Fundamentals of Electrostatic Discharge Part II: Creating Static Charge

Defined as “electric charge at rest”, static electricity is the result of imbalanced electrical charges on a material surface which produce an electric field. Electrostatic discharge, or ESD, is the rapid, spontaneous transfer of electrostatic charge induced by a high electrostatic field. ESD can negatively impact the electrical properties of a component or device, and may cause damage to equipment operation, malfunction and even failure.

Effective control of ESD requires a basic understanding of how electrostatic charge is generated by the contact and separation of two materials. These may be similar or dissimilar, although dissimilar materials usually generate more static charge. This is referred to as “triboelectric charging” and it occurs when the two materials are placed in contact and separated, resulting in the transfer of negatively charged electrons. Gain and loss of electrons is dependent on the materials.

Triboelectric charging is a complex process dependent on the affected area of contact, speed of separation, and other factors including relative humidity and material chemistry. If the resulting charge remains on the material, it is electrostatic charge. If it is transferred from the material, the charge then creates an ESD event. While often created through other processes, triboelectric charging is the most common cause of electrostatic charge.

How Material Characteristics Affect Static Charge

Triboelectric Series

The material’s position in a triboelectric series is representative of the polarity and magnitude of the charge caused by contact and separation. Triboelectric series tables illustrate how charges are generated on various materials, with those nearer to the top taking a positive charge and those nearer to the bottom a negative charge. Generally the farther apart two materials are on the triboelectric series, the greater the charge created.

Insulative Materials

Characterized by an extremely high electrical resistance, an insulator restricts or prevents flow of electrons across its surface or through its substance. Considerable negative and positive charges can be generated on an insulator surface, but the electrons cannot move freely across the surface.

Conductive Materials

Contrary to insulative materials, a conductive material is characterized by low electrical resistance which allows electrons to flow freely across its surface or through its substance. Any charge is distributed equally across the surface and is easily shared with another material. However, if the second conductive material is grounded, the electrons will flow to ground and excess charge will be neutralized.

Static Dissipative Materials

The electrical resistance of a static dissipative material falls between insulative and conductive materials, and while electrons may flow across the surface or through its substance, this flow is controlled by the material's surface or volume resistance. While static dissipative materials can be triboelectrically charged, like conductive materials they will allow the transfer of charge to ground or to a conductive material. The time it takes for the charge to transfer falls between the time it takes a charge to transfer from conductive and insulative materials.

Electrostatic Fields

Both electrostatic fields and lines of force are also associated with charged materials. If a conductive material enters the field, it will be polarized through induction. Negative electric fields will cause the surface to repel electrons, while a positive electric field will attract electrons to the surface. Insulative materials are not affected by induction.

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