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Ionizer pin cleaning maintains performance

Avoiding contaminant build-up is critical for controlling electrostatic charge

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Emitter electrodes in ionizing systems for electrostatic charge control will become contaminated with environmental residues over time and these residues will compromise performance by reducing ion density and by generating particles. This article describes why this is the case and how it can be avoided.

The production of semiconductors, flat-panel displays, disk drives, and medical devices involves a series of complex manufacturing processes, many of which require non-conductive materials and isolated conductors. These materials generate and retain large charge potentials. Electrostatic charge is one variable found throughout the process that, if left uncontrolled, affects both the yield rate and the quality of finished product. Control of electrostatic charge (static) in cleanroom manufacturing processes is therefore critical.

Ionizers add molecules to the air that have the ability to carry charge. These charged air molecules are able to neutralize electrostatic charge on both insulators and conductors.

Corona ionization

Electrically based, corona technology is the most widely used ion generation method for electrostatic charge control. Several types of commercial electrical ionizers are currently in use and all operate on the corona principle. Electrical ionizers generate ions by concentrating an electric field on a point. The three common types of corona ionizers are: AC, Steady State DC, and Pulsed DC.

Negative ions are produced in close proximity to emitter points driven by a negative power supply. Ions are generated in the plasma of the corona around the emitter. In the corona region, weakly bound electrons are driven from orbit and attach to a molecular cluster. The resulting negative molecule is repelled from the like-charged emitter.

Positive ions are produced in the area around emitter points driven by a positive power supply. The free electron is attracted back to the positive polarity emitter point. In this case, the resulting positive molecular cluster accelerates away from the like-charged electric field of the emitter electrode.

Ion current strength is a function of applied voltage, emitter geometry, and conductivity. Duration of applied voltage influences the ion current strength and the distance the ions are capable of traveling.

Ion current is affected by environmental conditions such as temperature, humidity, atmospheric pressure, and proximity to ground planes. Closely controlled environments such as minienvironments and cleanrooms eliminate much of the environmental variance concern for ionization.

A great deal of activity takes place at the emitter of an ionizer. The corona region at the tip of the emitter is a field of complex chemical reaction that results in the creation of ions, but also causes precipitation of trace elements from the environment onto the emitter. These deposits appear as a white substance at the end of the emitter electrode and are commonly referred to as white "fuzz" (see Fig. 1).

In a paper titled "Clean Corona Ionization" (Hobbs, Gross, Murray, 1990), researchers found that the overwhelming percentage of particles identified on ionizer emitter tips was ammonium nitrate (NH_4NO_3). In the same study, it was demonstrated that contamination problems could be avoided by isolating emitter electrodes in an environment of clean, dry air. The primary cause of emitter electrode contamination was found to be the result of interactions between the ionizers concentrated high voltage field and ambient humidity.

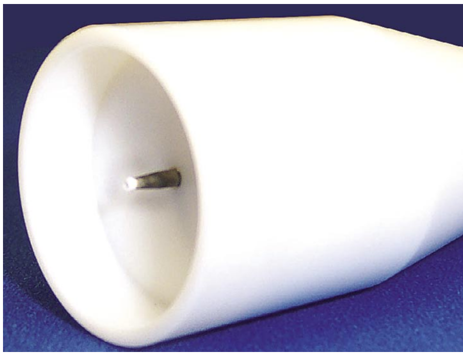

Figure 1. Deposits appear as a white substance at the end of the emitter electrode and are commonly referred to as white "fuzz."

Reduction in emitter performance

The build-up of deposits on the emitter electrode impacts ionizer performance. Deposits cause an increase in the emitter electrical resistance. Without a means of compensation, this condition will cause a reduction in ion emission and ionizer efficiency (see Table 1).

Ionizers designed with active feedback and control systems are capable of compensating for dirty emitters. And, to a point, deposition on the emitter will have no measurable performance impact. The better ionizers on the market today contain an active feedback system to control

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Table 1: Emitter performance before and after cleaning

	Before cleaning	After cleaning
Positive pin voltage	7140	6460
Negative pin voltage	7260	5960
Positive drive %	35.2	29.3
Negative drive %	30.5	28.4
Positive R effective/pin	9.4×10^9 Ohm	8.5×10^9 Ohm
Negative R effective/pin	9.8×10^9 Ohm	8.0×10^9 Ohm
Positive current/pin	0.76 µA/pin	0.76 µA/pin
Negative current/pin	0.74 µA/pin	0.74 µA/pin

Run time 300+ hours. Ionizer utilizing current-controlled closed-loop feedback.

output. A number of methods are used but the better methods function to maintain the selected output current level. As resistance increases on the pin, the measured output current drops and the ionizer power supply must increase voltage in order to maintain the selected output current level. Both the chemistry of the deposits and the increased drive level experienced by the emitter will nevertheless result in a shortened life. A dirty emitter condition causes accelerated emitter wear.

The problem escalates when the power supply is running at its highest output level and is no longer capable of maintaining the selected output current. At or near this point, a properly designed ionizer will issue a fault condition warning. This is a condition the user should avoid by properly cleaning and maintaining the emitter pins. Emitter tips should be cleaned once per quarter at a minimum. Consider more frequent cleaning if significant residues accumulate between cleanings.

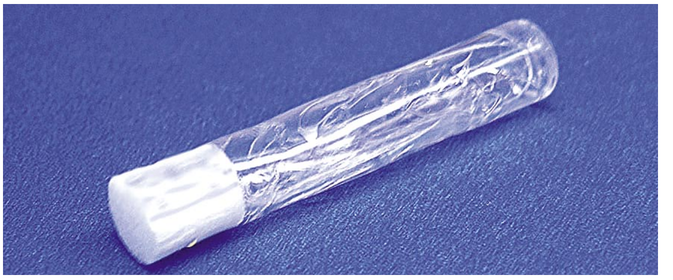

Figure 2. Emitter tips should be cleaned at regular intervals to maintain optimum system performance. One convenient method is to use a pre-wetted swab (shown here), which is shipped with a protective sleeve covering the white foam swab end. The swab incorporates an inner glass vial of alcohol inside a plastic tube.

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