WHITEPAPER

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How Anti-Static Flooring Protects Against Damaging Electro-Static Discharges

The electronics industry inherently relies on state-of-the-art technology, which while being innovative and very useful is also typically sensitive and delicate.

One common factor that electrical equipment needs to be protected from is static electricity discharges, which can easily impair or destroy fragile circuitry. This is illustrated by the fact that many components can be destroyed by a discharge of around 300 volts, however just one person walking across a floor can generate up to 3,000 volts!

Impact on the Electronics Industry

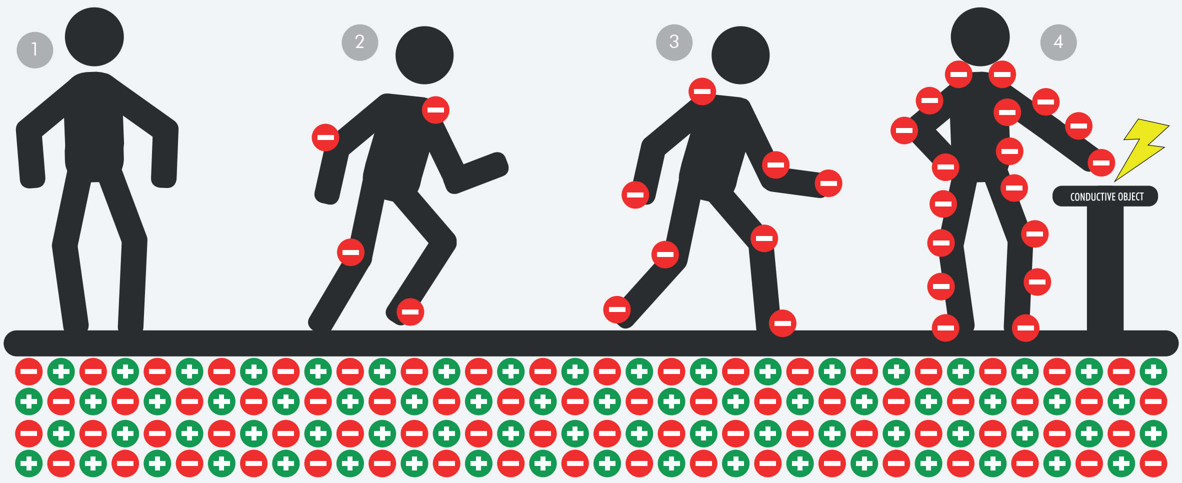
This challenge means that the electronics industry loses significant sums of money every year in damaged goods and broken equipment. To safeguard against this, it is important for facilities operating in this market sector to install anti-static flooring solutions as part of the overall ESD Management Scheme.

Making sure that a floor finish will meet a site's anti-static needs requires an understanding of the location's operational activity, how the floor build up works to remove this threat as well as the role that other factors such as testing and personnel clothing play.

How is a Static Charge Generated?

Electrical energy is generated by movement and if an object is insulated from earth the electrical charge builds up, this is known as a static charge because it does not flow to earth. The exact process through which a person builds up electricity is called triboelectric charging. This occurs because when someone moves across a floor they build up a negative charge, which increases the more the person moves around.

If the charge is large enough, then when a charged object nears an earthed object the charge will jump through the air to go to earth. This results in a spark and if a person is the charged object they receive a mild static shock, however if it is a piece of equipment that the charge has gone through then it could just have been irrevocably damaged.



1. Person is at rest and not currently carrying a charge. The charge is equalized between the person and floor.

2. With each step taken the separation of floor and footwear cause negative charges creating an electrical imbalance.

3. The charge is maintained on person or will increase as the person continues to walk on the non-esd grounded floor.

4. If the person comes in close proximity of a conductor or grounded object a Human Body Model event may occur.

This scenario has obvious implications for the electronics industry, although there are a wide variety of locations where sensitive electrical equipment needs to be protected. To name just a few, the healthcare world utilises a large number of high-tech, life-saving equipment, the aviation industry has to ensure that its machinery runs flawlessly in order to keep planes in the air and anywhere with a facility such as a data warehouse or clean room.

In environments where flammable gases, solvents or dust are present then this charge can even be a dangerous ignition source! This eventuality is more common in the munitions and military industries, however it can be a concern in any R&D, production space or healthcare environment where flammable elements are present.

Understanding Electrical Resistance

The rate at which an electrical charge is dispersed is controlled by the material's electrical resistance and is measured in ohms (Ω). The amount of electrical resistance relates directly to the material's conductivity and ability to move charges out of the area. Essentially, the less resistance there is the faster the charge can be removed.

Static Resistance Levels	
Insulating	$>$100,000,000 Ω (10^9)
Static Dissipative	1,000,000-1,000,000,000 Ω ($1 \times 10^6 – 10^9$)
Static Conductive	25,000-1,000,000 Ω ($2.5 \times 10^4 – 10^6$)
Conductive	$<$50,000 Ω (5×10^4)

For anti-static purposes, floors are ordered into different categories depending on how quickly electricity can move through them. Materials with the least resistance are defined as conductive, moving to dissipative floors that allow electricity to flow through at a controlled speed and floors at the most resistant end of the spectrum are called insulative.

A good way to think about this is to picture an electrical cable, with a highly conductive metal in the middle which the electricity can move through at a rapid pace, compared to the plastic wiring on the outside which is insulating and through which the electricity cannot move.

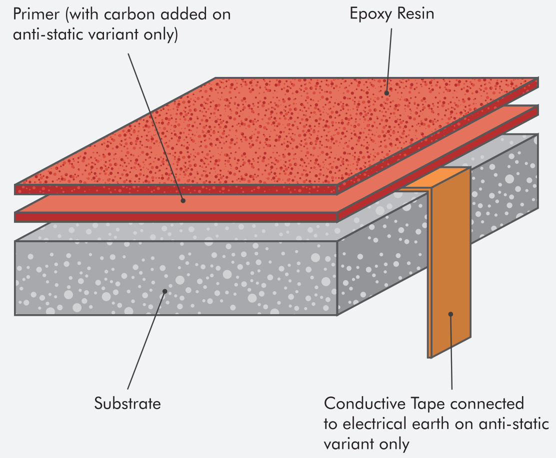
How Anti-Static Floors Work

Without an anti-static floor (i.e. if the finish is made from an insulating material), then the charge is retained in the person instead of passing to earth.

Anti-static floors instead ground the personnel moving around the site to ensure that damaging levels of static charge cannot build up. This is achieved by creating a flooring build-up designed to take the charge from a person and move it away safely to a defined earthing point. In practise, there are a number of ways that this can be done, so in this section we will focus on one of the most popular and effective methods.

The process starts with a resin coating that incorporates specialist conductive materials within the floor. These materials take the charge from people walking across the floor's surface when their feet come into contact with them and this starts a chain reaction that results in the charge being removed from the area.

Next the charge hits a conductive primer that has been filled with carbon to ensure a very low level of resistance. Finally, the charge then hits a copper tape buried under the floor coating which is connected to a safe earthing point. (This type of build-up is illustrated in the following diagram).



It's important to bear in mind that this is an ideal scenario and in practise there may be more or less steps. For example, it is possible to create a floor that removes static charge without using copper tape, however it won't be as conductive as a floor that does.

Copper Grids

Copper grids under the primer are an important part of the process, as installing this tape helps to make the flooring system much more conductive.

To recognise the role that the tape plays, it is important to understand its impact on surface resistance. Resistance to earth is measured from a fixed earth point on the floor. The distance from the point of measurement to the earth point has to be specified, if it is not then it should be assumed that it could be at any point on the floor.

This has a major impact on the need for a copper grid, since for materials that are not conductors then the measured resistance will increase when the distance between the measuring points is increased. Thus, the surface resistance will not change across a floor because the electrodes are a fixed distance apart, so the resistance to earth will increase as the electrode is moved further from the earth point.

To combat this, a conductive copper grid increases the size of the earth point and ensures that all parts of the floor are close to the earth point.

In order to work the grid needs to be continuous and all the grid bays have to be connected and/or earthed somehow. In practise this can raise some issues during the flooring project. One potential complexity is that expansion joints might break the flow of the tape. To avoid this, the tape needs to be put down into the joint's walls and run up the other side to ensure that it is not broken. Alternatively, multiple earthing points should be connected to ensure each bay is fully connected to earth.

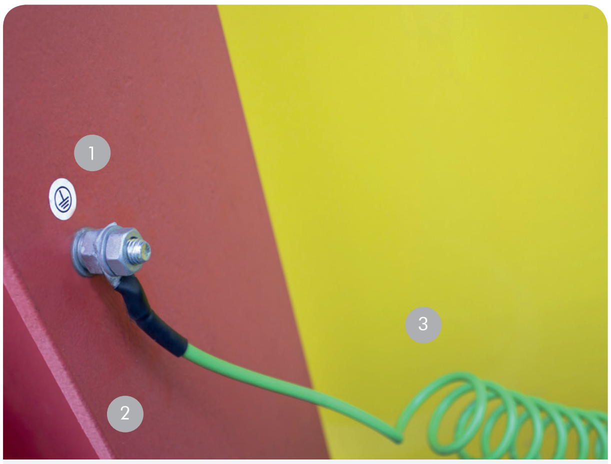
Usually the copper is applied in 3 m^2 grids, as this ratio helps to make sure that everyone moving across the floor is close enough to a line of tape. Any places that don't have copper tape nearby run the risk of being much less conductive than other parts of the floor area. However, it might not always be practical to install these grids due to the size or shape of the room.

In these instances, it can be useful to install the copper in a "crows' feet" formation, in which the tape spreads out from an earthing point in a number of straight, equally spaced out lines.

Earthing Requirements

An earthing point is simply an electrical connection that allows any charge transferred to the floor to escape to earth safely. Without an earth then the floor cannot be considered anti-static, as any charge that goes into it will just build up in the floor.

In practise an earthing point is usually a highly conductive metal rod driven deep into the building's slab to create a reliable grounding point. Other earthing options could include using the building's steel beams or even using a plug socket.



1. The earthing point should be designated with an international standard symbol as defined in IEC 60417. This specific mark shows that this is a "protective earth (ground)" type point.

2. The girder is the earthing point connected to the floor and driven deep into the ground. A girder is a highly effective way to remove electricity from the area.

3. This earthing point has been fitted with a cable which can be attached to metal canisters. This is beneficial when opening canisters likely to hold flammable gases.

Typically, one earthing point per 200 m^2 should be sufficient, but the exact requirements should be specified by an electrical engineer to ensure that the resistance or resistance to earth measurements are appropriate for the task at hand.

Recommended No. of Earthing Points	
2 points	400 m^2 floor area
3 points	600 m^2 floor area
4 points	800 m^2 floor area
5 points	1000 m^2 floor area

The Difference Between Conductive and Dissipative Floors

The term "anti-static flooring" is often used as a generalisation for both electro-static dissipative (ESD) and electro-static conductive (ESC) floors. As mentioned earlier, the proper definition depends on the conductivity of the floor, with conductive being any floor that has a resistance less than 1.0×10^6 ohms (1 million ohms) and dissipative being any floor that has a resistance between 1.0×10^6 and 1.0×10^9 ohms.

This is illustrated by the fact that there are many resin flooring coatings that could be either conductive or dissipative depending on how it is applied.

In very simple terms the greater the danger from a spark or electrical discharge (shock) the more conductive the floor should be.

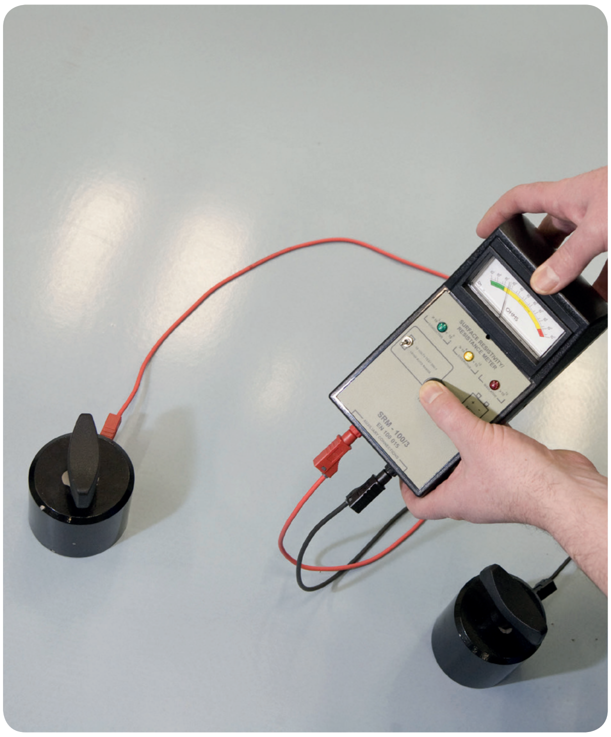
This categorisation into static conductive and static dissipative is particularly applicable for electronics areas where there is a risk of mains shock from hand tools.

Test Methods

There are a large number of options available to measure electrical resistance and they can give different results for the same material, therefore it is important to know the details of the test method. The main difference is the type of test i.e. surface resistance or resistance to earth.

The standard BS EN 61340-5-1 includes a method for determining the resistance of a floor that has become a popular choice in many countries. The standard details point-to-point conductivity testing using a meter to gauge the amount of resistance between two fixed points on the floor. The result of this test will determine whether the floor can be categorised as conductive, dissipative or insulative.

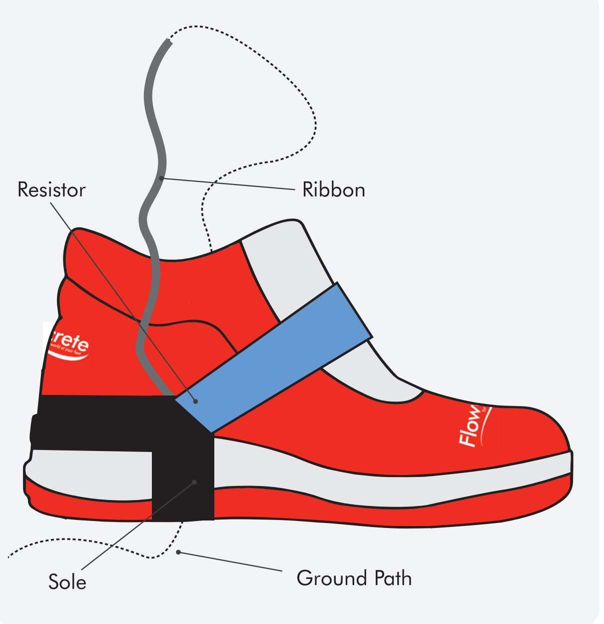
When testing the floor it is best to move the contact points around to ensure that a footprint sized space has been checked, as this is the contact size that needs to be covered to ensure that any charge held by a person is transferred into the floor.



In addition, it is best to check after each stage of the flooring project. This is because there might be failures underneath the floor coating, which won't be discovered if the test only takes place at the end. Ideally tests should take place after each stage, especially after the copper grid has been applied and then again after the primer has been laid down.

Clothing

It is important for those on site to be wearing appropriate clothing to maximise the likelihood of any charge built up within a person being safely grounded.



In some facilities, staff wear wrist straps directly connected to grounding points in order to remove charges as quickly as possible. However, while effective this is not always a practical approach, as these straps are very restrictive for the person wearing it.

To get the most out of an anti-static floor finish, anyone walking across its surface should be wearing special electro-static dissipative shoes. Without these shoes the static charge cannot be reliably grounded (as seen in the diagram opposite).

This guide has been produced to provide an overview of when anti-static flooring is required and how it works.

Further recommendations and advice on this topic are available from Flowcrete's network of regional technical and sales representatives.

For more information on Flowcrete's specialist flooring solutions, get in touch with the team today…

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