Keep your ionizers in balance

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By generating large, balanced quantities of positive and negative ions in the surrounding atmosphere, ionizers can increase the conductivity of the air, thus neutralizing charging on surfaces. In cleanrooms and small work areas, ceiling or bar-type ionizers (Figure 1) often provide the only acceptable way to reduce charges on insulating materials. A typical ionization system used in a room can remove 1000 V of accumulated charge in under 1 min, as shown in Figure 2.

Figure 1. A room-type ionizer provides electronics and emitters in an assembly that mounts on a room’s ceiling. Rooms may require several ionizers to provide adequate ESD protection, depending on their volume. Courtesy of Ion Systems.

But air ionizers only work effectively when you precisely calibrate and balance them. Proper balance refers to the production of equal quantities of positive and negative ions. An unbalanced ionizer can actually act as a charge source by producing more of one ion than of the other. Although many ionization units now include monitors or feedback circuits to help balance their outputs, these devices cannot replace the need for regular recalibration.

A variety of factors, such as changes in humidity, degradation of electrodes, and power-supply drift can unbalance an ionizer. But according to Carl Newberg, of River’s Edge Technical Services (Rochester, MN), the primary culprit is poor maintenance habits. Corona-ionization systems (see “Ionization Methods”), for example, accumulate material on the tips of the instrument’s emitters. The primary cause of these deposits is the interaction of the emitter’s electric field with moisture in the air. To optimize the performance and extend the life of an ionizer, you must clean it regularly. Most ionizer manufacturers recommend you clean and recalibrate monthly or quarterly. But critical environments may require weekly tests or, in some cases, the use of a system that constantly monitors ionization levels.

How far an ionizer can wander out of balance and still perform adequately varies by application. In some cleanroom semiconductor environments, engineers may specify a threshold as high as 30 to 50 V. Disk-drive manufacturers, on the other hand, require a lower threshold. In one case, ionizer imbalance had to remain under 6 V to avoid damage caused by transient currents to an MR head sitting on a floating conductor (Ref. 1).

In its ESD STM3.1 standard, the ESD Association (Rome, NY, www.esda.org) defines the proper procedures you should use to test and evaluate ionizer performance. The procedures include measurement techniques that will determine ion balance and charge neutralization times. The procedures call for the use of a charged-plate monitor (CPM) with a capacitance of approximately 20 pF, and a fieldmeter to monitor performance (Figure 3). The CPM tracks the ionizer’s positive and negative discharge times and measures the offset voltage on a 200-mm x 200-mm plate.

The ESD Association designed the test procedures described in ESD STM3.1 for periodic verification and acceptance testing. But the cost of the needed test equipment and the time needed to conduct the test typically make the process unacceptable for simple verification tests. So, the association wrote the ESD SP3.3 procedure to answer the need for a simpler verification test. Ideally, the results of this test procedure will let you know when you should recalibrate an ionizer by using a CPM as defined in ESD STM3.1.

Figure 2. This graph compares discharge times for various materials under two conditions—humid air and air ionization. A positive-charged aluminum plate shows the greatest difference from a 3001-s discharge time in humid air to a 20-s discharge time in ionized air.

Figure 3. A charge-plate monitor can charge a standard test plate to a given potential and then measure the time to discharge the plate to a known voltage. Courtesy of Simco.

You can apply the ESD SP3.3 procedure to quickly demonstrate ionizer performance under actual working conditions. To help you correlate the results obtained using this new procedure with those obtained using a CPM, the new procedure adopted the same discharge time and offset voltage (balance) tests defined in STM3.1.

Charge your fixture

The verification test defined in ESD SP3.3 requires a test fixture that consists of an isolated conductive plate separated from ground by insulting standoff. The test also requires a voltage source that can provide at least +1200 V and 21200 V to charge the test fixture’s isolated plate, a voltage monitor, and a stopwatch or other timer to track the plate’s discharge time. (Some test-instrument manufacturers now provide a fieldmeter, a detachable plate, and a charger in a single low-cost verification system.)

To begin a test, you charge the test plate to a convenient voltage in excess of the initial test voltage (1200 to 1500 V, or 21200 to 21500 V). After you charge the plate to a desired initial test voltage, it must not discharge more than 10% of the test voltage in less than 5 min in the absence of ionization. When the test plate voltage has decayed to a predefined initial test voltage, you start the stopwatch and continue timing until the test plate voltage decays to a defined final test voltage. In a typical example, you might set the initial test voltage at 1000 V and the final test voltage at 100 V. Then you repeat the test using 21000 V as the initial test voltage and 2100 V as the final test voltage.

Next, you momentarily ground the test plate to zero charge and then wait for the offset voltage reading to stabilize. ESD SP3.3 sets a maximum wait time of 5 min. Pulsed ionization systems require peak offset voltage readings for both polarities. The procedure also defines where you should take measurements for four popular types of ionizers: room, laminar-flow hood, work-surface, and compressed-gas units. You must ensure that the test technician and the test fixture are properly grounded during the test.

During testing, note any large obstructions that would alter the airflow in the test area. These obstructions will affect test results, so to accurately compare present results with those from future verification tests, you’ll have to recreate the same sort of obstructions to duplicate test conditions. To ensure accuracy, you may decide to verify your test results by using a CPM as defined in ESD STM3.1. You might use a handheld meter to find a problem, and then later verify it by using a CPM.

Alternative approach

The STM3.1 standard offers a consistent and effective method for measuring ionizer performance, but it has some limitations. The charged plate was originally used to model the electrical properties of a 150-mm semiconductor wafer. Some people argue that the current procedure doesn’t account for the diversity of object sizes in a cleanroom environment. Periodic testing and consistent maintenance help ensure air ionizers conform to the performance specs that minimize ESD susceptibility.

By John H. Snyder

Although traditional grounding practices form the backbone of most ESD-control programs, air ionization plays an increasingly important role in reducing accumulated charge on non-conductive materials. In the semiconductor, display, and drive industries, objects such as wafer cassettes, flat panels, and magnetoresistive (MR) heads can quickly accumulate a significant electrical charge. If these items lack a way to drain that charge, they could suffer severe damage when grounded.

At the ESD Symposium in 1999, three researchers proposed a new way to overcome the limitations of STM3.1 (Ref. 2). They found that a biased plate monitor (BPM)—a biased high-voltage plate equipped with a nano-ammeter—produced measurements they could correlate to conventional CPM offset voltages and discharge times. They reported that a BPM could accommodate different size plates and could work with a remote plate. Most importantly, a BPM provides an immediate readout of discharge time. Thus, in some applications this new approach may offer some advantages over the traditional procedure outlined in ESD STM3.1.


Ionization Methods

Equipment manufacturers generally use either nuclear or electrical sources to generate the ions that reduce charges that can lead to ESD damage. Nuclear ionizers use a low-level radiation source such as polonium-210 to generate alpha particles. Those particles collide with surrounding gases in air and create pairs of positive and negative ions. Radioactive-based ionizers are inherently non-electrical, so you can apply them in explosive environments. Moreover, the alpha-emission process automatically balances the output of positive and negative ions. But because polonium-210 has a half-life of 238 days, the output of these devices diminishes by half every 238 days. Federal agencies closely regulate nuclear-based ionizers.

The most widely used electrical sources use a corona system that intensifies an electrical field on a sharp point. The intense field overcomes the dielectric strength of the surrounding air and creates ions. Electrical ionizers come in three different types: AC, DC, and pulsed-DC.

AC ionizers use a high-voltage sinusoidal AC waveform to produce both positive and negative ions at the same emitter. Because the unit acts like a bipolar emitter in which the time and “distance” between ion polarities is short, users can locate the ionizer close to a target object. An AC ionizer generally features good balance stability and consistent performance. Such ionizers typically find used in industrial environments.

Steady-state DC ionizers provide independent positive and negative power supplies that each drive a dedicated emitter. These ionizers create a very high ion current and result in minimal space charging and low offset voltage. They often find used in rooms or on tables that require high air velocity.

Pulsed-DC ionizers also provide independent positive and negative power supplies, each connected to its own emitter. However, the ionizers use a single square-wave oscillator to drive the power supplies. The slow square wave lets a user change the balance (duty cycle) and ion output. The longer the pulse duration, the longer it takes for positive and negative ions to recombine, and the further the target object can be set from the emitter. These units prove especially effective in cleanrooms and other environments that require low air velocity.

—John H. Mayer