.



Charged Plate Monitor

Both the ESD Association (ESDA) and the Institute of Environmental Sciences and Technology (IEST) have standards for the performance of air ionization. These standards, ANSI/ESD STM3.1, ESD SP3.3, ESD SP3.4, specify a methodology for comparing different systems or the same system over time. The key instrument used is known as a charge plate monitor (CPM). The CPM has an isolated conductive plate that can be charged to a known voltage. It then measures the time required for the ionizer to reduce the charge to 10% of its initial value. Generally, measuring the discharge time is performed by charging the plate to 1000 volts and determining the time it will take for the voltage to drop to 100 volts. In normal air at 60% relative humidity, the decay rate is approximately 12 hours. An ionization system can typically accomplish the same results under a laminar hood in <15 seconds; <60 seconds in a cleanroom, and <300 seconds in an open room with minimal air conditioning. In the case of point-of-use air ionization, blowers can achieve the same results in <10 seconds and ionizing air guns may take only a second or two.

Ionization is a requirement for controlling static charge in any effective static control program. The ESDA has released the ANSI/ESD S20.20 static control program, which defines the performance of ionizers needed to protect ESD-sensitive devices. Semiconductor Equipment and Materials International (SEMI) has released two standards, SEMI E78 and SEMI E129, which specify acceptable static charge levels for semiconductor equipment and facilities, respectively. Air ionization is essential to achieving the levels recommended in these standards.

Conclusion

Clearly, the risk of damage due to static charge increases with the technological sophistication and miniaturization of products and processes. Scientific research has demonstrated that failure in electronic devices is often the direct result of electrostatic discharge. Air ionization along with "static awareness," personnel training and proper grounding techniques can achieve remarkable results in reducing loss due to ESD. In the cleanroom as well as in other critical production areas, air ionization may be the single most important factor in eliminating the ESD and contamination problems associated with static charge. From pressroom to disk drive factory to wafer fab, static control by means of air ionization can translate into cost savings, increased yields, and higher quality products. In an increasing number of high technology manufacturing facilities, successful production is impossible without air ionization.

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