Alpha Ionization for Neutralizing Sensitive Components in Tight Confines

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Air ionization is used to dissipate static charge on insulators and isolated conductors in semiconductor manufacturing. The ionizer is configured so that some of the ions find their way to the charged surface (the target) to neutralize charged surfaces. A variety of techniques are used to create the ions.

Alpha ionization is an alternative to corona ionization and finds many applications in the fields of high technology electronics manufacturing and testing. It has balance voltage fine for Class 0 applications and can be used in tight spaces like a handler. It requires no cleaning and works well

Corona Ionization – the most common type of ionizer used in high technology manufacturing. Ions are created at sharp pointed electrodes biased to high voltage (±5,000-20,000 V). The intense electric field at these emitter tips creates ions and expels them from the emitters. The ions are pushed by the field for ~1 mm. Beyond that, the field is too weak to push them effectively so additional propulsion is needed to move them to the target. Typically, this is provided by a fan or compressed air.

A corona ionizer is also a dust precipitator. The field from the emitter points draws contaminants in the air to the points. The accumulated material chokes off the ionization process, requiring that the emitter points to be cleaned. Most ionizers must have their positive and negative HV adjusted to balance the ionizer. The combination of cleaning and balancing is maintenance required by a corona ionizer.

Alpha Ionization – The alpha ionizer utilizes Polonium 210 (Po^{210}), a naturally occurring element in the soil, plants, vegetables, etc. The source emits 5.3 MeV alpha particles. After a few collisions within the source, the alphas emerge with an energy of up to 4.5 MeV, still quite large. The alphas move off through the air colliding with air molecules as they go. Each time they collide, they give up some of their energy by ionizing the molecules they strike. On the average, each alpha particle travels 3 cm though the air and creates hundreds of thousands of ion pairs along its path before it stops. At that point, the alpha particle picks up two electrons and becomes a helium atom, and drifts up through the atmosphere.

Figure 1. Location where ions are created by a Po^{210} source.

Figure 2 Location where ions are created by a corona ionizer

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Ion Creation Region - Because of its unique mechanism for creating ions, the alpha ionizer produces ions throughout a volume extending out ~ 3 cm from the source. This is to be contrasted with a corona ionizer which produces ions at essentially a single point. See Figures 1 and 2.

After ions are created they must be quite close to the target to be drawn in to neutralize the charge. If they are not already quite close, air flow is required to move the ions to the target so that they can become useful for static charge elimination. In the case of corona, the ionizer must be installed at a distance (typically>30 cm) from the target to avoid voltage induction on the target due to stray fields from the ionizer. Thus, a secondary propulsion method pushing ions away from a corona ionizer is necessary. Often a fan is used. In some instances compressed air is used and in other cases, the laminar flow from a HEPA is used. These choices are often not practical in semiconductor handler applications where high or low temperature must be carefully maintained. The alpha ionizer can be placed quite close to the target (typically < 3") so no secondary propulsion method is required. With no blower motors the ionizer can be employed over a broad range of temperatures.

Size issues – Blower type ionizers are available in a variety of sizes. The smallest ones (2" fan) can be made to fit into highly dense tools with difficulty. Still, without any moving parts or electronics, the alpha ionizer can be placed strategically inside of most tools used in semiconductor packaging and test. The smallest alpha ionizers are ~2.5 x 2.3 x 0.45 cm in dimension.

Balance Issues - the corona ionizer must be designed or adjusted so that the electric fields from the ionizer are minimal. This is a technical challenge since voltages as high as ±20,000 V are employed. In the case of an alpha ionizer, ions are not made by the corona method. As described above, they harness the kinetic energy of the alpha particles to create ions. In fact, the alpha ionizer must be grounded to operate correctly so the balance voltage is zero and the ionizer can be placed quite close to the target (~1-2"). No adjustment is required for an alpha ionizer.

Since the balance voltage of the alpha ionizer is zero the ionizer can be placed as close as 1 or 2 inches from the target, making the discharge speed quite rapid because the ions are actually created in the volume where the target is located. The 0 V balance of an alpha ionizer is becoming increasingly important as the technology moves to more sensitive Class 0 (<100 V HBM) components.

Maintenance Issues – As mentioned above, the corona ionizer needs to be cleaned and balanced regularly. The frequency of cleaning depends upon details of the cleanliness of the environment. A very clean work area allows the ionizer to be cleaned only 4 times a year and the dirtiest environment requires cleaning weekly. Typically, balance maintenance is required at cleaning time. The alpha ionizer loses its potency due to the natural decay process and needs to be replaced annually.

Summary - Corona ionizers are used for most of the applications in semiconductor packaging and test. In applications where temperature extremes are not required and there is adequate space to fit a blower into the process tool, blowers are used. The alpha ionizer finds its applications where there are temperature extremes, tight confines and in applications involving Class 0 highly static sensitive parts.

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