



Conductive, Static Dissipative and Antistatic Foams

When packaging sensitive items such as electronic equipment or parts, it is often necessary to take into consideration the possibility that the electrical or Triboelectrical (Charge Generating) properties of the packaging material can interact or affect the equipment being stored.

Static Electricity is a transfer of electrons that occur due to the sliding, rubbing, or separating of a material, which is a prime generator of electrostatic voltages -- e.g.: plastics, fiber glass, rubber, textiles, etc. Under the right conditions, this induced charge can build up to 30,000 or 40,000 volts. When this happens to an insulating material, such as a plastic, the built-up charge tends to remain in the localized area of contact. This electrostatic discharge (ESD) will initiate an arc or spark when the plastic material comes into contact with a body with a sufficiently different potential, such as a person or a microcircuit. Some micro-electronic parts can be destroyed or damaged by an ESD as low as 20 volts. Since people are prime causes of ESD, they often cause damage to sensitive electronic parts, especially during manufacturing and assembly. The consequences of discharge through an electrical component sensitive to ESD can range from erroneous readings to permanent damage resulting in excessive equipment downtime and costly repair or total part replacement.

Surface and Volume resistivity

For thermoplastic materials intended to dissipate electrostatic charges, surface resistivity is the most common measurement of a material's ability to do so.

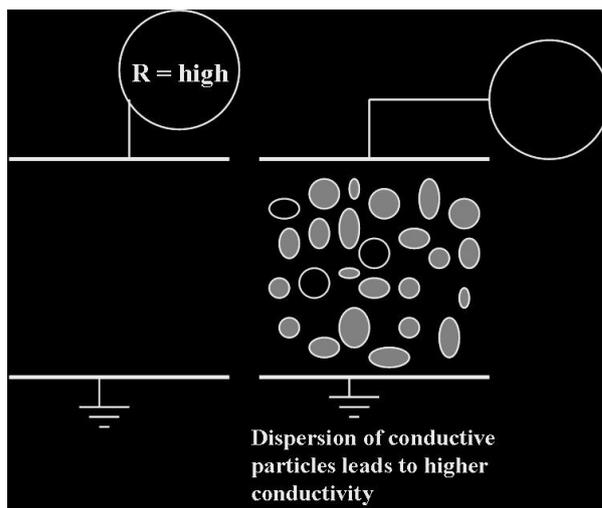
A widely accepted surface resistivity test method is ASTM D257. It consists of measuring the resistance (via an ohm meter) between two electrodes applied under load to the surface being tested. Electrodes are used rather than point probes because of the heterogeneous makeup of compounded thermoplastics. Simply touching the surface with a point contact may not give readings consistent with the overall part (readings of this type are often insulative even when the part is actually conductive).

It is also important to maintain good contact between the sample and electrodes, which can require considerable pressure. The resistance reading is then converted to

resistivity to account for the dimensions of the electrodes which can vary depending on the size and shape of the test samples. Surface resistivity is equal to resistance times the perimeter of the electrodes divided by the gap distance, yielding ohms/square.

Volume resistivity is useful for evaluating the relative dispersion of a conductive additive throughout the polymer matrix. It can roughly be related to EMI/RFI shielding effectiveness in certain conductive fillers.

Volume resistivity is tested in a similar fashion to surface resistivity, however electrodes are placed on opposite faces of a test sample. ASTM D257 also refers to volume resistivity, and a conversion factor again based on electrode dimensions and part thickness is used to obtain the resistivity value from a resistance reading. [Volume resistivity is equal to resistance times the surface area (cm²) divided by the thickness of the part (cm) yielding ohm-cm.]



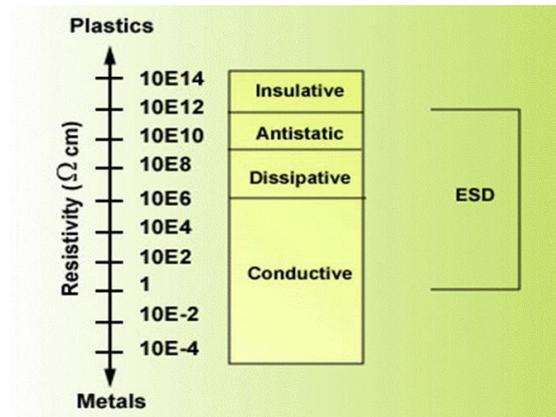
Volume resistivity measured through the thickness of the sample. When a material has a high concentration of conductive particles, resistivity goes down (i.e. conductivity goes up).

ESD packaging categories

According to the Standard ANSI/ESD S541-2003 there are different categories for packaging ESD sensitive items. They are:

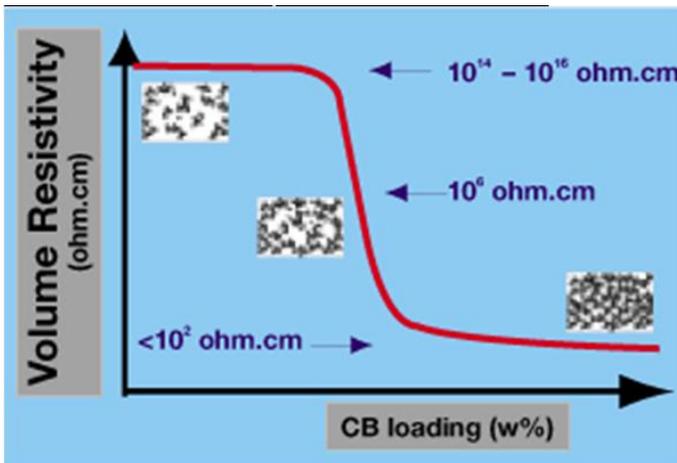
- **Shielding:**
 - Electrostatic Discharge
 - Electric-field
- **Resistance:**
 - Conductive
 - Dissipative
 - Insulative
- **Low Charging (antistatic)**

Depending upon what the product is, will decide what form of packaging is necessary.



Conductive and Static Dissipative foams

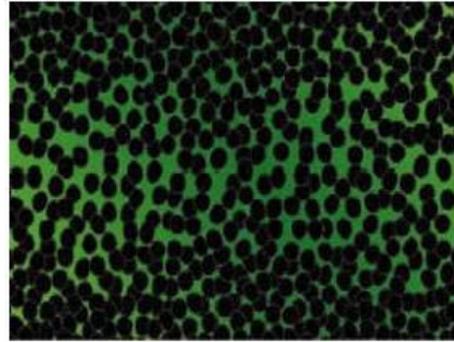
These foams contain conductive carbon black and have permanent conductive properties.



The volume resistivity of a polymer is 10^{14} to 10^{16} ohm.cm. A virgin polymer is therefore a good insulator. The volume resistivity of dry carbon black is 10^{-2} to 10^{-3} ohm.cm. Dry carbon black is therefore a good conductor. When carbon black is compounded into plastics the conductivity is imparted by the carbon black. The level of conductivity obtained is a function of the carbon black loading (the relationship is not however linear).

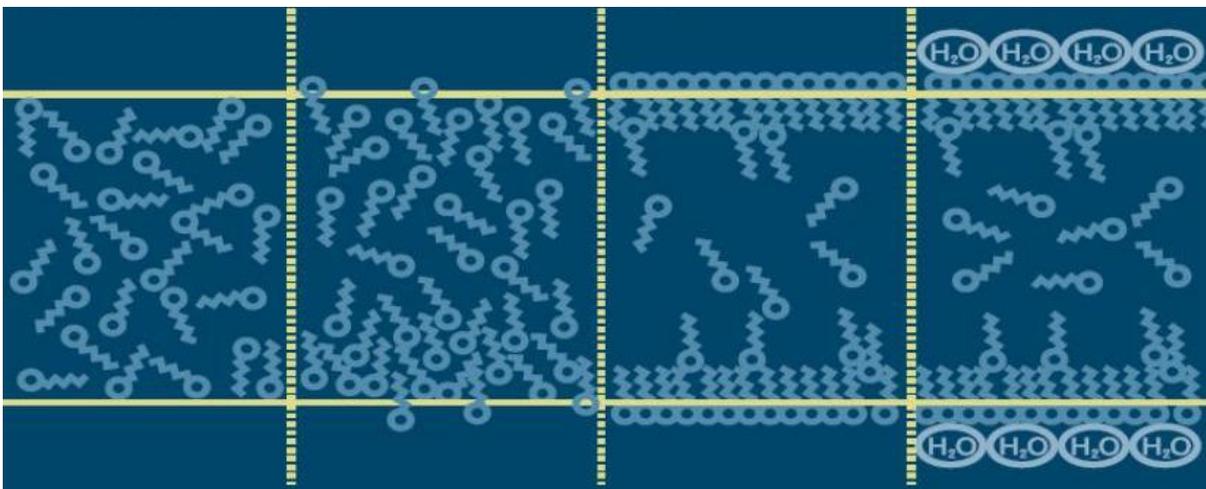
The graph shows resistivity as a function of carbon black loading and is called a **percolation curve**. At low loadings, the carbon black particles are not close enough to each other to form a path for the passage of electrical charge. At a certain loading, called the **percolation threshold**, the system passes rapidly from insulative to fully conductive as the particles are now sufficiently numerous to form a network to lead the current. At higher loadings, conductivity will improve further but not dramatically.

As seen in the picture on the right, the percolation threshold has been reached and the carbon black particles allow the passage of charge through the polymer matrix.



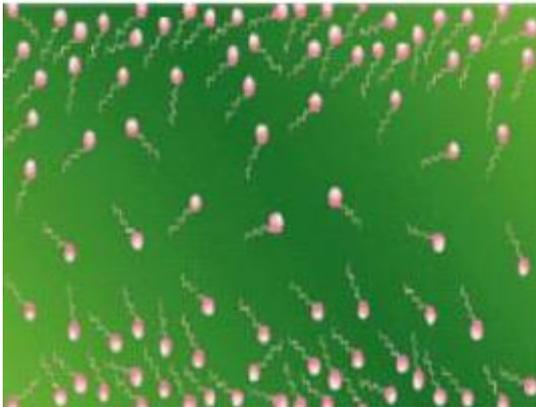
Anti-static foams

Anti-Static materials work in a different way to those containing conductive carbon black.



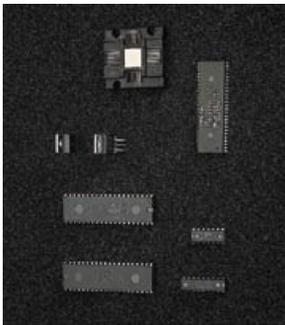
During the extrusion or compounding phase, the Antistatic additive material (often Glycerol Monostearate- GMS) is homogeneously mixed into the polymer. After processing, the GMS slowly migrates to the edges of the sheet and the molecules start to line up on the surface. The protruding hydrophilic end of the GMS molecule absorbs moisture from the ambient air and builds up a conductive path on the polymer's surface. This surface conductivity is not a permanent feature as it also depends both on the initial quantity (or loading) of the antistatic agent and on its rate of migration towards the polymer's surface. Relative humidity will

dramatically affect the antistatic properties as well. The whole effect will eventually diminish and the surface resistivity will increase until it can no longer be considered to be antistatic.



On the left, molecules of GMS can be seen migrating to the surface of a film.

Products



Conductive foam for Chip storage and transport

Anti-static foam examples



As can be seen, Palziv has answers to virtually all of the questions posed by difficult packaging applications: be it Regular, Fire Retardant, Conductive or Anti-static XLPE foam.

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