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A Feasibility Study of Ion Balance Measurement by Partial Surfaces

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Abstract

This paper reports a feasibility study of the ion balance measurement by the partial surfaces. The partial surfaces were exposed under the dc corona ionizer which could be varied ion balance. The appearance of electrostatic potential, which is caused by the imbalance of positive and negative ions, was measured by the high impedance electrostatic voltmeter. The result from these partial surfaces was compared with the standard test method which is using the 6″×6″ charged plate. The average voltages of all segments of the partial surfaces are correlated to the electrostatic potential values which were measured by the standard 6″×6″ charged plate. Moreover, the partial surfaces offer the fine-grained level of results. It validates that the precision of the ion balance measurement can be improved by the partial surfaces.

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Keywords: Ion balance, partial surfaces, ion balance analysis, ionizer measurement.

1. Introduction

Since 1970s, the electrostatic discharge (ESD) had been a problem in electronic industry [1]. The ESD events were damaging devices, harming the systems. Moreover, an electrostatic charges can be inducing the product contamination on the charged surfaces due to electrostatic forces. The ground connecting is a general method for making an

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equipotential surface to prevent the ESD event. However, this method is less effective to remove the static charges on the insulator. The ionization is widely used to remove the static charges from insulator surfaces. This method provides the opposite polarity ions to neutralize the electrostatic charges on the object surfaces.

The standard test method (STM) to measure the ionizer is based on ANSI/ESD STM3.1-2006 [2] and IEC 61340-4-7 [3]. The STM requires the ion balance and decay time measurement based on the standard charged plate monitor (CPM). This measurement is insufficient resolution because the charged plate is much larger than a miniaturized device such as an integrated circuit or a magneto resistive head [6]. Some of these devices are requiring the ion balance within +/-1V or even tighter to prevent the ESD damage. The sub-1V ion balance controlled area requires the sufficient resolution to identify the ionizer balance [4]. The miniaturized ion balance analyzer using the 1″×1″ plate was launched to serve that requirement. However, this analyzer does not characterize the full surface area that is measured by the standard CPM and analyzed results are reported as single points at a time. Then the partial surfaces have been studied [6]. The electrostatic finite element analysis (FEA) of the 4-segment, 9-segment 16-segment partial surfaces and the standard CPM were analyzed. The single level of electrostatic potential was observed on the standard CPM model. On the other hand, the multi-levels are observed on the partial surface models. It concluded that the ion balance measurement resolution could be enhanced by this technique.

This paper aims to study the feasibility of the resolution enhancement by the partial surface technique which is described on [6]. The 25-segment partial surfaces have been assembled over the square 6″×6″ area with the insulative base. It is put below the dc corona ionizer which is used as the adjustable ion source. The apparent voltage on each plate is measured by the high impedance electrostatic voltmeter. The experimental results can prove the feasibility of the partial surfaces ion balance analyzer.

2. Ionizer Measurement

The electrostatic charges on the surface of insulators or isolated conductors can be neutralized by the opposite air ions. Ionizer is designed to supply the positive and or negative air ions to the object to be neutralized. The typically is the corona ionizer. The ions are generated by the collision between the neutral molecules and electrons when they are accelerated by an electric field which exceeds the inception level. The inception voltage calculation is described on Ohsawa's model [5].

In order to characterize the ionizer, a CPM is used to measure the ionizer's performance [2], [3]. The standard CPM need the 6″×6″ floated conductive plate to collect the ions in ionized air which is supplied from the ionizer. The ion balance is defined from the accumulation of positive and negative ions on that plate. It can be monitored by the electrostatic voltmeter. When the plate capacitance is fixed in the range of 20 pF, the appeared voltage can be defined by the ratio of the charge on that plate and its capacitance as

$$V = \frac{Q}{C}, \tag{1}$$

where V is the voltage on the plate with respect to ground, Q is the charge on the plate in coulombs, and C is the plate capacitance with respect to ground.

However, these accumulated charges could be rapidly discharged through the voltmeter then resulting in zero volt. To maintain the existed charges on that conductive plate, the measuring of the electric field from the plate using a non-contacting electrostatic voltmeter are preferred to prevent the charge drainage from that plate.

Nowadays, the electronics manufacturers are producing a miniaturized devices which is quite smaller than the standard CPM. It is concerning the insufficient resolution and accuracy to measure ionizer balance because the standard CPM is larger than the handled devices as the describing on [4]. Then the modeling [6] had validated that the resolution of ion balance measurement can be enhanced by partial surfaces method which divides the standard plate in to 4, 9 and 16 segments. The highest segments plate provides the best resolution. However, that feasibility has been analyzed by using the computer simulation. It requires actual measurement evaluation to validate the feasibility before build the prototype of partial surfaces ion balance analyzer.